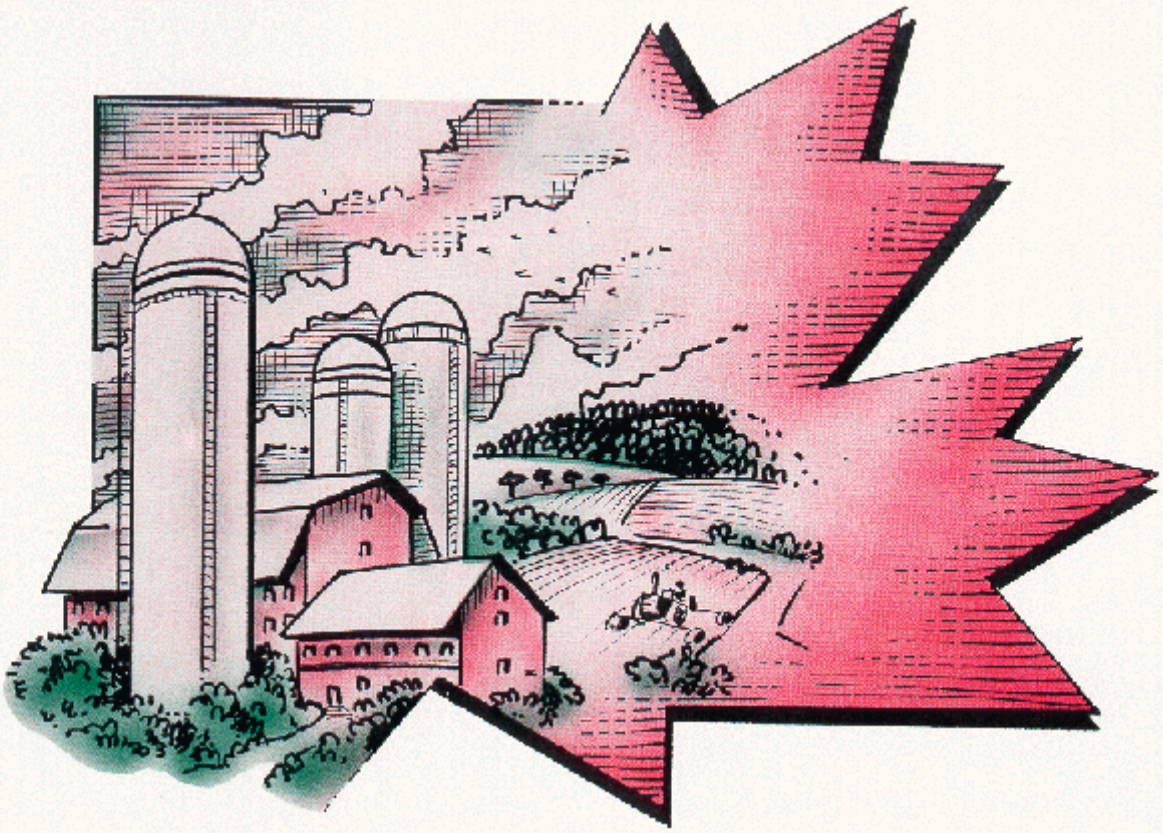

AGRICULTURE MODULE | **MODULE – AGRICULTURE**

BASIC KNOWLEDGE REQUIREMENTS FOR PESTICIDE EDUCATION IN CANADA

CONNAISSANCES FONDAMENTALES REQUISES POUR LA FORMATION SUR LES PESTICIDES AU CANADA

CAPCO

Health Canada Santé Canada

AGRICULTURE MODULE

BASIC KNOWLEDGE REQUIREMENTS

FOR

PESTICIDE EDUCATION IN CANADA

AUSSI DISPONIBLE EN FRANÇAIS

Prepared by the National Task Force on Pesticide Education, Training and Certification

If you would like additional information on the Standard for Pesticide Education, Training and Certification or to be on our mailing list, please write to:

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BASIC KNOWLEDGE REQUIREMENTS
FOR PESTICIDE EDUCATION IN CANADA
AGRICULTURE MODULE

The Agriculture category includes the use of pesticides by ground application (excluding the use of restricted fumigants which are gases at room temperature) for the production of agricultural crops and livestock, including but not limited to grains, forages, pastures, rangelands, seed crops, tree fruits, berries, grapes, field vegetables, shelter belts, ornamentals and tree seedlings. This category also includes control of noxious weeds, bird and rodent control, aquatic weed control in dugouts with no outflow, Christmas tree plantations, control of livestock and poultry pests, on-farm seed treating, soil fumigation and pest control around farm buildings associated with crop and livestock production. This category does not include use of pesticides in greenhouses or commercial seed treating.

The knowledge requirements described in this module are additional to the knowledge requirements detailed in the Applicator Core, common to all certification categories. This module adds details to sections of the Core, where it is necessary to include agriculture specific information. An outline of the knowledge requirement for the agriculture module is presented on the following page. This outline shows which sections of the Core have been expanded in this module.

The knowledge requirements provided here is the information a trainer would use to provide training to an applicator on the responsible use of pesticides. It is targeted to the trainer for teaching purposes and is not intended as an applicator manual.

In addition to the applicator core, modules have been developed for the following categories:

Aerial
Agriculture
Aquatic Vegetation
Forestry
Fumigation
Greenhouse
Industrial Vegetation
Landscape
Mosquito and Biting Flies
Structural

AGRICULTURE MODULE

CONTENTS

Category: AGRICULTURE

Concept: REGULATIONS

General Objective: To understand the pesticide regulations in Canada.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pesticide Residue Testing		
A comprehensive program of random residue testing by Health Canada is done to ensure that pesticide residues do not exceed maximum residue limits (MRL). If residues exceed the MRL, the crop could be seized or ordered destroyed and legal action could be taken against the applicator.	**Know what can happen if the maximum residue limits are exceeded.**	**Describe what can happen if the maximum residue limits are exceeded.**
Pesticide Residues Compensation Act		
Under the Pesticide Residues Compensation Act, a producer can be compensated for losses incurred when the sale of food products is stopped because the maximum residue limit was exceeded. It must be proven that the residues exist through no fault of the producer and that all label directions were followed.	**Know the limitations for receiving compensations under the Pesticides Residues Compensation Act.**	**Identify the limitations for receiving compensation from the Pesticides Residues Compensation Act.**
Label Terminology		
A pre-harvest interval (PHI) is the time between the last application of the pesticide and harvest. Harvesting the crop before the pre-harvest interval can result in excessive residues on the crop. Harvest refers to the cutting of the crop or removal of the produce from the plant by machine or animal. **Pre-harvest intervals are being established for grazing and cutting for hay of immature crops treated with pesticides. If the PHI has not passed grazing animals could ingest pesticide residues and possibly be poisoned or produce contaminated milk or meat.** **A pre-slaughter interval is the time period that must pass after a pesticide is applied to an animal before that animal can be slaughtered.**	**Understand the terms, pre-harvest interval and pre-slaughter interval.**	**Define pre-harvest interval and pre-slaughter interval.**

Category: AGRICULTURE

Concept: HUMAN HEALTH - MEASURING ACUTE TOXICITY

General Objective: To understand acute and chronic toxicity; routes of exposure; factors affecting exposure; reducing exposure; and, risk.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Acute Toxicity Assessment		
There is a perception that insecticides are more dangerous than herbicides. However, the toxicity of each pesticide is reflected in the LD_{50} number of the specific product. Potential hazard of an acute poisoning should be based on product specific information, such as the LD_{50} number, and not solely on the pesticide's target group.	**Understand why the acute toxicity assessment should not be based solely on the target group.**	**Describe why the acute toxicity assessment should not be based solely on the target group.**
Cholinesterase Testing		
Organophosphate or carbamate pesticides, which may be used in pest management programs, inhibit cholinesterase. Cholinesterase is an enzyme in the blood that affects the nervous system and the way the brain sends messages to different parts of the body.	**Know why cholinesterase testing is done.**	**Describe why cholinesterase testing is done.**
Cholinesterase levels can vary widely between individuals, and therefore it is important to know an individual's baseline level of cholinesterase before handling these pesticides.		**Identify when an applicator should have a cholinesterase test.**
Applicators who handle these pesticides on a regular basis should have:		
1) A baseline test to determine cholinesterase enzyme levels before exposure;		
2) A regular blood test to check cholinesterase levels during the exposure period.		

Category: AGRICULTURE

Concept: PESTICIDE SAFETY - APPLICATION RECORDS

General Objective: To know how to keep useful records of pesticide applications.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Crop Rotations		
Application records should be kept. They are useful in making decisions on appropriate rotational crops. Some crops may be damaged by pesticide residues remaining in the soil.	**Know how application records can be useful.**	**Describe how application records can be useful.**

Category: AGRICULTURE

Concept: PESTICIDE SAFETY - PROTECTIVE CLOTHING AND EQUIPMENT - SOIL FUMIGATION

General Objective: To know to select, correctly wear and maintain suitable clothing and equipment for the handling of pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Definition of a Fumigant		
A fumigant is a chemical which at a specific temperature and pressure, can exist in the gaseous state in sufficient quantities to be lethal to a pest organism. As such, a fumigant is primarily effective in the gaseous state.	**Know the term fumigant.**	**Define fumigant.**
Respiratory Protection		
Respiratory protection is absolutely essential during a fumigation procedure. All fumigants require a minimum of full face protection. Respiratory equipment must fit properly and must be equipped with canisters which are certified to provide protection for the fumigant being used. Canisters have a number of limitations such as maximum gas concentrations for effectiveness, exposure life, gas specific removal and shelf life limitations.	**Understand that respiratory protection is essential for fumigation activities.**	**Describe the respiratory equipment requirements for fumigation.**
Skin Protection		
Attention should be taken to ensure that fumigant formulations do not come in contact with the skin. Always check the product label to determine what specific protective clothing requirements are identified.	**Know that the label may state specific protective clothing requirements.**	**Identify that the label may state specific protective clothing requirements.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weeds		
A weed is a plant growing where it is not wanted. **Weeds are pests when they:** **- compete with cultivated plants for light, water or nutrients;** **- reduce crop yield or quality;** **- harm people or livestock;** **- are alternate hosts for other pests.**	**Know what a weed is.**	**Define what a weed is.**
Types of Weeds		
Weeds can be classified according to how long they live. **Annual weeds complete their life cycle within one year. Most annuals produce many seeds to ensure their survival. Annuals can be divided into two groups: summer annuals which germinate in the spring, and winter annuals which germinate in the fall.** **Biennial weeds live more than one year but less than two years. They grow from seed which usually germinates in the spring. During the first year of most biennial weeds, the foliage is only a rosette of leaves and food is stored in short fleshy roots. Next season, the plant uses the stored food to grow vigorously and produces seed before dying.**	**Know the weed classification according to how long the weed lives and know the difference between annual, biennial and perennial weeds.**	**Describe how weeds are classified according to how long they live. Describe the difference between annual, biennial and perennial weeds.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Perennial weeds are plants that live more than two years. Seed is the primary method by which most perennial weeds reproduce, although many also spread (and some exclusively) by vegetative means.		
Weed Identification		
The following physical structures will aid in the identification of plants: **- leaves, e.g.,** **compound or simple** **shape** **margins** **surface (smooth or hairy)** **arrangement along the stem** **(opposite, alternate, whorled)** **- stems, e.g.,** **branching habit** **woody or herbaceous** **upright or spreading** **- flowers, e.g.,** **arrangement** **number of petals, sepals** **reproductive parts** **seeds** **- roots, e.g.,** **fibrous, creeping, or tap**	**Know the plant parts that aid in the identification of weeds and desirable vegetation.**	**List the plant parts that aid in the identification of weeds and desirable vegetation.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Identifying Leaf Stages		
Many herbicide labels refer to a specific weed and/or crop leaf stage for application. Application at leaf stages other than those indicated may result in reduced weed control and/or crop damage.	**Understand why it is important to know how to identify leaf stages of desirable plants and weeds.**	**Identify why it is important to know how to identify leaf stages of desirable plants and weeds.**
Monitor the crop regularly to determine weed sizes and leaf numbers since they change rapidly.		
Leaf Stages of Broadleaf Plants		
Cotyledons are the seed leaves that usually form first. They are usually a different shape than the true leaves and may dry up and disappear or stay beneath the soil surface.	**Know how to distinguish between cotyledons and true leaves.**	**Describe cotyledons and true leaves.**
True leaves are the next leaves (and all subsequent leaves) that appear on the dicotyledon plant. True leaves are used to identify the plant.		
Leaves are arranged along the stem as: alternate, opposite, whorled, or a combination of these patterns.	**Know how leaves can be arranged along the stem of a broadleaf plant.**	**Describe the arrangements of leaves along the stems of broadleaf plants.**
Alternate leaves emerge singly at each node on alternate sides of the stem and are not directly opposite each other.		
Opposite leaves are pairs of leaves coming from the same node and situated across the stem from each other.		
Whorls are groups of three or more leaves coming from the same node on the stem.		

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Legumes such as alfalfa and clover have compound leaves which are made of several small leaves called leaflets.		
When counting leaf numbers, count each true leaf whether alternate, opposite, in a whorl or compound, unless the recommendation refers to the number of whorls or pairs of leaves. Cotyledons are not counted when determining the number of leaves.	**Know how to count leaves of broadleaf plants.**	**Describe how to count the number of leaves on each plant.**
Leaf Stages of Grasses		
The first leaf is a single coleoptile (protective sheath) attached at the first node, which stops growing when it hits light. The true leaves emerge alternately along the stem.	**Know how to count the leaves of grasses.**	**Describe how to accurately count the number of leaves on a grass plant.**
Count all the leaves on the main shoot. A leaf should be counted as soon as it emerges. Do not include tillers or the cotyledon in a leaf count.		
Tillers (or stools) are the secondary shoots of a grass plant which emerge from the base of the leaves, generally at the three to five leaf stage.	**Be able to recognize tillers.**	**Describe tillers.**
Types of Herbicides		
Herbicides are classified according to: **- selectivity;** **- mode of action;** **- timing of application;** **- residual effectiveness.**	**Know the ways herbicides are classified.**	**List the ways herbicides are classified.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Selective herbicides only kill or damage certain plants; non-selective herbicides kill or damage all plants. Some herbicides are both selective and non-selective depending on the pesticide rate.	Know how to classify herbicides according to selectivity. Know the difference between selective and non-selective herbicides.	Describe how to classify herbicides according to selectivity. Identify selective and non-selective herbicides.
Mode of Action explains how the herbicide kills a plant. Herbicides are either contact or systemic.	Know how to classify herbicides according to mode of action.	Describe how to classify herbicides according to mode of action.
- contact herbicides kill plant parts contacted by the herbicide. There is little or no movement of the herbicide in the plant. Contact herbicides are not effective against perennial weeds as they only "burn off" the tops. - systemic herbicides enter the roots or above ground parts of plants. These herbicides move in and through the plant (translocated). Effects may not show for a week or more after treatment. Too much systemic herbicide on the leaves may kill the leaf cells too quickly and prevent translocation to the site of action in a plant.	Know the difference between contact and systemic herbicides.	Identify contact and systemic herbicides.
Timing of application classifies herbicides according to when they are applied. Herbicides are classified as: - pre-plant; - pre-emergence; - post-emergence.	Know how to classify herbicides according to timing of application.	Describe how to classify herbicides according to timing of application.
Pre-plant herbicides are applied to the soil before seeding or transplanting. In pre-plant soil-incorporated treatments the herbicide is incorporated into the soil after application. Pre-emergence herbicides are applied to the soil after planting but before the emergence of the specific crop or weed. Pre-emergence may refer to the germination of either the weed or the crop; check with the label for specific instructions. Pre-emergence herbicides control weeds before or soon after they emerge.	Know the difference between pre-plant, pre-emergence, and post-emergence herbicides.	Identify pre-plant, pre-emergence and post-emergence herbicides.

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Post-emergence herbicides are applied after the specific crop or weed has emerged. The application may be soon after emergence or up to a specific height or leaf number. Post-emergence herbicides control established weeds.		
Residual Effectiveness		
Residual effectiveness refers to how long the herbicide remains active and alters weed or crop growth after application. Herbicides are classed as either residual or non-residual.	**Know how to classify herbicides according to residual effectiveness.**	**Describe how to classify herbicides according to residual effectiveness.**
Non-residual herbicides degrade rapidly and become inactive in the soil after application and do not affect future crops.	**Know the difference between residual herbicide, non residual herbicide and soil sterilant.**	**Identify residual herbicides, non-residual herbicides and soil sterilants.**
Residual herbicides do not break down quickly and may control weeds for several weeks to several years. Special precautions are required when using residual herbicides due to the long term effects. Carefully consider the environmental impacts, future crops and site conditions.		
Non-selective residual herbicides (soil sterilants) are applied to soil to prevent growth of plants for an extended period of time (a few months to many years). These products do not sterilize the soil of all micro-organisms or seeds.		

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Herbicide Effectiveness		
There are many factors that affect herbicide effectiveness, for example: **- shape and surface of leaves;** **- weather factors;** **- age of the weed;** **- nutrition;** **- soil type;** **- soil moisture;** **- cultivation;** **- resistance.**	**Know what factors can affect herbicide effectiveness.**	**List the seven factors that can affect herbicide effectiveness.**
Shape and Surface of the Leaves		
The shape and surface of the leaves affect how much herbicide will be retained and absorbed by the plant. Adjuvants can improve effectiveness of some post-emergence herbicides in specific situations. Adjuvants can alter the spray droplet for better adhesion to the leaf or coverage of the leaf surface. Adjuvants should only be used with a herbicide when recommended on the label.	**Know how the shape and surface of leaves can affect herbicide effectiveness.** **Know what adjuvants can do and when to use them.**	**Describe how the shape and surface of leaves affects herbicide effectiveness.** **Describe what adjuvants can do and when to use them.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weather Factors		
Weather factors such as temperature, humidity, rain, and wind can affect herbicide effectiveness. Moderate conditions are usually better than extremes. The label may indicate what weather conditions should be avoided. **Cool or dry conditions slow the production and movement of food in the plant and reduce the movement of systemic herbicides. Hot dry weather may make the herbicide/ carrier evaporate quickly from the weed leaves and therefore reduce effectiveness.** **Rain or irrigation during or after an application can wash the herbicide off plants. However, some soil applied herbicides require irrigation or rain after application.** **Wind can cause spray drift and prevent the herbicide from reaching the target.**	**Know how weather can affect herbicide effectiveness.**	**Describe how the weather can affect herbicide effectiveness.**
Age of the Weed		
The age of the weed can affect herbicide effectiveness. Herbicides are often more effective on rapidly growing weeds. **Systemic herbicides, which move with the food and water, are usually more effective in young weeds than in older weeds because of the increased translocation rates. The label may reference one or more herbicide rates based on the specific age of the weed.** **Herbicides are less likely to kill plants that are in full flower or producing seed.**	**Know how the age of the weed can affect herbicide effectiveness.**	**Describe how the age of the weed can affect herbicide effectiveness.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Perennial weeds often become more resistant to herbicides as they grow older, but may become more susceptible again in the bud or early flowering stage. In this stage, the food is being stored in the roots or rhizomes. The herbicide is also translocated to these sites and so kills the entire plant.		
Soil Type		
The soil type affects the performance of soil active herbicides. The label may reference one or more herbicide rates based on the type of soil. **Higher herbicide rates may be needed for organic (peat or muck) or fine textured soils (clay or silt). Sandy soils usually have lower herbicide rates.** **Other soil characteristics such as pH or sodium levels may also affect the herbicides effectiveness.**	**Know how soil type and peculiarities can affect herbicide effectiveness.**	**Describe how soil type and peculiarities can affect herbicide effectiveness.**
Soil Moisture		
Soil moisture can affect herbicide effectiveness. Soil applied herbicides usually work best in warm, moist soils. The moisture aids in moving the herbicide into contact with the weed roots or seed.	**Know how soil moisture affects herbicide effectiveness.**	**Describe how soil moisture affects herbicide effectiveness.**
Cultivation can affect herbicide effectiveness by: **- weakening some weeds making them easier to control;** **- breaking some weeds into pieces making them harder to control.** **Read the label to determine if cultivation is recommended.**	**Know how cultivation affects herbicide effectiveness.**	**Describe how cultivation affects herbicide effectiveness.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out the safe and effective control of weeds.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The stale seed bed technique requires cultivating unseeded soil so that weed seeds are encouraged to germinate. When they appear they are sprayed with a non-selective herbicide. The seeds of desirable vegetation can then be planted.	**Know the procedures for the stale seed bed technique.**	**Describe the stale seed bed technique.**
Resistance		
When weeds develop a resistance to a certain herbicide, the herbicide is no longer effective.	**Know how resistance affects herbicide effectiveness and how to slow the development of resistance.**	**Describe how resistance affects herbicide effectiveness and how to slow the development of resistance.**
The development of weed resistance may be slowed by: **- using a variety of chemical and non-chemical control methods;** **- using a herbicide only when needed;** **- alternating herbicides from different chemical families or modes of action;** **- using registered tank mixes that will control weeds by way of two different modes of action.**		

Category: AGRICULTURE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out the safe and effective pest control of insects, mites and molluscs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insects and Mites		
Insects are a group of animals that (as adults) have jointed bodies, 6 jointed legs and an outer skeleton. The adult insect body has three main sections: head, thorax and abdomen. Three pairs of legs and one or two pairs of wings (if present) are attached to the thorax. Insects breath through spiracles (pores) in their outer skeleton.	**Know the general descriptions of an insect and a mite and be able to distinguish between them.**	**Describe the body parts of an insect and mite. List the major differences between the two.**
Mites are a group of animals that (as adults) have jointed bodies, 8 jointed legs and an outer skeleton. Mites differ from insects in that their bodies are not divided into obvious sections and they have only two main body parts: a fused head and thorax and an abdomen. The adult has four pairs of legs. The larval stage only has three pairs of legs. Mites do not have wings. They are generally extremely small (less than 1 mm in length).		
There are a number of insects and mites that affect plants.	**Know which insects and mites are a problem in your province and be able to identify them.**	**Identify the insects and mites which are a problem in your province.**
Insects and mites can do most of their damage with their mouthparts in the course of feeding. The mouthparts of pests are adapted for one or more of the following: chewing, sucking, siphoning, and lapping.	**Know how the type of mouthparts an insect or mite has will affect the damage done.**	**List the types of mouthparts of insects and mites and describe the damage done by each.**
Insect and Mite Life Cycles		
Insects and mites can go through three or four different stages as they mature. The common stages are: egg, nymph or larva, pupa, adult. During the nymphal or larval stage they may moult several times before progressing to the next stage. The stage between each moult is called an instar.	**Know the stages of growth that insects and mites may go through.**	**List and describe the stages that insects and mites may go through.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out the safe and effective pest control of insects, mites and molluscs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The most common life cycles of insects are: **1. Egg to nymph to adult (gradual development or incomplete metamorphosis). A nymph is similar in appearance to the adult but lacks reproductive organs. Generally, they have compound eyes and externally developing wings; for example, grasshoppers and leafhoppers. These insects do not have a pupal stage.** **2. Egg to larva to pupa to adult (complete metamorphosis). The larva is very different from the adult. It is a grub-like feeding stage; for example caterpillars and wireworms. Larvae do not have compound eyes. The pupa is a non-feeding resting stage during which a complete change of shape occurs. The adult is the reproductive stage and is usually winged; for example butterflies and beetles.**	**Know the most common life cycles of insects.**	**List and describe the most common life cycles of insects.**
Mites generally go through three stages: egg to nymph to adult.	**Know the life cycles of mites.**	**Describe the life cycle of mites.**
Molluscs **Slugs and snails are soft bodied animals that move by means of a single ventral "foot". They have a distinct head with two pair of tentacles. Snails have distinct shells, slugs do not.** **Terrestrial slugs and snails are active mainly during the evening and night, on cool overcast days or immediately following a rain. They spend most of the day hiding under** **damp refuse, rocks and other objects on the soil surface. Often, they will return to the same hiding place day after day, unless disturbed.**	**Know if slugs and snails are a problem in your province and be able to identify them.**	**Describe the slugs and snails which are a problem in your province.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out the safe and effective pest control of insects, mites and molluscs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The route taken out is usually retraced on the return trip, leaving a "slime trail". They will avoid all dusty, dry or sharp objects, if possible.		
Life Cycle of Slugs and Snails		
Slugs and snails reproduce by laying eggs. They have three distinct stages in their life cycle: egg, nymph and adults.	**Know the life cycle of slugs and snails.**	**Describe the life cycle of slugs and snails.**
Control Measures for Insects, Mites and Molluscs		
Insects, mites and molluscs are most effectively controlled in their early stages (larva or nymph). The adults can also be controlled to a lesser extent. Eggs and pupae are generally not affected by insecticides, miticides and molluscicides.	**Know the life cycle stages during which the best insect, mite and mollusc control is usually achieved.**	**Identify the life cycle stages during which the best control of insects, mites and molluscs can be achieved.**
Control of these pests involves one or more of the following methods: exclusion, cultural, mechanical, biological, and chemical. An IPM program should be implemented if possible.	**Know the control methods for insects, mites and molluscs in pest management.**	**List and describe the control methods for insects, mites and molluscs in pest management.**
Chemical control is the use of insecticides to control insects, miticides to control mites and molluscicides to control slugs and snails.	**Know which insecticides, miticides and molluscicides are registered for the control of insects, mites, slugs and snails.**	**List and describe the pesticides registered for the control of insects, mites, slugs and snails.**
Classification		
Insecticides, miticides and mollusicides are classified according to their mode of entry, residual effectiveness, and selectivity.	**Know the ways that these pesticides are classified.**	**List the ways that these pesticides are classified.**
Mode of Entry describes how the pesticide reaches the insect, mite or mollusc and/or how it then affects the pest.	**Know what mode of entry refers to.**	**Describe mode of entry.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out the safe and effective pest control of insects, mites and molluscs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Contact pesticides must come in contact with the pest to be effective. They can be applied to the pest or to surfaces over which the pest moves. Some contact pesticides have a residual effect and can kill the pest for some time after application.	Understand what contact insecticide/miticide/ molluscicide means.	Describe a contact insecticide/miticide/ molluscicide.
Suffocating pesticides are a specific group of contact pesticides. They clog the pest's breathing pores.	Understand what a suffocating pesticide is.	Describe a suffocating pesticide.
Stomach poisons must be swallowed by the pest to be effective. They are usually applied to the pest's food and taken in with the food. Sometimes stomach poisons are mixed with food to form a poisonous bait.	Understand what a stomach poison is.	Describe a stomach poison.
Systemic pesticides are a specific group of stomach poisons. They are applied to the host plants and are translocated in the plants with the sap or water. The pests suck the poisoned sap or eat poisoned plant parts.	Understand what a systemic insecticide, miticide/ molluscicide is.	Describe a systemic insecticide, miticide/ molluscicide.
Fumigants are pesticides that work in a gaseous form. The pest breathes in the poisonous fumes. Some pesticides have a fumigant action but are not considered true fumigants.	Understand what a fumigant is.	Describe a fumigant.
Attractants are chemicals that attract insects, mites or molluscs. They may attract female insects for egg laying, attract male insects to sticky traps or attract slugs to water traps.	Understand what an attractant is.	Describe an attractant.
Residual Effectiveness refers to how long the pesticide remains effective after application. Some insecticides remain effective for only a few days, others for several weeks.	Know what residual effectiveness refers to.	Describe residual effectiveness.
Selectivity refers to which insects, mites or molluscs will be affected by the pesticide.	Know what selectivity refers to.	Describe selectivity.
Selective pesticides only control certain insects, mites or molluscs. They generally do not harm non target organisms.	Understand what a selective pesticide is.	Describe a selective pesticide.

Category: AGRICULTURE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out the safe and effective pest control of insects, mites and molluscs.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Non-selective pesticides may control all insects, all mites and/or all molluscs. They may also harm other non target organisms. Extra caution should be taken when using these pesticides.	**Understand what a non-selective pesticide is.**	**Describe a non-selective pesticide.**
Factors Affecting Insecticide/Miticide/Molluscicide Effectiveness **Factors affecting the effectiveness of the pesticide include: timing of application, pest resistance and weather conditions.**	**Know the factors that affect insecticide, miticide and molluscicide effectiveness.**	**List and describe the factors that affect insecticide, miticide and molluscicide effectiveness.**
Timing of Application **The pest may need to be present at the time of application. It may need to be in a susceptible stage of development. Generally, the younger the pest is, the easier it is to control with contact and stomach poisons.**		
Resistance **Some insects, mites and molluscs have developed resistance to specific types of families of pesticides. To reduce resistance, alternate families of pesticides.**		
Weather Conditions **Sunlight, temperature, humidity and rain can adversely affect the effectiveness of pesticides by increasing pest sensitivity or by decreasing the residual activity of the pesticide. Some insecticides lose effectiveness with temperature extremes.**		

Category: AGRICULTURE

Concept: PEST MANAGEMENT - DISEASES AND NEMATODES

General Objective: To understand pest management principles required to carry out safe and effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Diseases		
Plants may be diseased when their appearance or function is not normal.	Know when plants are diseased.	Describe how you know when plants are diseased.
Disease symptoms are caused by environmental stress or infection by microorganisms. Similar symptoms may be caused by insect damage (e.g., gall forming insects) or herbicide damage. It is important to correctly identify the cause of the symptoms so that an effective diagnosis and treatment can be chosen.	Know what can cause disease symptoms. Understand why it is important to correctly identify the cause of disease symptoms.	List the major causes of disease symptoms. Identify other things that could cause similar symptoms. Describe why it is important to correctly identify the cause of disease or disease-like symptoms.
Environmental Stress		
Unfavourable environmental conditions that stress plants and cause abnormal growth or disease-like symptoms include extremes of light, temperature, water or nutrients, and toxic chemicals (e.g., air pollutants). Plants weakened by environmental stress are more likely to be infected by pests. Recognizing and relieving the stress will help prevent infectious diseases.	Know environmental conditions which can stress plants and cause abnormal growth or disease-like symptoms. Understand why it is important to recognize and relieve stress on plants.	List the environmental conditions that could stress plants and cause abnormal growth or disease-like symptoms. Describe why it is important to recognize and relieve environmental stress.
Diseases caused by environmental stress cannot be spread from plant to plant.	Realize that diseases caused by environmental stress cannot spread from plant to plant.	Identify that diseases caused by environmental stress cannot spread from plant to plant.
Infection by Microorganisms		
Microorganisms can cause diseases. Pest microorganisms include fungi, bacteria, viruses and nematodes. These organisms are usually too small to see. Identification is usually based on the symptoms that can be seen, or on laboratory investigations.	Know pest organisms which can cause diseases. Realize disease identification is based on symptoms and laboratory investigations.	List types of organisms that can cause diseases. Describe how a disease can be identified.
Diseases caused by microorganisms (pest infection) are called infectious diseases. These diseases can spread from plant to plant.	Know what an infectious disease is. Realize that diseases caused by microorganisms can spread from plant to plant.	Define infectious disease. Identify that diseases caused by microorganisms can spread from plant to plant.

Category: AGRICULTURE

Concept: PEST MANAGEMENT - DISEASES AND NEMATODES

General Objective: To understand pest management principles required to carry out safe and effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Microorganisms are pests when they damage desirable plants.	**Know when microorganisms are pests.**	**Identify when microorganisms are pests.**
Fungi are the largest group of organisms which cause plant diseases. They are organisms which feed on living or decaying organic matter. This group includes moulds, mushrooms, and rusts.	**Know about fungi that cause plant diseases.**	**Describe what a fungus is.** **List organisms that are considered fungi.**
Most fungi reproduce by tiny spores. When spores germinate, they usually produce threadlike filaments which can infect the host, absorb nutrients, and give off toxins that cause disease symptoms.	**Know how fungi reproduce and cause disease symptoms.**	**Describe how fungi reproduce and cause disease symptoms.**
The life cycles of many fungi follow a similar sequence. An example of the sequence is: The fungus stays on a diseased leaf over winter. As the weather becomes warmer in spring, the fungus becomes active and produces spores. The spores are released into the environment and they are moved by wind or water. Some land on healthy parts of a plant. If environmental conditions are poor for spore germination the spores may die, be washed off by rain, or remain dormant. Spores are fairly resistant to fungicides during this stage. If environmental conditions are good, the fungus spores will germinate. The fungus is most vulnerable to fungicides or unfavourable growing conditions between germination and infection. Infection begins when the fungus is able to enter the plant tissues.		**Describe the life cycle of a typical fungus.**
When the plant responds to infection by growing abnormally it is said to be diseased. Inside the plant the fungus is protected and difficult to control. A systemic fungicide may control the disease, if applied before the infection is too severe. Some fungi (e.g., rusts) need 2 different hosts to survive and reproduce. Fungi are spread by spores or tiny pieces of the fungus. Movement of infected plants, plant parts and soil may also spread the fungus.		

Category: AGRICULTURE

Concept: PEST MANAGEMENT - DISEASES AND NEMATODES

General Objective: To understand pest management principles required to carry out safe and effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Some symptoms that may be caused by fungi include cankers, dieback, galls, leaf spots, rots, rusts and wilts.		List symptoms of a disease that could be caused by a fungus.
Bacteria cause serious plant diseases. Bacteria are one-celled organisms which can only be seen with a microscope. They usually enter a plant through openings or wounds. Under favourable conditions, bacteria reproduce very quickly, using the plant as a source of food.	Know about bacteria.	Describe what a bacteria is. Describe how bacteria can infect plants.
Bacteria are spread by wind and rain, ground or surface water, or by contact with contaminated animals or equipment.	Understand how bacteria are spread.	List ways bacteria could be spread.
Some blights, galls and rots are caused by bacteria.	Know about the bacterial diseases in your province.	Describe bacterial diseases in your province.
Viruses are extremely small. They cannot be seen with an ordinary microscope. Viruses cause diseases which often reduces plant vigour and crop yields.	Know about viruses.	Describe what a virus is.
Viruses reproduce only when they are in living cells.	Know how viruses reproduce and spread.	Describe how viruses reproduce.
Viruses can be spread by mechanical means (e.g. during pruning or harvesting), in propagation material (seeds, tubers and other plant parts) or by vectors (insects, mites, nematodes, fungi).		List ways viruses can be spread.
Mosaics, ringspot and leaf roll are examples of diseases caused by viruses.	Know about the diseases caused by viruses in your province.	Describe diseases caused by viruses in your province.
No pesticides are available to control viruses directly. However, some pesticides may be used to control virus vectors.	Know that there are no pesticides to control viruses.	Identify the fact that pesticides can not be used to control viruses.
Nematodes are very small "worm-like" organisms which may feed on plant root, stems, and leaves. They can affect the movement of water and nutrients in a plant and they create wounds which may allow fungi or bacteria to enter.	Know about nematodes.	Describe what nematodes are.
Nematodes multiply by producing eggs.		Describe how nematodes reproduce.

Category: AGRICULTURE

Concept: PEST MANAGEMENT - DISEASES AND NEMATODES

General Objective: To understand pest management principles required to carry out safe and effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nematodes spread by movement of infected plants, animals, and seeds, contaminated soil and water.		**Describe how nematodes spread.**
Some symptoms that can be caused by nematodes are wilting, stunting, lack of vigour, and growth deformities.		**List symptoms that may be caused by nematodes.**
Approaches to Disease Management		
Three things must be present for infectious disease to develop. They are: **1. A disease causing organism (pathogen).** **2. A host susceptible to the disease.** **3. An environment favourable to the disease organism.**	**Know the three things necessary for an infectious disease to develop.**	**List the three things necessary for an infectious disease to develop.**
Taking away or changing any one of these 3 things will control or avoid the disease. For example, a disease problem can be prevented by: keeping the organism out of an area, using strains of plants that are resistant or are not affected by the disease, reducing the population of disease causing organisms, or by manipulating the environment to favour the host but not the pathogen.	**Understand how diseases can be controlled.**	**Describe how diseases can be controlled.**
Fungicides		
Fungicides are often described according to how they work (mode of action).	**Know how fungicides work.**	

Category: AGRICULTURE

Concept: PEST MANAGEMENT - DISEASES AND NEMATODES

General Objective: To understand pest management principles required to carry out safe and effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Protectant fungicides provide a protective film of fungicide on or around the host to prevent fungus spores from germinating. Protectant fungicides must be used before the fungi reach the infectious stage. After the plant is infected the fungicide normally will not kill the fungi inside the plant but it can protect the plant from more infection. New plant growth which appears after application is not protected. Therefore reapplication is required. Protectants can be applied to seeds, foliage, flowers, fruit, or to roots.		**Describe how protectant fungicides work.**
Eradicant fungicides kill fungus organisms that have infected but not become well established within the plant. Eradicant fungicides have limited value for fungi that are well established within plants.		**Describe how eradicant fungicides work.**
Systemic fungicides are absorbed by plants and move within them. They may act as protectants, eradicants, or both. Once inside the plant, systemics move to new areas of plant growth.		**Describe how bactericides work.**
Bactericides		
Bactericides are chemicals that are toxic to bacteria. They kill bacteria on contact and must be used before the bacteria infect a plant.	**Know how bactericides work.**	**Describe how bactericides work.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - DISEASES AND NEMATODES

General Objective: To understand pest management principles required to carry out safe and effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nematicides		
Nematicides are chemicals that move through the soil as a gas or in soil water. The presence of spaces between the soil particles is important for their movement. Nematicides may be applied as liquid or granular formulations. They may act by direct contact with nematodes or systemically so that nematodes feeding on or in the diseased plant acquire a lethal dose.	**Know what pesticides are used for nematode control and how they work.**	**Identify the formulations of pesticides used for nematode control.** **Describe how nematicides work.**
Fumigants		
Fumigants are chemicals that when in a gaseous state are lethal to pest organisms. The fumigants may move through air spaces between soil particles (soil fumigation) or through air in structures (space fumigation).	**Know what a fumigant is.**	**Define a fumigant and describe how it works.**
Factors Affecting Fungicide/Bactericide Effectiveness		
Timing of Application - the fungicide/bactericide should be on or in the plant (in effective concentration) prior to or during the infection period of the fungus/bacteria.	**Know factors affecting fungicide/bactericide effectiveness.**	**Describe how timing of application can affect the effectiveness of fungicides/ bactericides.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - DISEASES AND NEMATODES

General Objective: To understand pest management principles required to carry out safe and effective disease control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fungus/Bacteria Life Cycle and Weather - the frequency of applications varies depending on the type of fungus/ bacteria, the fungicide/bactericide, and the weather. If the fungus/bacteria has a short life cycle and if there are good conditions for its growth, it can have many infection periods and many applications may be needed. If the conditions are poor for its growth, few applications may be needed. Moisture, rate of plant growth, and type of fungicide/bactericide also affect the frequency of applications. If the fungicide/bactericide is washed off, if new leaves grow or if the fungicide/bactericide breaks down quickly, applications may need to be repeated.		**Describe how the weather and fungus/ bacteria life cycle can affect the effectiveness of fungicides/bactericides.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - VERTEBRATES

General Objective: To understand pest management principles required to carry out the safe and effective control of vertebrates.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Vertebrates		
Vertebrate pests include: **- birds;** **- rodents;** **- regional pests such as bats, wolves, raccoons, skunks, moose, deer and rabbits.**	**Know which vertebrate animals are pests in your province and be able to identify them.**	**List and describe the vertebrate animals which are pests in your province.**
Vertebrates are pests when they damage property, crops, feed, food, or livestock; and when they carry diseases affecting man or animals or birds.	**Know when vertebrates are pests.**	**Identify when vertebrates are pests.**
When planning a control program, consider: **- benefits as well as damage;** **- hazards of the control program to non-targets.**	**Know the factors to consider when planning a control program.**	**List the factors to consider when planning a control program.**
Pest Behaviour and Biology		
Knowing vertebrate pest behaviour and biology is important as it helps you determine the most effective control methods, the best time to implement the control and the best location for control.	**Understand why it is important to know about the behaviour and biology of vertebrate pests.**	**Describe the behaviour and biology of vertebrate pests.**
The selection of effective control methods will depend upon the pest's: **- population density of the pest;** **- mobility of the pest;** **- habitat;** **- availability of preferred foods;** **- physical abilities of the pest;** **- wariness of man and foreign objects;** **- place in the food chain;** **- impact on non-target species;** **- public opinion.**	**Know what should be considered when selecting a vertebrate pest control method.**	**List the factors to consider when selecting an effective control method.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - VERTEBRATES

General Objective: To understand pest management principles required to carry out the safe and effective control of vertebrates.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The best time to implement a control will depend upon: **- the availability of food;** **- when migration takes place;** **- when the young are born (population numbers are the lowest before the young are born). Controls should be set in place before this time;** **- when the pests are actively moving about in search of food;** **- whether the pest hibernate.**	**Know what should be considered when selecting the timing for a vertebrate control program or method.**	**List the factors to consider when selecting the time for controlling vertebrate pests.**
The best locations to trap, shoot or poison a vertebrate pest can depend upon finding: **- den;** **- burrow or nest and the exits;** **- regularly travelled routes;** **- feeding routes.**	**Know what should be considered when selecting the location for a vertebrate control method.**	**List the factors to consider when selecting the location for a vertebrate control method.**
Vertebrate Pest Management Methods		
Use integrated pest management whenever possible.	**Understand that integrated pest management should be used whenever possible.**	**Identify that integrated pest management should be used whenever possible.**
Vertebrate pests may be controlled by: **- excluding them from a feeding or breeding area;** **- destroying or changing their habitat;** **- encouraging natural predators;** **- frightening away or repelling them (ultrasonic sound or cannon);** **- shooting them;** **- trapping them;** **- gassing with carbon monoxide;** **- poisoning them with pesticides;** **- preventing pest reproduction with chemosterilants.**	**Know the methods of controlling vertebrate pests.**	**List and describe the methods for the control of vertebrate pests.**

Category: AGRICULTURE

Concept: PEST MANAGEMENT - VERTEBRATES

General Objective: To understand pest management principles required to carry out the safe and effective control of vertebrates.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The decision of how to control vertebrate pests will depend on the legal status, cost, and effectiveness of the available control methods.	**Know the factors that have a bearing on the choice of a control method.**	**List the factors which affect the choice of a control method.**
Legal Status of Control Methods		
Legislation for the protection of wildlife may prevent the destruction of some pests or may require special permits for their control.	**Know how laws may affect the control of vertebrate pests.**	**Identify the laws which affect the control of vertebrate pests.**
Shooting, trapping and pesticides may be limited to specific times and locations. Check with provincial authorities about laws that could affect vertebrate control programs before implementing a control program.	**Know who to ask regarding laws which affect control programs for vertebrate pests.**	**Identify where to obtain information about laws that may affect proposed vertebrate control programs.**
Pesticides Used for Vertebrate Control		
Avicides kill birds.	**Know the types of vertebrate control products and how they work.**	**List and describe the types of vertebrate control products.**
Rodenticides kill rodents.		
Acute rodenticides kill rodents soon after one feeding. Anticoagulant rodenticides kill rodents over several days by causing internal or external bleeding. They can be single-dose and need one feeding or multiple-dose and need several feedings over several days.		
Predacides kill predatory animals.		
Chemosterilants reduce pest populations by reproductively sterilizing female and/or male adults.		
Chemical repellents are used to frighten away bird pests. A few birds eat the chemical and their strange behaviour, before they die, frightens away other birds.		

Category: AGRICULTURE

Concept: PEST MANAGEMENT - VERTEBRATES

General Objective: To understand pest management principles required to carry out the safe and effective control of vertebrates.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Chemical repellents cause other vertebrate pests to avoid an area or desired food material. **Sticky pastes are used to repel birds or to trap rodents.** **Fumigants are used to kill burrowing vertebrate pests.**		

Category: AGRICULTURE

Concept: PEST MANAGEMENT - VERTEBRATES

General Objective: To understand pest management principles required to carry out the safe and effective control of vertebrates.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Selection **Application equipment can be divided into two common types of equipment according to the type of formulation applied:** **- sprayers;** **- granular applicators.** **Sprayers are used to apply a liquid spray mixture while granular applicators are used to apply granular pesticides.** **NOTE: The agricultural industry uses a wide variety of pesticide application equipment. Agricultural producers are expected to be knowledgable regarding the more common application equipment used in their specific type of crop production.**	**Understand that application equipment can be commonly divided into sprayers and granular applicators.**	**Identify that sprayers apply liquids and granular applicators apply granular pesticides.**
Sprayer Selection **A variety of application equipment is available for applying a liquid spray in agricultural operations. Sprayer options include: field sprayers, backpack sprayers, air-assist sprayers, air-blast sprayers, and soil fumigation equipment. There are many similarities between all of these different types of equipment. Boom sprayers are liquid sprayers, which use nozzles placed on a boom to distribute the spray mixture over the treatment area. Field sprayers, backpack sprayers, and air-assist sprayers can be grouped together as boom sprayers.**	**Know the types of sprayers which are used in agricultural operations.**	**List the types of sprayers used in agricultural operations.** **Describe similarities between the various types of sprayers.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - APPLICATION EQUIPMENT SELECTION

General Objective: To know how to select the correct type of application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Field Sprayers **Field sprayers are used for treating large areas. Field sprayers have tank sizes ranging from 500-4000 litres and boom widths ranging from 6-36 meters. The tank and booms may be mounted on a three point hitch frame or a separate trailer. Field sprayers may be equipped with a variety of auxiliary devices to improve their control, accuracy and safety.**		**Describe field sprayers.**
Backpack Sprayers **Backpack sprayers are used for treating small areas and spot spraying. Backpack sprayers have tank sizes from 5 to 25 litres and hand-wands (booms) with 1-4 nozzles. The risk of applicator exposure is increased because the spray mixture is carried by the applicator who works in close proximity to the spray.**		**Describe backpack sprayers.**
Air-Assist Sprayers **Air-assist sprayers are very similar to field sprayers except they use an air stream to propel the spray droplets to the target. Boom widths do not exceed 22 meters. Air-assist sprayers can use a finer spray droplet, improving pesticide penetration and coverage without increasing spray drift potential yet the capital cost is greater.**		**Describe air-assist sprayers.**
Air-Blast Sprayers **Air-blast sprayers are most often used on orchard crops, grapes and blueberries. Air-blast sprayers have tank sizes from 400-3000 litres. Air-blast sprayers do not have a boom suspended over the target but rather the nozzles are placed in a very high speed air stream produced by a fan. The air stream propels the very fine spray droplets to the target. In addition, the air stream creates leaf movement, allowing better coverage of insecticides and fungicides.**		**Describe air-blast sprayers.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - APPLICATION EQUIPMENT SELECTION

General Objective: To know how to select the correct type of application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The calibration procedures for air-blast sprayers are based on the same principles and formulae used in calibrating field, backpack and air assist sprayers. Modified calibration procedures based on tree row volume are being used by some producers. This calibration procedure assesses the volume of tree foliage and determines the amount of pesticide to apply based on the volume.		
Soil Fumigation Equipment		
Soil fumigation equipment for liquid fumigants is similar to small field sprayers with respect to tank and boom size. Spray nozzles are replaced with hose shanks, which inject the liquid fumigant into the soil where it will volatilize. Extreme caution must be used when fumigating because highly toxic gases are released.		**Describe soil fumigation equipment for liquid fumigants.**
Granular Application Equipment		
Granular application equipment is used to apply granular pesticides. The factors to consider in selection are: **- treatment area;** **- pesticide type and size;** **- type of drive and metering mechanism;** **- application type (broadcast or banded).** **A wide variety of hopper sizes are used depending on the treatment area and pesticide rate. The type of drive and metering mechanism will influence the application accuracy.**	**Know about granular application equipment.**	**Describe granular application equipment.**
Other Pesticide Application Equipment		
Several other types of application equipment are used by agricultural producers to apply pesticides. Regardless of equipment type, the main objective is to apply the correct amount of pesticide to the target in a manner that maximizes efficacy and minimizes off-target placement.	**Know about other types of application equipment used in your province.**	**Describe other types of application equipment used in your province.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - APPLICATION EQUIPMENT SELECTION

General Objective: To know how to select the correct type of application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
There are several situations where pesticides are applied to agricultural products during handling, storage or processing. For example, seed protectants are applied with equipment very similar to a small sprayer with a modified boom. The sprayer output is not based on treatment area but rather volume of seed being treated.		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - APPLICATION EQUIPMENT SELECTION

General Objective: To know how to select the correct type of application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Basic Components of Boom Sprayers		
Sprayer components include: **- tanks;** **- pumps;** **- agitators;** **- filter;** **- controls;** **- pressure gauge;** **- plumbing;** **- nozzles.**	**Know the various components of boom sprayers.**	**List the main components of boom sprayers.**
Tanks		
Tanks hold the spray mixture and are available in a variety of shapes, sizes and materials. Desirable features in the selection of a tank are that they: **- resist corrosion;** **- be strong;** **- be shaped to aid agitation;** **- be easy to fill;** **- be easy to clean;** **- have graduated markings;** **- have baffles to prevent sloshing;** **- not react to pesticide.** **The most common tank shapes are oval and cylindrical. Rectangular tanks and flat bottomed tanks are more difficult to agitate and clean.** **Tank size should be proportional to the sprayer boom width and sprayer output.**	**Know the desirable features of a spray tank.**	**List the desirable features of a spray tank.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: COMPONENTS

General Objective: To understand the basic components of a boom sprayer to ensure correct selection and operation.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pumps		
Pumps provide the flow of spray mixture from the tank to the nozzle. Choose a pump suitable for the: **- required output and operating pressure;** **- pesticide properties;** **- carrier properties;** **- power supply.**	**Know the factors to consider in selecting the correct type and size of pump.**	**List the factors to consider when selecting a pump.**
Choose a pump with sufficient capacity, considering: **- number of nozzles;** **- nozzle output;** **- agitation requirements;** **- bypass filtration requirements, and then oversize by twenty percent.**		
The type of pump affects the installation of controls. Refer to pump manufacturer's instructions. Piston and diaphragm pumps require a pulsation damper to minimize pressure fluctuations.		
Agitators		
Agitation mixes the formulated pesticide and carrier together and prevents the suspended pesticides from settling out. The amount of agitation needed depends on the type of formulation used. It is important that proper agitation occurs. Both under and over agitation can reduce pesticide performance.	**Know why agitation is required.**	**Identify why agitation is required.**
Two types of agitation systems are commonly used. They are mechanical and hydraulic.	**Know the main types of agitation systems.**	**List and describe the main types of agitation systems.**
Mechanical systems use paddles to stir the contents of the tank, whereas hydraulic systems use special agitation nozzles in the tank to create spray mixture movement.		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: COMPONENTS

General Objective: To understand the basic components of a boom sprayer to ensure correct selection and operation.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Filters		
Filters prevent any debris and undissolved pesticides in the spray mixture from damaging the pump or plugging the nozzles.	**Know why filtration is required.**	**Identify why filtration is required.**
Filters can be installed: **- in the tank opening to prevent debris from entering the tank during filling;** **- between the tank and the pump to protect the pump from damage;** **- after the pump to remove finer particles before entering the spray lines;** **- in the nozzle bodies to prevent the nozzles from clogging.**	**Know where filters can be installed.**	**Describe where filters can be installed.**
Follow manufacturer's recommendations for the specific size of filters required to protect their nozzles and pumps. Smaller nozzles require finer filters.	**Know how to select the correct filter size.**	**Identify where to obtain information on correct filter size.**
Controls		
Two common control systems are pressure control systems and volume control systems.	**Know how control systems work.**	**List and describe how control systems work.**
Pressure control systems use a pressure regulating valve (PRV) to maintain a constant operating pressure.		
Volume control systems (volumetric) allow the operating pressure/nozzle output to vary according to forward speed/engine RPM.		
Control systems can be manually or electronically operated. Items such as spray monitors and spray controllers may improve the application of pesticides by supplying the operator with more information.		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: COMPONENTS

General Objective: To understand the basic components of a boom sprayer to ensure correct selection and operation.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Plumbing		
Under-sized hoses and fittings can severely reduce the capacity of any pump. Flow restrictions create a drop in pressure, resulting in a non-uniform nozzle flow rate. **Common sources of flow restrictions are:** **- under-sized boom plumbing;** **- under-sized controls or fittings;** **- kinked hoses;** **- under-sized or clogged filters.**	**Understand how plumbing can affect the pressure.**	**List common plumbing problems which affect the pressure.**
Boom Design		
The design/operation of the boom can affect the uniformity of application. **Excessive boom movement either vertically or horizontally during application will reduce the uniformity of spray coverage. Sprayers should be operated at a speed that minimizes boom movement.**	**Understand the importance of boom design.**	**Describe the importance of boom design.**
Pressure Gauge		
The pressure gauge measures the operating pressure. A pressure gauge is used to initially set the sprayer at the desired pressure and can be observed for changes in pressure as an indicator of problems. **Gauges are available as either liquid filled or dry. A liquid filled gauge dampens pressure pulsations resulting in a steadier reading. Pulsation dampers are available for dry gauges.** **The maximum pressure indicated on the gauge should be approximately twice the intended operating pressure.** **Gauges should sense the pressure as near to nozzles as possible.**	**Know why a pressure gauge is used.**	**Identify why a pressure gauge is used.** **Describe pressure gauges.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: COMPONENTS

General Objective: To understand the basic components of a boom sprayer to ensure correct selection and operation.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nozzles		
The three primary functions of a nozzle are to: **- meter the amount of spray delivered (nozzle output);** **- atomize the liquid into droplets;** **- disperse the droplets in a specific pattern.**	**Understand what a nozzle does.**	**List the functions of a nozzle.**
Nozzles are available in a wide range of types, sizes and materials. Nozzles are classified on the basis of type of spray pattern that is developed.	**Know how nozzles are classified.**	**Describe how nozzles are classified.**
Pesticide labels may recommend specific types and sizes of nozzles. Follow label directions.	**Know that pesticide labels may recommend specific types and sizes of nozzles.**	**Identify pesticide labels as a course of nozzle recommendations.**
The most common nozzle types are the flat fan and hollow cone nozzles.	**Know the most common nozzle types.**	**List the most common nozzle types.**
Other nozzles are available for drift reduction, banding, soil incorporation or boomless operation.		
Spray Angle		
The nozzle spray angle is the measurement (in degrees) of the spray angle formed by a single nozzle at a specific pressure. The spray angle will vary with pressure. Nozzles can be purchased in a variety of standard spray angles. The most common flat fan nozzle angles are 80E, 110E, and 65E.	**Know what the nozzle spray angle refers to.**	**Define nozzle spray angle.**
Wider nozzle angles can give a uniform application with lower boom heights. Correct boom height depends on the spray angle and nozzle spacing. Refer to nozzle manufacturer's recommendations or provincial recommendations for the required amount of overlap to achieve a uniform application.	**Understand the factors that determine the correct boom height.**	**Identify the factors that determine the correct boom height.** **List the sources of information for the amount of spray overlap.**
Flat Fan Nozzles		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: COMPONENTS

General Objective: To understand the basic components of a boom sprayer to ensure correct selection and operation.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Flat fan nozzles are generally used for herbicide applications. Properly operated flat fan nozzles can provide a high level of application uniformity. There are many different types of flat fan nozzles.	**Know that flat fan nozzles provide a high degree of uniformity.**	**Identify why flat fan nozzles are used for herbicide work.**
Flat fan nozzles are designed to be used at low pressures (between 100 and 400 KPa).	**Understand that flat fan nozzles are to be used at low pressures.**	**Identify that flat fan nozzles are to be used at low pressures.**
Tapered flat fan nozzles are the most common type of flat fan nozzles. They should be used in an overlapping spray pattern to achieve uniformity (i.e., one nozzle spray angle overlaps the next nozzle spray angle). Offset tapered flat fan nozzles slightly (5-10 degrees) from the boom to prevent spray interference.	**Know how to position tapered flat fan nozzles on a boom.**	**Describe how to position tapered flat fan nozzles on a boom.**
Even flat fan nozzles are available for banding applications and low pressure or other special flat fan nozzles are available for reduced drift applications.	**Know that other types of flat fan nozzles are available.**	**Describe other types of flat fan nozzles.**
Hollow Cone Nozzles		
Hollow cone nozzles are generally used to apply fungicides and insecticides because they generally produce a finer spray quality and provide greater penetration into the crop canopy.	**Know why hollow cone nozzles are often used for insecticide and fungicide work.**	**Describe why hollow cone nozzles are often used for insecticide and fungicide work.**
These nozzles are best suited for directed sprays where a uniform application is not the priority. They can be operated over a wide range of nozzle pressures (200 to 2000 kPa).		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calibration Objectives		
The four objectives when calibrating a boom sprayer are: **- to ensure that the spray mixture will be applied uniformly;** **- to ensure that the nozzle pressure combination produces a droplet size that limits spray drift;** **- to determine the sprayer output and adjust it to meet label requirements;** **- to correctly determine the amount of formulated pesticide to add to the spray tank.**	**Know the objectives of sprayer calibration.**	**List the objectives of sprayer calibration.**
Select a calibration procedure that meets these objectives.		
Sprayers should be calibrated: **- when the sprayer is new;** **- at the start of each season;** **- when travel speed, nozzle spacing, or nozzles are changed;** **- when the sprayer output changes;** **- when the sprayer is modified.**	**Know when sprayers should be calibrated.**	**Describe when sprayers should be calibrated.**
Application Uniformity		
Application uniformity affects pesticide performance. Non-uniform application will result in areas of over and/or under application reducing the pesticide's effectiveness.	**Understand the importance of uniformity in application.**	**Identify the effects of non-uniform application.**
Non-uniform application can occur from either: **- variations across the width of the boom, or;** **- localized variations within the total application area.**	**Understand how non-uniformity can occur.**	**List possible causes of non-uniformity.**
Variations across the width of the boom are caused by: **- variations in nozzle outputs caused by mismatched nozzles, worn nozzles, or pressure variations across width of boom;** **- variations in nozzle spacing;** **- incorrect boom height.**		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Variations over the total application area can be caused by: **- variations in sprayer output caused by fluctuating travel speed or pressure;** **- excessive boom movement.**		
Sprayer Output		
Sprayer output refers to the spray mixture (pesticide and carrier) that is applied to a unit area (i.e., hectare, acre or meter of row). Knowing the sprayer output allows the applicator to calculate the correct amount of pesticide to add to the tank.	**Know what sprayer output refers to and why it is important.**	**Define sprayer output and identify why it is important.**
Sprayer output for a boom sprayer can be calculated by measuring the following three factors: **- the nozzle spacing;** **- the travel speed;** **- the nozzle output.**	**Know the factors that determine sprayer output.**	**Identify the factors that determine sprayer output.**
Sprayer output = Nozzle output x constant ÷ travel speed ÷ nozzle spacing. **L/ha = L/min x 60000 ÷ km/h ÷ cm.** **L/acre = L/min x 5940 ÷ mph ÷ inches.** **GPA = gpm x 5940 ÷ mph ÷ inches.**	**Know how to calculate sprayer output.**	**Describe how to calculate sprayer output.**
Conversion factors can be used to convert any metric unit or measurement into either Imperial or American units.		
The constant in the formula is a conversion factor to account for different units of measurement.	**Understand what the constant in the formula refers to.**	**Describe the purpose of the constant in the formula.**
Sprayer output can also be determined by measuring the volume of spray mixture that was applied to a known area. The limiting factor of this approach is that it does not assess the uniformity of the nozzles.	**Know the limitations of assessing sprayer output by measuring the volume of spray applied to a known area.**	**Identify the limitations of assessing sprayer output by measuring the volume of spray applied to a known area.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Factor #1. - Nozzle Spacing		
The nozzle spacing is the difference between nozzles on a boom for broadcast sprayers. For single nozzle units or for hand spraying it is the actual width sprayed. For air-blast sprayers it is the width of the orchard rows or the actual width sprayed depending on how it is being used.	**Know what nozzle spacing refers to for different types of sprayers.**	**Describe what nozzle spacing refers to for different types of sprayers.**
The closer the nozzles are together on a boom, the greater the sprayer output (everything else being equal).	**Understand how nozzle spacing affects sprayer output.**	**Identify how nozzle spacing affects sprayer output.**
Spacing of nozzles depends on: **- nozzle type and spray angle;** **- type of crop;** **- boom height.**	**Know what nozzle spacing depends on.**	**List the factors to consider for nozzle spacing.**
The nozzle spacing on a boom generally is not adjusted to change the sprayer output. Nozzle spacing on a boom must be equal to ensure application uniformity.	**Know the importance of a consistent spacing across the boom.**	**Identify the importance of a consistent spacing across the boom.**
Factor #2. - Travel Speed		
The travel speed of the sprayer affects the sprayer output. For a given nozzle output, increasing travel speed will decrease the sprayer output.	**Know the importance and procedure for determining the forward speed of the sprayer.**	**Identify the importance and procedure for measuring forward speed of the sprayer.**
Excessive travel speed causes boom movement, resulting in non-uniform application. Select a travel speed that will minimize boom movement.		
Measure travel speed: **- in the field;** **- with the sprayer half full of water;** **- repeat in both directions then average the results.**		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calculate travel speed by using the following equation: **Travel Speed = Test distance ÷ Time x Constant.** **km/h = metres ÷ seconds x 3.6.** **mph = feet ÷ seconds x 0.68.**		
Factor #3. - Nozzle Output		
Nozzle output is the volume of spray mixture a nozzle delivers in a specific period of time. Nozzle output is usually rated in litres per minute (L/min) or gallons per minute (gpm).	**Know what nozzle output refers to.**	**Define nozzle output.**
Nozzle output depends on the nozzle size and operating pressure. Increasing nozzle size and/or operating pressure, increases the nozzle output.	**Understand the factors affecting nozzle output.**	**List the factors affecting nozzle output.**
Manufacturer catalogues provide nozzle outputs in either metric or American units. Nozzle catalogues do not commonly use Imperial units. Manufacturers usually list nozzle output over the range of acceptable operating pressures.	**Know where to obtain information on nozzle output.**	**Identify where to obtain information on nozzle output.**
Adjusting Sprayer Output		
Adjustments to the sprayer, which change any of the three factors, will change the sprayer output. Small adjustments of sprayer output can be made by fine tuning the pressure or travel speed. Large changes of the sprayer output or excessive nozzle wear may require selecting new nozzles.	**Know how to adjust sprayer output.**	**Describe how to adjust sprayer output.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nozzle Wear and Replacement		
The rate of nozzle wear depends on: **- nozzle material;** **- pesticide formulation;** **- operating pressure;** **- nozzle size;** **- the amount of use (time).**	**Know the factors that affect nozzle wear rates.**	**List and describe the factors that affect nozzle wear rates.**
In general, the harder the nozzle material the longer the nozzle will last but the higher the cost. Brass is one of the softest nozzle materials and ceramic is one of the hardest. Other materials such as stainless steel and plastics fall between these two. **Nozzle wear increases with more abrasive formulations, higher operating pressures, smaller nozzle size, and longer use.**		
Replace nozzles when they are worn out. The nozzle output and spray pattern changes reducing application uniformity. Compare worn nozzle flow rate to a new nozzle to determine the amount of wear.	**Understand why nozzles must be replaced.**	**Identify why nozzles must be replaced.**
Check nozzle wear by: **1) Measuring the nozzle output (water only) for each nozzle at a constant operating pressure.** **2) Calculating the average output for the set of nozzles. Replace nozzles whose output varies by more than five percent from the average output. Properly maintained nozzles should wear evenly, allowing for replacement of the entire set.** **3) Replacing nozzles whose output is more than 15 percent higher than the manufacturers specified output. Nozzles with streaky or skewed spray patterns should be replaced even if they are not worn.**	**Know how to assess the maximum variation allowed in flow rates for a set of nozzles.**	**Describe how to assess the variation in flow rates for a set of nozzles.**
Selecting New Nozzles		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
New nozzles should be selected when: **- the existing nozzles are worn out;** **- the sprayer output must be changed by more than 10 percent;** **- new piece of application equipment is purchased;** **- a different type of nozzle is required;** **- the spray quality (droplet size) must be changed.**	**Know when to replace nozzles.**	**Identify when to replace nozzles.**
Select new nozzles from manufacturers' catalogues based on the nozzle output and acceptable operating pressures.	**Know how to select new nozzles.**	**Describe how to select new nozzles.**
The required output on the new nozzles can be determined if the recommended sprayer output, travel speed and nozzle spacing are known. **Nozzle output = sprayer output x travel speed x nozzle spacing ÷ constant.** **L/min = L/ha x km/h x cm ÷ 60,000.** **gpm = GPA x mph x inches ÷ 5940.**	**Know how to determine nozzle output.**	**Describe how to determine nozzle output.**
Pesticide Use Calculations **Pesticide use calculations determine the size of the treatment area, total amount of pesticide required, and the amount of pesticide required for each tank. These calculations are based on the pesticide rate that the applicator selects from the label.** **Before making a pesticide application, perform the following calculations:** **1. Determine the size of the treatment area. It can be obtained by measuring or from other sources such as property maps or deeds.**	**Know how to determine the size of treatment area, total pesticide required, area covered per tank, amount of pesticide required per tank, total number of tanks, volume of spray mixture required for the final load, pesticide required for the final load.**	**Calculate the following: size of treatment area, total pesticide required, area covered per tank, amount of pesticide required per tank, total number of tanks, volume of spray mixture required for the final load, pesticide required for the final load.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES

Treatment Area of a rectangular or square shape = length x width.
Hectares = Length(m) x Width(m) ÷ 10000 m^2/ha.
Acres = Length(ft) x Width(ft) ÷ 43560 ft^2/acre.

2. Total pesticide required = treatment area x pesticide rate.

Litres = Hectares x Litres/hectare.
Kg = Hectares x Kg/hectare.
Litres = Acres x Litres/acre.
Kg = Acres x Kg/acre.

3. Area covered per tank = tank size ÷ sprayer output.

Hectares/tank = litres ÷ litres/hectare.
Acres/tank = litres ÷ litres/acre.
Acres/tank = gallons ÷ gallons/acre.

4a. When pesticide rate is expressed as a rate per area.

Pesticide per tank = pesticide rate x area covered per tank.
Litres = Litres/hectare x hectares/tank.
Kg = Kg/hectare x hectares/tank.
Litres = Litres/acre x acres/tank.
Kg = Kg/acres x acres/tank.

4b. When the pesticide rate is expressed as a dilution factor.

Pesticide per tank = tank size x dilution factor.
Litres = Litres x Litres/Litres.

5. Total number of tanks = treatment area ÷ area covered per tank.

Tanks = hectares ÷ hectares/tank.
Tanks = acres ÷ acres/tank.

6. Area left to be sprayed = total area - area already sprayed.

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of pesticides will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES

Hectares = hectares - hectares.
Acres = acres - acres.

7. **Volume of spray mixture for partial tank = treatment area left to be sprayed x sprayer output.**

   Litres = hectares x litres/hectare.
   Litres = acres x acres/hectare.
   Gallons = acres x gallons/acre.

8. **Pesticide for partial tank = treatment area left x pesticide rate.**

   Litres = Hectares x Litres/hectare.
   Kg = Hectares x Kg/hectare.
   Litres = Acres x Litres/acre.
   Kg = Acres x Kg/acre.

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Spray Drift		
Before beginning any application, evaluate the weather conditions at the site to assess the spray drift potential. Consider: **- air and ground temperature;** **- relative humidity;** **- wind speed and direction;** **- impending weather conditions;** **- water quality.**	**Know what weather conditions must be considered when applying pesticides.**	**List weather factors to consider when applying pesticides.**
Minimize spray drift by: **- spraying under favourable weather conditions;** **- choosing suitable application equipment;** **- correctly operating the application equipment;** **- using drift control agents;** **- choosing a pesticide that is less subject to drift (e.g., amine versus ester).**	**Know how spray drift can be minimized.**	**List methods of minimizing spray drift.**
Favourable weather conditions are those that will not reduce the efficacy of the pesticide or increase the potential of environmental damage by spray drift.		
Temperature Effects on Drift		
High air temperatures may: **- reduce effectiveness of certain pesticides;** **- increase droplet evaporation;** **- create a temperature inversion.**	**Know how temperature may adversely affect the application of pesticides.**	**Identify how temperature may adversely affect the application of pesticides.**
High temperature combined with low relative humidity increases the rate at which airborne droplets evaporate. Evaporation decreases droplet size resulting in droplets that are more prone to drift.	**Understand how high temperatures combined with low relative humidity may increase drift.**	**Describe how high temperatures with low humidity may increase drift.**
A temperature inversion is a condition where air at ground level is cooler and more stable than air above the ground. The inversion prevents very fine spray droplets from settling, allowing them to remain suspended in the air for long periods of time and move off target.	**Understand how a temperature inversion may increase drift.**	**Describe how a temperature inversion may increase drift.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Wind Effects on Drift		
Increases in wind speed will increase the potential for spray drift. Maximum acceptable wind speeds and temperatures may be referenced on the label by provincial recommendation/legislation. Wind speed indicators and pictorial comparisons are available to determine wind speed. If spray drift occurs, stop the application, even if wind speeds are acceptable.	**Understand how wind may adversely affect the application of pesticides.**	**Describe how wind may adversely affect the application of pesticides.**
	Know where to find recommendations for acceptable wind speeds and temperatures.	**List sources of information for acceptable wind speeds and temperatures.**
No-wind conditions can cause herbicide sprays to remain suspended in the air. These can later be blown onto sensitive plants. A wind, 2 km/hr is generally adequate to prevent this situation.	**Understand how no-wind conditions may adversely affect the application of pesticides.**	**Describe how no-wind conditions may adversely affect the application of pesticides.**
Equipment Operation Effects on Drift		
To reduce spray drift: **- increase spray droplet size;** **- lower boom height;** **- use maximum recommended spray output;** **- use spray shields.**	**Understand possible methods of operating application equipment to minimize spray drift.**	**Describe possible methods of equipment adjustments for reducing spray drift.**
Applicators can reduce spray drift by increasing the droplet size being produced by the nozzles on the sprayer. Droplet size decreases as nozzle orifice size (output) decreases and pressure increases.		
A specific nozzle output can be obtained from a variety of different nozzle/pressure combinations. A small nozzle operated at high pressure can have the same nozzle output as a larger nozzle at a lower pressure yet the drift potential is much greater for the small nozzle.		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insecticides and fungicides are generally applied with a finer spray droplet than herbicides. Smaller droplet size increases coverage (number of drops per leaf) and the ability of the spray to penetrate a dense canopy. Using large sized droplets when applying insecticides and fungicides can reduce pesticide performance.		
Reduce the spray drift potential by using larger nozzles and lower pressures.		
Selecting the maximum recommended sprayer output from the label will require larger nozzles. These produce larger droplets and reduce drift.		
Minimize drift by lowering the boom height. Use nozzles with wider spray angles or tilt the nozzles forward (to effectively lower boom height).		
Additional equipment that shield the spray droplets from the wind has been developed to effectively reduce spray drift.		
Water Quality		
Temperature, sediment, pH, and presence of salt in the water that is mixed with pesticides may affect pesticide performance.	**Understand how water quality may affect the performance of the pesticide.**	**List characteristics of water quality which could adversely affect the performance of the pesticide.**
The pH of a spray solution can have a significant effect on the performance of some pesticides.	**Know the factors which affect the rate of pesticide breakdown.**	**List the factors which affect pesticide breakdown.**
Alkaline water can reduce the effectiveness of some pesticides. The rate at which breakdown occurs depends on: **- the pH of the water;** **- the amount of pesticide added to a fixed amount of water;** **- the water temperature;** **- the length of time the solution is left in the spray tank.**		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Silt and organic matter in the water can cause: **- premature pump wear;** **- plugging of screens;** **- decreased effectiveness.**	**Know the effects of silt and organic matter in the water.**	**Describe the effects of silt and organic matter in the water.**
If you suspect there is a problem with water quality you should: **- have the water tested;** **- seek another source of water;** **- obtain advice on pesticide application.**	**Know the options if water quality is a problem**	**Identify the options if water quality is a problem.**
Refer to the pesticide label or to provincial publications for specific recommendations.	**Know where to find specific recommendations for water quality.**	**Identify where to find specific recommendations for water quality.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - BOOM SPRAYERS: MAINTENANCE

General Objective: To understand the basic procedure in maintaining and cleaning mounted sprayers.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Maintenance		
Proper maintenance of application equipment minimizes the chance of a breakdown and increases the service life.	**Understand the importance of and procedure for a maintenance program for application equipment.**	**Identify the importance of properly maintaining application equipment.**
Rinse the equipment thoroughly at the end of each spraying day by flushing clean water through the pump, hoses, and nozzles. Check all screens, filters and nozzles and clean them if necessary. Assess the sprayer for wear and replace worn or damaged parts. Critical parts to check include agitator, regulator and pressure gauge for accurate operation, couplings and clamps for proper seal, and hose flex points for wear. Wash the sprayer and dispose of rinsate only where residues will not cause any adverse environmental harm. Follow directions on the label and provincial regulations.		**Describe how to maintain application equipment.**
Decontaminate the sprayer when changing from one target type of pesticide to another (i.e., herbicides to insecticides). Decontamination procedures vary depending on the pesticides being used. Consult the pesticide label or manufacturer's representative for specific recommendations.		
To prepare the sprayer for storage: **- thoroughly clean the sprayer and drain it completely, especially all components that may retain water. Follow manufacturer's recommendations on the addition of antifreeze solutions;** **- check the sprayer for worn parts, list all the parts that need replacement, and order the parts well before the next spraying season;** **- before winter storage, remove the pump and follow the manufacturer's recommendations for storage;** **- seal all openings to prevent entry of dirt, debris, or rodents;** **- store the sprayer where it will not be damaged by other equipment, livestock or weather.**	**Know how to prepare a sprayer for storage.**	**Describe the steps in preparing a sprayer for storage.**
Store polyethylene tanks under cover to prevent deterioration by sunlight and galvanized steel tanks away from moisture to prevent rusting.		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: COMPONENTS

General Objective: To understand the basic components of a granular application equipment to ensure correct selection and operation.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Components of Granular Application Equipment		
The main components of granular application equipment include: **- storage hoppers;** **- a metering mechanism;** **- a distribution system.**	**Know the main components of granular application equipment.**	**List the main components of granular applicator equipment.**
Storage Hopper		
Storage hoppers hold the granular pesticide and are available in a variety of different shapes, sizes and materials. Desirable features in the selection of a hopper are that they: **- resist corrosion;** **- be strong;** **- be shaped to improve granule flow;** **- by easy to fill;** **- be easy to clean;** **- have graduated markings.**	**Know about storage hoppers.**	**List the desirable features of a storage hopper.**
Agitators can be installed in hoppers to prevent bridging (blockage) of the granules. The tendency of a granular pesticide to bridge depends on: **- the pesticide characteristics;** **- the shape of the hopper;** **- air temperature and humidity.**		**Describe agitators and identify why they are installed in hoppers.**
Coarse screens can be installed on hoppers to prevent pieces of the pesticide bag or clumps of product from entering the hopper. This will prevent possible clogging of the drive mechanism.		**Identify the function of course screens on hoppers.**
Metering Mechanism		
Two types of metering mechanisms are commonly. They are gravity flow and positive.	**Know the types of metering mechanisms.**	**List the types of metering mechanisms.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: COMPONENTS

General Objective: To understand the basic components of a granular application equipment to ensure correct selection and operation.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Gravity flow metering mechanisms use openings that can be manually adjusted in size to regulate the flow of pesticide from the hopper. A hopper agitator is usually used to provide a steady flow of granules to the opening.	**Know the difference between gravity flow and positive metering mechanisms.**	**Describe gravity flow metering mechanisms.**
Positive metering mechanisms use an auger or a fluted-feed roll at the bottom of the hopper to regulate the flow of granules from the hopper. Positive metering mechanisms are usually powered by a ground driven wheel. They provide greater accuracy than gravity flow metering mechanisms.		**Describe positive metering mechanisms.**
Distribution System		
Granular application equipment is classified according to the type of distribution system used. Two common types of distribution systems used are broadcast and banding.	**Know the common types of distribution systems.**	
Broadcast application equipment applies granules over the entire field surface. Broadcast application equipment commonly use a very wide hopper with closely spaced gravity flow openings, a single gravity flow opening with a mechanical spreader or a pneumatic delivery system.	**Know the difference between broadcast and banding distribution systems.**	**Describe broadcast application equipment.**
Band application equipment applies granules in narrow bands usually corresponding to crop rows, leaving untreated areas between the rows. Banding reduces pesticide use by achieving chemical control only in the treated area.		**Describe band application equipment.**
Banding application equipment can use: **- simple spreaders to distribute the granules across the desired band width on the soil surface;** **- small drop tubes or soil openers to deposit the granules under the soil surface near the seed in well defined bands.**		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calibration Objectives		
The two objectives of granular application equipment calibration are: **- to achieve the correct application equipment output;** **- to verify that uniform and correct placement can occur.**	**Know the objectives of calibrating granular application equipment.**	**Identify the objectives of calibrating granular application equipment.**
Application Uniformity		
Application uniformity affects pesticide performance. Non-uniform application will result in localized areas of over and under application reducing the pesticide effectiveness.	**Understand the importance of application uniformity.**	**Identify the importance of application uniformity.**
Non-uniformity can result from: **- variations in granule flow rates;** **- variations in forward speed;** **- variations in discharge heights when banding.**	**Know the reasons for non-uniformity.**	**List the reasons for non-uniformity.**
Application Equipment Output		
Application equipment output refers to the weight of pesticide per unit area that the granular application equipment applies.	**Know what the terms application equipment output and pesticide rate refer to.**	**Define application equipment output.**
The pesticide rate refers to the weight per unit area that is recommended on the pesticide label.		**Define pesticide rate.**
Application equipment output and pesticide rate are commonly expressed as: **- broadcast treatment stated as kg/ha;** **- banding treatment stated as kg/ha or kg/m of row.**	**Know the units of measure.**	**Describe the units of measure.**
Conversion factors can be used to convert metric units to Imperial units.		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The applicator output depends on: **- the granule flow rate;** **- the forward speed;** **- the treatment width.**	**Know the factors that determine applicator output.**	**Identify the factors that determine applicator output.**
Granule Flow Rate		
Granule flow rate is the rate at which granules flow from the hopper. Granular flow rate depends on: **- the size of opening;** **- the granule size and density;** **- chemical characteristics;** **- air temperature and humidity.**	**Know what the term granular flow rate refers to. Know what factors can affect the granular flow rate.**	**Define granular flow rate and list the factors that affect it.**
An increase in the humidity level can result in a decrease in granule flow rate.	**Know how humidity level affects granule flow rate.**	**Identify how changes in the humidity level can affect granule flow rate.**
The metering mechanism can be adjusted to regulate the granule flow rate from the hopper. The correct setting is determined during calibration. Once set, metering mechanisms are not usually adjusted during the application.	**Know how to regulate the granule flow rate.**	
The flow rate of gravity flow mechanisms can be adjusted by changing the size of the opening. The rotational speed of the agitator can also affect the flow rate.		**Describe how to adjust the flow rate of gravity flow mechanisms.**
The flow rate of positive metering mechanisms can be adjusted by changing the metering surface area (size of opening) or the rotational speed of the metering mechanism.		**Describe how to adjust the flow rate of positive metering mechanisms.**
Field conditions can affect the flow rate from the hopper. Rough fields causing the equipment to bounce will disrupt the steady flow of granules. The varying flow rates will reduce uniformity.	**Know how field conditions can affect the flow rate.**	**Identify how field conditions can affect granule flow rate.**
The granular flow rate of every discharge opening should be measured to ensure uniform application across the total width of the applicator.	**Know how to ensure uniform application over the total width of the applicator.**	**Describe how to ensure uniform application over the total width of the applicator.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Travel Speed		
The travel speed will affect the application equipment output.	**Know how the travel speed affects application equipment output.**	**Identify how travel speed affects application equipment output.**
For granular application equipment using gravity flow metering mechanisms, increasing travel speed will decrease the application rate for a given setting.		
For granular application equipment using positive metering mechanisms, small changes in forward speed do not significantly alter the application equipment output when the metering mechanism is ground driven.		
Regardless of the metering mechanism, the travel speed selected during calibration should be maintained during application.		
Treatment Width		
The treatment width is used to determine the application equipment output and depends on the type of distribution system used.	**Understand treatment width and how it varies with the type of distribution system.**	
For broadcast application equipment, the treatment width equals the total width that granules are applied.		**Describe the treatment width for broadcast and band application equipment.**
For band application equipment, the treatment width equals the total of all the individual band widths for one pass.		
When granules are banded under the soil surface, the application equipment output is generally expressed as kg/m of row and treatment width is not considered.	**Know how application equipment output is expressed when granules are banded under the soil surface.**	**Identify how application equipment output is expressed when banding under the soil surface.**
Granular Application Equipment Calibration		

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Granular application equipment should be calibrated: **- when the application equipment is new;** **- at the start of each season;** **- when travel speed, metering mechanism, weather conditions, or pesticide are changed;** **- when the application equipment output changes.** **1. Determine a suitable field speed, taking into consideration the field conditions. Select the appropriate gear/rpm setting that will provide the desired travel speed. Record this information and maintain this speed throughout calibration and application.** **2. Select a test site. Either in the field where the application will occur or in an area having similar soil and terrain conditions. In a fairly level area, mark a test distance of at least 50 meters in length.** **3. Fill the hoppers approximately half full for average weight conditions.** **4. Consult the operators manual for the recommended setting of the metering mechanism. Never assume that the operators manual is correct, as the flow rate may vary significantly depending on the type of pesticide, weather, and field conditions. Always complete the calibration procedure to verify that the granule flow rate is correct.** **5. Attach bags or other containers under each opening to collect the granules during calibration. If possible use a blank carrier to avoid exposure. Special collection containers that are calibrated with a scale indicating weights may be available from the pesticide manufacturer. For granular equipment with a pneumatic delivery system, use either porous mesh bags (e.g., nylon) or shut off the air flow and catch the granules at the metering mechanism.**	**Know when and how to calibrate granular application equipment.**	**Describe when and how to calibrate granular application equipment.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
6. Operate the application equipment over the test distance at the correct gear/rpm selection. To minimize the error in collecting granules, the acceleration and deceleration distances should be kept as short as possible because at these times the granule flow cannot be controlled from the operator's seat.		
7. Remove the bags/containers, weigh and record the quantity collected in each. Sufficient material must be collected during the test to allow for accurate weighing on scales that are available. Do not use a scale that is used for food.		
8. Repeat the test in both directions, averaging the results.		
9. Assess the flow rate uniformity by comparing the individual values to the average value. Adjust and recalibrate if necessary.		
Always verify that the correct placement of granules occurs during calibration. To adjust band width, spreaders or tubes may be adjusted in height.	Know how to adjust band width.	Describe how to adjust band width.
Calculate: - the calibration area; - total amount collected; - treatment area; - total amount of pesticide required.	Know the calculation required for a granular applicator.	List the calculations required for a granular applicator.

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: CALIBRATION

General Objective: To understand the calibration procedure to ensure that the correct amount of granules will be uniformly applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calculations **Calibration area = test distance length x test distance width. Convert units to hectares or acres.** **Total granule flow rate = sum of the weights of individual openings.** **Treatment area (square/rectangular shape) = field length x field width. Convert units to hectares or acres.** **Broadcast or Banding (kg/ha units): Application equipment output = total granule flow rate ÷ calibration area. Record this in the operators manual for future reference.** **Banding (kg/m units): Application equipment output = total granule flow rate ÷ number of bands ÷ calibration test distance.** **Total pesticide required = treatment area x application equipment output.**	**Know how to perform the field calculations for granular application equipment.**	**Calculate area, application equipment output and total pesticide required.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on granular application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weather Conditions		
Before beginning any application, always evaluate the weather conditions at the site to assess potential problems. **High winds could affect the distribution of granules, decreasing uniformity or changing band width.** **A change in the humidity level can alter the flow rate of the granules, in turn affecting the application equipment output.**	**Know the environmental conditions which may influence a granular application.**	**Identify the environmental conditions which may influence a granular application.**
Wildlife		
Granular insecticides should be incorporated into the soil to reduce wildlife impact by minimizing the potential for ingestion. Refer to the pesticide label for specific instructions.	**Know how to minimize the impact of granular insecticides on wildlife.**	**Identify how to minimize the impact of granular insecticides on wildlife.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - GRANULAR APPLICATION EQUIPMENT: MAINTENANCE

General Objective: To understand the basic procedure in maintaining and cleaning granular application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Maintenance		
Proper maintenance of the application equipment minimizes the chance of a breakdown and increases the service life.	**Understand the importance of and procedure for a maintenance program for granular application equipment.**	**Identify the importance of properly maintaining granular application equipment.**
Never leave granules in the hoppers for extended periods as they can absorb moisture and harden into lumps. Before using the application equipment make sure that no moving parts are seized from corrosion. **The abrasive nature of the granules will require that all moving parts of the application equipment be frequently greased or oiled. Excessive lubrication can accumulate granules, dust and dirt, which can increase wear and possibly interfere with the operation of the equipment.** **Check all tires for proper inflation before use. The air pressure used will determine the effective size of the tire and the application equipment output. Over-inflated tires increase bouncing, decreasing uniformity.** **Check the delivery system to make sure the granules have an unobstructed path from the metering mechanism to the target.**		**Describe how to maintain granular application equipment.**
To prepare the equipment for storage: **- thoroughly clean the equipment, wearing appropriate protective clothing;** **- lubricate all moving and vital parts. Follow the manufacturer's recommendations;** **- check the equipment for worn parts, and replace them;** **- store the equipment where it will not be damaged by other equipment, livestock or weather.**	**Know how to prepare the equipment for storage.**	**Describe the steps in preparing the equipment for storage.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - SOIL FUMIGATION EQUIPMENT - GENERAL

General Objective: To understand the general usage of soil fumigation equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Types of Soil Fumigation		
Soil fumigation is used to kill weeds, weed seeds, insects and disease-causing organisms including nematodes which live in the soil.	**Understand where soil fumigation can be used in pest control programs.**	**Identify where soil fumigation can be used in pest control programs.**
There are three types of soil fumigation namely: **- tractor mounted injectors;** **- soil incorporators;** **- fumigation under sheets.**	**Know the types of soil fumigation.**	**List the types of soil fumigation.**
Tractor Mounted Injectors		
For larger areas, tractor-mounted chisel injectors and plough injectors) are usually used to apply fumigants. As the chisel moves through the soil, it creates an opening 6 to 8" deep. the injector, located immediately behind the chisel, releases measured amounts of fumigant. After the injector passes, soil falls back and closes the opening. Immediately after application, drag the soil to remove chisel marks. Roll the soil to further reduce the release of fumigant. For very volatile fumigants the treated area is covered with a gas-proof film such as polyethylene. Edges are sealed with soil to prevent the release of the fumigant.	**Know how to fumigate soil using tractor mounted injectors.**	**Describe how to fumigate soil using tractor mounted injectors.**
Soil Incorporators		
Soil incorporators can also be used when applying less volatile fumigants. The fumigant is sprayed on the field and is immediately cultivated (15 cm or less). The field is **then compacted with suitable equipment. An alternative to compaction is to irrigate the field following fumigation, as fumigants diffuse through water at a slow rate.**	**Know how to fumigate soil using soil incorporators.**	**Describe how soil incorporators can be used for soil fumigation.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - SOIL FUMIGATION EQUIPMENT - GENERAL

General Objective: To understand the general usage of soil fumigation equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fumigation under Sheets		
Sheets capable of retaining fumigant vapours may be used to cover the soil while the fumigation process is taking place. **Sheets made of polyethylene or polyvinyl chloride are generally used. Sheets should be at least 0.1 mm (4 mil) in thickness.** **If possible, use one large sheet instead of several small ones. Allow at least 1/2 metre of extra sheeting along the edge to allow for sealing.** **If sheets have to be joined, allow at least 1 metre of overlap, which can then be rolled to form a satisfactory joint.** **Once the release of the fumigant has been completed, the covering sheets should be checked for leakage along all joints and at the edges.**	**Know how to fumigate soil under sheets.**	**List the major steps in sheet fumigation.**
In those cases where the use of volatile fumigants require sheet sealing of the treatment area, care must be taken when aerating the treatment area. Always wear a full face canister respirator when aerating a site. Start by lifting the corner of the sheet to allow for gradual release of the fumigant. After 30 minutes the entire sheet can be removed. No one should work in the treated area until virtually all fumigant is gone.	**Know the precautions to take when aerating the treated area.**	**Describe the precautions to take when aerating the treated area.**
Small Treatment Areas		
For small areas such as seed beds, the technique of fumigation under sheets can be used as described earlier. Liquid fumigants can be applied with an injector or with hand held sprayers. A light sprinkling of water should then be sprayed over the treated area to prevent release of the fumigant.	**Know how small areas can be treated.**	**Describe how small areas can be treated.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - SOIL FUMIGATION EQUIPMENT - ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Application Timing		
The optimum time to apply soil fumigants is generally late summer or early fall.	Know the optimum time to apply soil fumigants.	Identify the optimum time to apply soil fumigants.
This allows sufficient time for the fumigant to be in the soil. Also, there is sufficient time for fumigant residues to disappear before planting in the following spring.	Understand why timing is important.	Describe why timing of the fumigation application is important.
Factors Affecting Performance		
The basic principle is to apply a fumigant to the soil and to allow it to diffuse through the soil. Several factors influence movement of fumigants within the soil. These include: - soil moisture; - soil compaction; - soil temperature; - organic matter.	Know the factors which influence movement of fumigants within the soil.	List the factors that influence movement of fumigants within the soil.
Soil Moisture		
If the soil is too wet, there is not enough air space within the soil to allow the gas to move about freely. If the soil is too dry, there will be too little moisture around the soil particles to absorb the fumigant. Also, the fumigant will readily escape through the soil and into the air above the soil.	Understand the relationship between soil moisture and fumigation effectiveness.	Describe the relationship between soil moisture and fumigation effectiveness.
Soil moisture should be sufficient that a handful of soil, when squeezed, just retains its shape but should crumble when touched. For drier soils or sandy soils, moisture may have to be added to the soil.	Know how to determine if the soil has sufficient moisture.	Describe how to determine if the soil has sufficient moisture.
Soil Compaction		
Heavy or compacted soils are not suitable for fumigation. These soils must be cultivated before they are fumigated.	Understand that soil compaction or very loose soil affects fumigation.	Identify that soil compaction or very loose soil affects fumigation.

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - SOIL FUMIGATION EQUIPMENT - ENVIRONMENTAL CONSIDERATIONS

General Objective: To understand the influence of environmental conditions on the application equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Light or sandy soils do not allow the fumigant sufficient residence time as it escapes too quickly.		
Soil Temperature		
When soil temperatures are below 4EC (at a depth of 15-20 cm) the fumigant converts slowly to a gas. Diffusion also occurs at a very slow rate. At temperatures approaching 25EC and beyond, the fumigant is converted rapidly to a gas and leaves the soil quickly. Residence time for the gas is insufficient to achieve effective pest control. **Soil temperature at a depth of 15 to 20 cm should be in the range of 10 to 20EC.**	**Understand how soil temperatures affect fumigation.**	**Describe how soil temperatures affect fumigation.**
Organic Matter		
Organic matter can bind the fumigant and prevent it from diffusing through the soil. Where organic material or crop residues are high, additional fumigant may be required to achieve effective pest control.	**Understand how organic matter reduces the effectiveness of the fumigant.**	**Describe how organic matter reduces the effectiveness of the fumigant.**

Category: AGRICULTURE

Concept: APPLICATION TECHNOLOGY - SOIL FUMIGATION EQUIPMENT - MAINTENANCE

General Objective: To understand the basic procedure in maintaining and cleaning soil fumigation equipment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Equipment should be thoroughly washed with water. Be sure to flush all parts of the system. **Once the system has been flushed with water, a final cleaning may be necessary. Check product label for specific instructions.** **Be sure to wear a proper respirator when cleaning the application equipment because fumigant residue may still exist.**	**Know procedures for cleaning fumigation equipment.**	**Describe the procedures for cleaning fumigation equipment.**