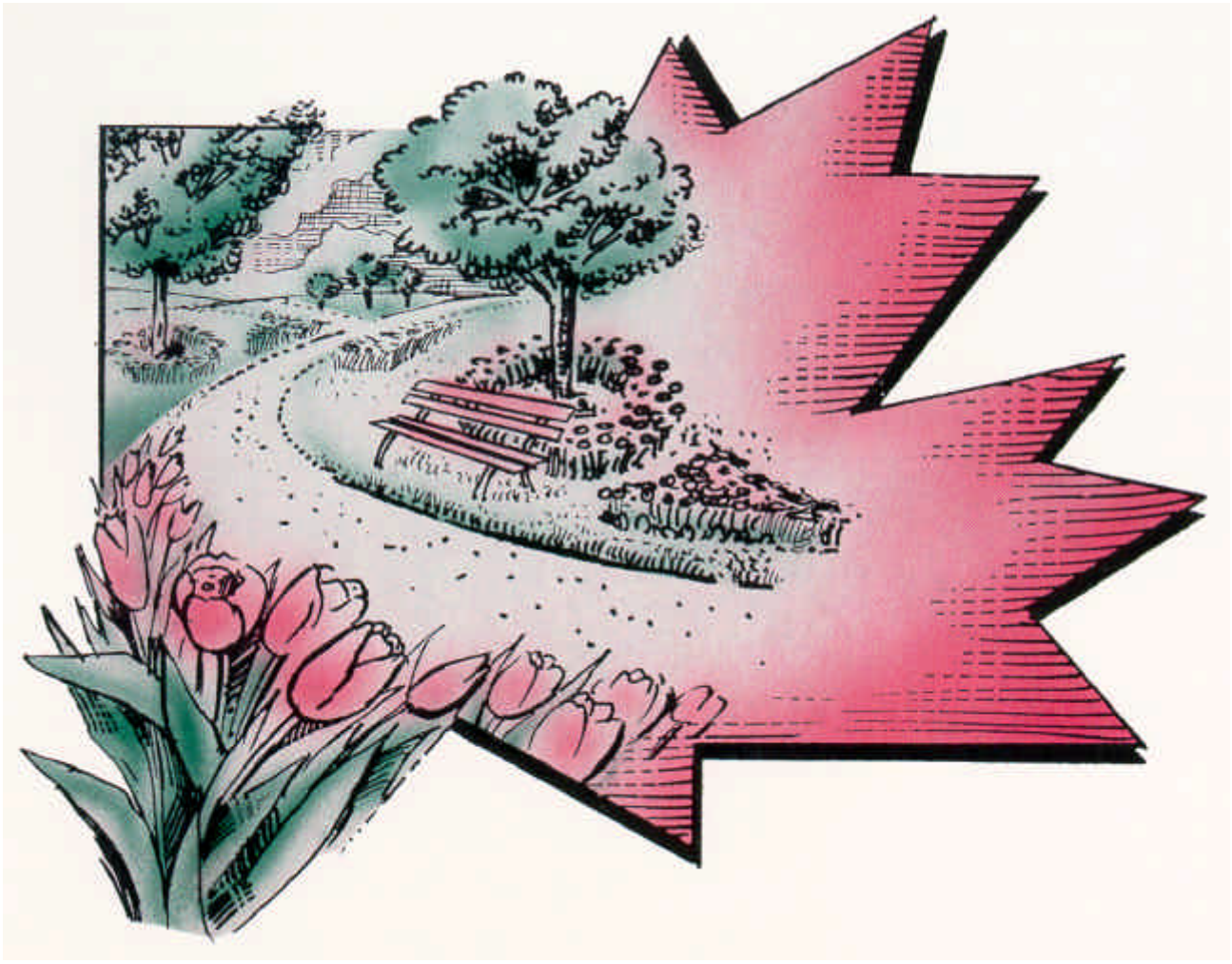

LANDSCAPE MODULE

BASIC KNOWLEDGE REQUIREMENTS FOR PESTICIDE EDUCATION IN CANADA

Federal/Provincial/Territorial Committee
on Pest Management and Pesticides

Edition 2004

Health Canada
Pest Management Regulatory Agency

LANDSCAPE MODULE

BASIC KNOWLEDGE REQUIREMENTS

FOR

PESTICIDE EDUCATION IN CANADA

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Prepared by the Working Group on Pesticide Education, Training and Certification

Edition 2004

The Standard for Pesticide Education, Training and Certification in Canada is posted on the Pest Management Regulatory Agency's website at:

http://www.hc-sc.gc.ca/pmra-arla/english/edutran/edutran-e.html

If you would like additional information on the Standard for Pesticide Education, Training and Certification in Canada, please contact:

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First Edition 1995

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Edition 2004 of the Landscape Module was developed by the Working Group on Pesticide Education, Training and Certification of the Federal/Provincial/Territorial Committee on Pest Management and Pesticides. It is the second edition of the Landscape Module and is an update of the original 1995 edition.

The 2004 Edition of the Landscape Module, was coordinated by Susan Hickey, Newfoundland and Labrador Department of Environment.

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Edition 1995 was developed by the National Task Force on Pesticide Education, Training and Certification of the Canadian Association of Pest Control Officials. This Task Force was re-formed as the Working Group on Pesticide Education, Training and Certification in 1996.

The 1995 Edition Landscape Module was written and its coordination and completion overseen by Sandra Shiels, Saskatchewan Institute of Applied Science and Technology.

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DIRECTIONS FOR USE OF THE LANDSCAPE MODULE:

The Landscape Module is organized into ten concepts. They are:

1. General Information
2. Regulations
3. Labelling
4. Human Health
5. Pesticide Safety
6. Environment
7. Pest Management
8. Application Technology
9. Emergency Response
10. Professionalism

Each concept is written in a three column format: Course Outline, Instructional Objectives and Learning Outcomes. The Course Outline contains the information the applicator must know, the Instructional Objectives are what the instructor must ensure the applicator learns, and the Learning Outcomes are what the applicator must be able to do (how their knowledge is measured).

- This module is intended to be used as information to develop applicator manuals and training materials. This module along with the Applicator Core is the minimum knowledge requirements for landscape applicators in Canada. No attempt has been made to expand concepts or to provide examples (except in cases where those were required to adequately describe a concept). This would be done during the development of training materials.

- Trainers developing applicator manuals need to include all the information in this module BUT do not have to maintain the sequence of information indicated in this module or the chapter headings.

- Information that is inconsistent or that requires updating should be referred to the Working Group on Pesticide Education, Training and Certification.

- Notes in this module are for anyone reading/using the document. The information required in the notes should be incorporated into the training manuals but the notes themselves should not appear in the Training Manuals.

IPM components unique to landscape have been described in the module as examples. Manuals should contain applicable examples to further explain the concept of IPM.

BASIC KNOWLEDGE REQUIREMENTS
FOR PESTICIDE EDUCATION IN CANADA
LANDSCAPE MODULE

The Landscape Category includes the use of pesticides (other than fumigants) by ground application for the maintenance of ornamental trees, shrubs, flowers and turf, on outdoor residential, commercial (e.g., golf courses and cemeteries), recreational and public land.

This category also includes pesticide use:

- in outdoor nurseries under plastic cover or open air (except inside greenhouses) for propagation of landscape and garden plants;
- on easements and surrounding lands that benefit the property;
- by injection into trees.

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 in the core, where it is necessary to include landscape specific information. An outline of the knowledge requirement for the landscape module is presented on the following page. This outline shows which sections of the Core have been expanded in the 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 landscape module, other modules have been developed for the following categories:

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

LANDSCAPE MODULE

CONTENTS

Category: LANDSCAPE

Concept: GENERAL INFORMATION - GROUPING PESTICIDES

General Objective: To know the general properties of the different chemical groupings in the landscape industry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pesticides can be grouped by: - Mode of Action; - Target Pest; - Chemical Families/Groups. The groupings are inter-related and can be used separately or in combination to describe a pesticide (e.g., 2,4-D is a systemic, selective, non-residual Group 4 phenoxy herbicide).	Know how pesticides can be grouped.	List how pesticides can be grouped.
Grouping by Mode of Action Common pesticides groupings by mode of action in the landscape category include: - By Inherent Properties; • Route of entry - contact or systemic, • Selectivity - selective or non-selective, • Residual Effectiveness - residual or non-residual, - By effect on the Pest; • attractant, • chemosterilant, • defoliant, • desiccant, • feeding stimulus, • growth regulators, • repellent, • toxicants (neurotoxins, acute toxicant, anticoagulants, fumigants, *Bacillus thuringiensis*), - By Timing of Application; • protectant (fungicides), • pre-plant (herbicides), • pre-emergence (herbicides), • post-emergence (herbicides).	Know the modes of action of pesticides used in the landscape category.	List the modes of action of pesticides used in the landscape category.

Category: LANDSCAPE

Concept: GENERAL INFORMATION - GROUPING PESTICIDES

General Objective: To know the general properties of the different chemical groupings in the landscape industry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
See the Pest Management Concept for a definition or description of each Mode of Action (where applicable) relevant to the landscape category.		
Grouping by Target Pest		
Common pesticides groupings by target pest in the landscape category include: - Fungicides; - Insecticides; - Bacteriacides; - Miticides; - Molluscides; - Herbicides; - Rodenticides. Consult the Applicator Core for a description of the above pesticides.	Know the types of pesticides by target pest that are used in the landscape category.	List the types of pesticides by target pest that are used in the landscape category.
Grouping by Chemical Family/Groups		
The target pest grouping can be further subdivided into chemical families/groups.		
The common herbicides families/groups used in the landscape category include: - ACCase Inhibitors (Group 1). These herbicides block a plant enzyme called acetyl CoA carboxylase (ACCase) that helps in the formation of grass plants roots. Examples include aryloxythenoxy propionate family (diclofop-methyl, fenoxaprop-ethyl, fluazifop-butyl) and cyclohexane dione family (sethoxydim and tralkoxydim);	Know the common herbicide families used in the landscape category. Understand that the different herbicide families/groups affect weeds differently.	List the common herbicide families used in the landscape category. Identify how the different herbicide families/groups affect weeds differently.

Category: LANDSCAPE

Concept: GENERAL INFORMATION - GROUPING PESTICIDES

General Objective: To know the general properties of the different chemical groupings in the landscape industry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- ALS/AHAS inhibitors (Group 2). These herbicides block the function of two enzymes called acetolactate synthase (ALS) and aceto-hydroxyacide synthase (AHAS) that are essential in amino acid synthesis. Examples include sulfonylurea family (chlorsulfuron, metsulfuron-methyl, thifensulfuron-methyl, tribenuron-methyl) and imidazolinone family (imazamethabenz, imazamox, imazapyr, imazethapyr); - microtubule assembly inhibitors (Group 3). These herbicides inhibit the cell division in roots causing seedling stunting and death. An example includes dinitroaniline family (trifluralin and ethalfluralin); - synthetic auxins (Group 4). These herbicides are plant growth regulators, which disrupt plant cell growth in the newly forming stems and leaves leading to malformed growth and tumors. Examples include: • phenoxy family (2,4-D, MCPA, mecoprop), • benzoic acid family (dicamba), • carboxylic acid family (clopyralid, picloram, and triclopyr); - photosynthetic inhibitors (Groups 5, 6 & 7). These groups all inhibit photosynthesis. This occurs by different effects at different sites in the photosynthetic process. Examples include: • triazine family (atrazine, simazine), • triazinone family (hexazinone, metribuzin), • uracil family (bromacil), • nitrile family (bromoxynil), • benzothiadiazole family (bentazon), • urea family (diuron, linuron, tebuthiuron), ‣ amide family (propanil); - Phosphate synthesis inhibitors (Group 9). This group inhibits the synthesis of an enzyme in the phosphate production cycle. An example includes glyphosate.		

Category: LANDSCAPE

Concept: GENERAL INFORMATION - GROUPING PESTICIDES

General Objective: To know the general properties of the different chemical groupings in the landscape industry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The common bactericide/fungicide families/groups used in the landscape category include: - Dithiocarbamate family (Group M) – Protectant, broad-spectrum fungicides that are used as foliar sprays. Examples include mancozeb, maneb, thiram; - Dicarboximide family (Group 2) – Protectant fungicides that affect cell division and are used as foliar sprays. Examples include vinclozolin, and iprodione. Benzimidazole family (Group 1) – Systemic foliar fungicides that inhibit tubulin formulation. Examples include benomyl and thiabendazole; - Inorganic family (Group M) – Wide-spectrum protectant fungicides that are used as foliar sprays. Examples include sulphur and copper; - Antibiotic family (Group 18) – Pesticides that inhibit fungal or microbial activity. Examples include azoxystrobin and streptomycin.	Know the common bactericide/fungicide families used in the landscape category. Understand that these different families/groups affect disease organisms differently.	List the common bactericide/fungicide families used in the landscape category. Identify how these different families/groups affect disease organisms differently.
The common insecticide/miticide/molluscicide chemical families/groups used in the landscape category include: - Carbamate family (Group 1A) – Contact and systemic insecticides that have short residual activity and inhibit cholinesterase activity. Examples include carbaryl and propoxur; - Nicotinoid family (Group 4) – Systemic insecticides that disrupt nerve transmission (antagonists). Examples include imidacloprid, thiamethoxam and difenoconazole; - Organophosphate family (Group 1B) – Contact and systemic insecticides that inhibit cholinesterase activity and where most have a short residual activity. Examples include acephate, dimethoate, oxydemeton-methyl, azinphos-methyl, chlorpyrifos, diazinon and	Know the common insecticide/miticide/molluscicide families used in the landscape category. Understand that the common insecticide/miticide/ molluscicide families/groups affect pests differently.	List the common insecticide/miticide/molluscicide families used in the landscape category. Identify how the common insecticide/miticide/ molluscicide families/groups affect pests differently.

Category: LANDSCAPE

Concept: GENERAL INFORMATION - GROUPING PESTICIDES

General Objective: To know the general properties of the different chemical groupings in the landscape industry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
malathion; - Pyrethroids family (Group 3) – Botanical insecticides or synthetic analogues of botanical insecticides that stimulate repetitive nervous discharges and have a wide range of knockdown and killing power. Examples include pyrethrum, pyrethrins, cypermethrin, deltamethrin, permethrin, resmethrin; - Organochlorine family (Group 2A) – Systemic and contact insecticides that interfere with nerve receptors. This pesticide family/group has limited uses allowed and is being phased out due to concerns about bioaccumulation. An example includes endosulfan; - Bt (*Bacillus thuringiensis)* microbial family (Group 11) – bacteria that causes the larvae of specific insects to stop feeding and die.		
The common vertebrate pesticides used in the landscape category include: - Chemical repellents that may be non-poisonous (e.g., sticky pastes) or poisonous to, deer, rabbits, rodents and other animals. Pesticide repellents are painted or sprayed on trees and shrubs to repel rodents, rabbits and deer (e.g., thiram); - Anticoagulant rodenticides that prevent blood from clotting after they are eaten. They are multiple-dose rodenticides (e.g., chorophacinone, warfarin) and need several feedings over several days.	Know the common vertebrate pesticide families used in the landscape category.	List the common vertebrate pesticide families used in the landscape category. Describe chemical repellents. Describe anticoagulant rodenticides.
Other references on chemical families/groups may be indicated - on pesticide labels, - in government publications, - in industry association publications, - in manufacturer publications,	Know where to find other references to chemical families/groups.	Identify where to find other references to chemical families/groups.

Category: LANDSCAPE

Concept: GENERAL INFORMATION - GROUPING PESTICIDES

General Objective: To know the general properties of the different chemical groupings in the landscape industry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- by educational institutions. **NOTE: The chemical families/groups (except for vertebrate pesticides) identified above have been taken from the Pest Management Regulatory Agency (PMRA) Regulatory Directive 99-06.**		
Chemical Additives		
Common chemical additives used in the landscape category include: - Aromatic Hydrocarbons; - Petroleum Distillates; - Petroleum Products; - Polymerized Butenes (sticky pastes).	Know the common chemical additives used in the landscape category.	List the common chemical additives used in the landscape category.
The effects of these additives may include: - making the pesticide more effective, extending or increasing storage stability and/or handling of the pesticide; - increasing the toxicity and flammability of a pesticide product.	Know the effects of these additives.	Describe the effects of these additives.
Hazardous chemical additive(s) included in a pesticide formulation will be indicated in the Material Safety Data Sheet. The label will also indicate any effects or concern related to the chemical additive. For example, if the additive makes the product flammable or toxic, a warning sign will be included on the label. If the additive requires specialized medical treatment upon exposure, that information will be contained in the Toxicological Information and/or First Aid sections of the label.	Know where to find details of the chemical additives in a pesticide.	Identify where to find details of the chemical additives in a pesticide.

Category: LANDSCAPE

Concept: GENERAL INFORMATION - GROUPING PESTICIDES

General Objective: To know the general properties of the different chemical groupings in the landscape industry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Some additives have pesticidal properties and so are registered as pesticides themselves, examples include dormant and summer oils that act by suffocating the pests. NOTE: The active ingredient examples provided in this module are meant to assist course designers and trainers with development of student manuals. The examples were current at the time of writing and are not all-inclusive.	Understand that some additives have pesticidal properties.	Identify that some additives have pesticidal properties.

Category: LANDSCAPE

Concept: REGULATIONS

General Objective: To know provincial and municipal pesticide regulations.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Provinces or municipalities may have legislation that requires - Public notification e.g. posting signs, newspaper ads. - Restricting the use of pesticides - Pesticide use approvals	Know municipal requirements for public notification of pesticide use. Know provincial requirements for public notification of pesticide use.	Identify the municipal requirements for public notification of pesticide use. Identify the provincial requirements for public notification of pesticide use.

Category: LANDSCAPE

Concept: HUMAN HEALTH

General Objective: To understand toxicity factors that affect and/or reduce exposure and risk.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Medical Fitness		
All individuals handling or using pesticides should have regular medical examinations and identify the nature of their work to their physician (i.e. pesticides and application method being used and personal protective equipment to be worn). This will enable the physician to assess the individual's "fitness" to perform the work.	Know why individuals handling or using pesticides should have a regular medical examination.	Identify why individuals handling or using pesticides should have a regular medical examination.
Some medical conditions may preclude the ability to safely perform pesticide applications including: - respiratory or heart disease that may preclude the use of respiratory protection; - low levels of cholinesterase may preclude use of organophosphate or carbamate pesticides.	Understand that some medical conditions may preclude the ability to safely apply pesticides.	Identify medical conditions that may preclude the ability to safely apply pesticides.
Medical conditions that preclude or require restrictions on the handling or use of pesticides should be brought to the attention of the employer and/or supervisor.	Know whom to report medical conditions that preclude or require restrictions on the handling or use of pesticides.	Identify whom to report medical conditions that preclude or require restrictions on the handling or use of pesticides.
Cholinesterase Testing		
Organophosphate and many carbamate pesticides inhibit cholinesterase. A pesticide's potential to inhibit cholinesterase is indicated on the label, usually under the Toxicological Information section.	Know the families that contain pesticides which inhibit cholinesterase.	Identify the families that contain pesticides which inhibit cholinesterase.
	Know that this information is usually on the label in the Toxicological Information.	Describe where to find information on whether a pesticide is a cholinesterase inhibitor.
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. When cholinesterase is unable to perform its normal function, the nerves in the body continue to send messages to the muscles causing muscle "tremors" or "fibrillations" to occur and can lead to fits or convulsions.	Understand what cholinesterase is.	Describe cholinesterase.

Category: LANDSCAPE

Concept: HUMAN HEALTH

General Objective: To understand toxicity factors that affect and/or reduce exposure and risk.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Quick medical treatment is required in cases of organophosphate or carbamate poisoning. Many pesticides in this group are highly toxic and are readily absorbed through the skin, lungs or digestive tract. Even the least toxic of this group is easily capable of poisoning humans when used improperly. Symptoms of acute poisoning occur during exposure or usually within 12 hours of contact.	Know that quick medical attention is required in cases of organophosphate or carbamate poisoning.	Identify that quick medical attention is required in cases of organophosphate or carbamate poisoning.
In general, mild exposure to these pesticides at infrequent intervals is unlikely to produce toxic effects. However, there is a danger from repeated small exposures, as symptoms of poisoning may occur suddenly without warning if cholinesterase levels are not allowed to return to normal. There are usually no serious long-term effects from small exposures, providing renewed exposure is avoided until cholinesterase levels have returned to normal. However, if exposure continues, there may be a potential for long-term health effects.	Know the potential effect of repeated mild exposure to these pesticides.	Describe the potential effect of repeated mild exposure to these pesticides.
The symptoms of carbamate poisoning are similar to those caused by the organophosphate pesticides, but of shorter duration.	Know the symptoms of carbamate and organophosphate poisoning.	Identify the symptoms of carbamate and organophosphate poisoning.
Applicators who handle these pesticides on a regular basis should have: 1. A baseline test to determine their cholinesterase enzyme levels before exposure as they vary between individuals. 2. A regular blood test to check cholinesterase levels during the exposure period. 3. A blood test after accidental exposure.	Identify when an applicator should have a cholinesterase test.	Identify when an applicator should have a cholinesterase test.
Blood samples should be analysed by a physician familiar with pesticide exposure and cholinesterase testing.	Know who should analyze the blood sample.	Identify who should analyze the blood sample.

Category: LANDSCAPE

Concept: HUMAN HEALTH

General Objective: To understand toxicity factors that affect and/or reduce exposure and risk.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
General Pesticide Effects on Human Health		
General pesticide related effects on human health have been described in the core.		
Acute toxicity is only one component in determining the overall toxicity of a pesticide. Examples of other components include chronic toxicity, cancer causing effects and ability to cause birth defects. In addition, the health risk of any pesticide is a combination of the overall toxicity and the risk of exposure.		
The following is a description of how different pesticide groupings may have different levels of acute toxicity.		
Herbicides Most herbicides have low acute mammalian toxicity however some chemical families have higher acute mammalian toxicity. For example: - Some families have moderate toxicity including phenoxys (e.g., 2,4-D, MCPA), difenzoquat, amitrole, triclopyr, amide family (propanil); - several families have high acute toxicity including pyridylium family (e.g., paraquat, diquat), benzonitriles (e.g., bromoxynil), endothall.	Know that acute mammalian toxicity for herbicides is generally low but that there are some exceptions	Identify that the acute mammalian toxicity for herbicides is generally low. Identify exceptions.
Insecticides In general, insecticides tend to have high acute mammalian toxicity and are more toxic to wildlife, fish, bees and other non-target organisms than herbicides or fungicides.	Know that acute toxicity for insecticides is generally high although some families have moderate or low toxicity.	Identify that acute toxicity for insecticides is generally high.
Some insecticides families however have only moderate toxicity including: - Nicotinoids (imidacloprid, thiamethoxam, metalaxyl-M, etc.); - Pyrethroids (cypermethrin, permethrin, pyrethrin, etc.).		Identify insecticide families that have moderate or low toxicity.

Category: LANDSCAPE

Concept: HUMAN HEALTH

General Objective: To understand toxicity factors that affect and/or reduce exposure and risk.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Some insecticide families have low toxicity including: - Microbials (*Bacillus thuringiensis, nuclear polyhedrosis virus)*; - Sorptive dusts (diatameous earth, silicone dioxide); - Borates (borax, boric acid); - Mineral oils (dormant or summer oils); - Soaps (insecticidal).		
Fungicides Fungicides tend to have low acute mammalian toxicity, (some exceptions apply e.g., cymoxanil, formaldehyde, thiram) though they are sometimes combined with insecticides (especially in seed treatment pesticides), which can substantially increase toxicity of the pesticide product.	Know that acute mammalian toxicity for fungicides is generally low (except when formulated with insecticides).	Identify that the acute mammalian toxicity for fungicides is generally low (except when formulated with insecticides). Identify fungicides that are exceptions.
Rodenticides In general, rodenticides all have very high acute mammalian toxicity and should be used very carefully.	Know that acute mammalian toxicity for rodenticides is generally high.	Identify that the acute mammalian toxicity for rodenticides is generally high.
With all pesticides, applicators should ensure they review the label and identify the toxicity from the warning symbols/specific warnings and identify probability of exposure before use of the pesticide.	Know how to determine toxicity and risk of exposure before using pesticides.	Describe how to determine toxicity and risk of exposure before using pesticides.
Petroleum Products		
Petroleum products are used as solvents, carriers, and diluents or for their pesticidal properties (e.g., dormant oils). Two types may affect human health: - petroleum distillates; - aromatic hydrocarbons.	Know the petroleum components of pesticides that may affect human health.	Identify the petroleum components of pesticides that may affect human health.
Petroleum Distillates (e.g., kerosene, mineral oil, diesel oil) are used as part of the pesticide formulation as a diluent or as pesticides themselves. They have a wide range of toxicities.	Know the symptoms of acute and chronic poisoning from petroleum distillates.	List the symptoms of acute poisoning from petroleum distillates.

Category: LANDSCAPE

Concept: HUMAN HEALTH

General Objective: To understand toxicity factors that affect and/or reduce exposure and risk.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Symptoms of acute poisoning may include nausea, vomiting, coughing and irritation to the lungs. This may progress to bronchial pneumonia with fever, weakness, dizziness, slow and shallow respiration, unconsciousness and convulsions. Chronic poisoning may cause weakness, weight loss, anemia, nervousness, and pains in the limbs or peripheral numbness.		List the symptoms of chronic poisoning from petroleum distillates.
Aromatic Hydrocarbons (e.g., xylene) are used as part of the pesticide formulation. They have a wide range of toxicities. Symptoms of acute poisoning may include dizziness, euphoria, headache, nausea, vomiting, tightness in chest and staggering. More severe symptoms are blurred vision, rapid respirations, paralysis, unconsciousness and convulsions.	Know the symptoms of acute poisoning from aromatic hydrocarbons.	List the symptoms of acute poisoning from aromatic hydrocarbons.
NOTE: The active ingredient examples provided in this module are meant to assist course designers and trainers with development of manuals. The examples were current at the time of writing and are not all-inclusive.		

Category: LANDSCAPE

Concept: PESTICIDE SAFETY – GENERAL PRECAUTIONS

General Objective: To know general safety precautions to take when applying pesticides.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Avoid spraying over shoulder height to minimize applicator and bystander exposure from drift.	Know the proper height to apply pesticides to avoid drift.	Indicate the proper height to apply pesticides to avoid drift.
Landscape applicators may be exposed to pesticide residues when handling treated plant material such as sod or grass clippings.	Understand that there is potential for exposure to the applicator during other activities such as laying sod and gathering treated grass clippings.	Identify other activities where landscape applicators may be exposed to pesticide residues.

Category: LANDSCAPE

Concept: ENVIRONMENT – PROTECTING THE ENVIRONMENT

General Objective: To know major concerns for and guidelines to prevent pesticide contamination of the environment.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The potential negative impacts of pesticides applied in urban or recreational areas include the following: - exposure of nesting birds and foraging bees when trees are sprayed; - exposure of birds feeding on treated lawns; - runoff into storm sewers or into open bodies of water; - unintentional drift, runoff to neighbouring properties; - leaching to desirable plant roots; - exposure of fish ponds and pools.	Know the potential negative impact on the environment.	Identify potential negative impacts to the environment.
The following guidelines will help to protect the environment: - use IPM principles; - abide by all label directions; - apply under appropriate weather conditions; - select pesticides to minimize risks to sensitive species in the area, e.g., nesting birds; - time applications to avoid sensitive species when nesting or feeding; - use appropriate drift management techniques and equipment; - consider site characteristics when selecting products; - select pesticides that have a low potential to leach or runoff.	Know guidelines for protecting the environment.	List guidelines for protecting the environment.

Category: LANDSCAPE

Concept: PEST MANAGEMENT – INTEGRATED PEST MANAGEMENT

General Objective: To understand the principles of Integrated Pest Management required to carry out safe and effective pest control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Integrated Pest Management		
All elements of an IPM program (prevention, identification, monitoring, injury and action levels, treatments and evaluation) are used in IPM programs in the Landscape category. IPM in landscapes is based on preventing pest problems by growing healthy plants. It is similar to the plant health care approach, which sees pest problems as indicators of plant health problems. Maintaining healthy plants can be a challenge in urban landscapes. Plants may be stressed from air pollution, high summer temperatures, poor air circulation and disturbed or compacted soils. Good site design is essential to growing a healthy landscape. Site planners should choose trouble free plants suited to local growing conditions and design planters, beds and other facilities to provide good growing conditions. Where sites have continuing pest problems, an IPM program should include long term plans to correct underlying problems.	Know how IPM is unique to the Landscape Category.	Describe how IPM is unique to the Landscape category.
Putting IPM into Practice		
When starting to implement IPM, it is often best to set realistic objectives for a small site or for a few types of pests before using IPM on a large scale.	Understand that it is often best to implement IPM for a small site or for a few types of pests before using IPM on a large scale.	Identify how it is best to first implement an IPM program.

Category: LANDSCAPE

Concept: PEST MANAGEMENT – INTEGRATED PEST MANAGEMENT

General Objective: To understand the principles of Integrated Pest Management required to carry out safe and effective pest control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Before beginning an IPM program, it is important to collect and analyze information about a management site, including: - physical characteristics; - an inventory of plants or animals that require protection; - use patterns and environmental concerns; - past records of pest problems or treatments; - regulatory requirements or bylaws that apply; - treatments that could be used; - financial and other resources available to implement the IPM program.	Know the types of information that should be collected about a management site before developing an IPM program.	Describe the types of information that should be collected about a management site before beginning an IPM program.
When starting an IPM program, a plan should be developed that includes all the IPM elements (prevention, identification, monitoring, injury and action levels, treatments and evaluation). Steps to develop the plan may include: - setting a policy that pests must be correctly identified before action is taken; - choosing suitable monitoring methods and a record keeping system; - setting injury and action thresholds (this may require setting temporary thresholds, if none are available, and determining how to collect data to refine these thresholds); - establishing policies on what treatments will be used; and - developing an evaluation schedule.	Know the key steps for developing an IPM Plan.	List the key steps for developing an IPM Plan.
Revisit the IPM plan at least once a year to make improvements based on the evaluations.	Know how often to revisit the IPM plan.	Identify how often to revisit the IPM plan.

Category: LANDSCAPE

Concept: PEST MANAGEMENT – INTEGRATED PEST MANAGEMENT

General Objective: To understand the principles of Integrated Pest Management required to carry out safe and effective pest control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Maintenance Categories		
A useful way to set priorities for an IPM program is to divide maintenance sites into categories according to the level of pest management service required. This makes it easier to determine where to put resources for monitoring and treatment efforts. It also allows setting appropriate injury levels for each site category.	Know how to set priorities for monitoring and treatment efforts in an IPM program. Know why it is important to categorize maintenance sites.	Describe how to set priorities for monitoring and treatment efforts in an IPM program. Identify why it is important to categorize maintenance sites.
Landscape sites can be divided into 3 categories: - Class A – High level of service: These are high value, high visibility or high maintenance sites such as formal display beds in parks, residential front yards, fine lawns, golf and bowling greens, hanging baskets, botanical gardens, plant nurseries and conservatories. - Class B – Moderate Level of Service: These are medium visibility or moderate maintenance sites, such as boulevards and medians, general park and playground areas, residential backyards and perennial borders in parks. - Class C – Low Level of Service: These include low profile or low maintenance sites, such as nature parks, recreational areas, picnic areas, hiking trails, maintenance yards and industrial sites.	Know how to categorize sites in landscaped areas.	Describe how to categorize sites within landscape areas.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weeds		
A weed is a plant growing where it is not wanted.	Know what a weed is.	Define weed.
Weeds are pests when their numbers are above a level that cannot be tolerated (threshold), including when they: - compete with cultivated plants for light, water or nutrients; - when they reduce crop yields; - pose a threat to people or livestock; - contaminate foods; - are alternate hosts for other pests; - reduce visibility along transportation corridors; - affect the playability on a sports field or playground; - are aesthetically unpleasant.	Know when weeds are pests.	Identify when weeds are pests.
Life Cycles		
Weeds go through different stages as they grow. The stages describe change in function. The common stages are: seed, vegetative and reproductive stages. Some weeds die after the reproductive stage (annuals and biennials). Others continue to live and grow and may enter the vegetative and reproductive stages many times (perennials). Weeds are usually classified according to how long they live. Weeds can be classified as annuals, biennials or perennials. **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 that germinate in the spring, and winter annuals that germinate in the fall.	Know the types of weed life cycles.	Describe the types of weed life cycles.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Biennial weeds live more than one year but less than two years. They grow from seed, which usually germinates in the spring. The first year they store food, usually in short fleshy roots. Usually the foliage is only a rosette of leaves. Next season the plant uses the stored food and grows vigorously. It produces seed in the summer or fall and then dies.		
Perennial weeds live more than two years. Often no seed is produced the first year; thereafter seeds can occur every year for the life of the plant. Most perennial weeds spread by seed. Many also spread vegetatively by producing creeping stems, stolons, creeping roots, rhizomes, and bulbs. There are shallow-rooted and deep-rooted perennials.		
Weed Identification		
The following physical structures will aid in the identification of weeds and desirable vegetation: - leaves, e.g., • cotyledons • compound or simple • shape • margin • surface (smooth or hairy) • arrangement along the stem - stems, e.g., • branching habit • woody vs. herbaceous • upright or spreading - flowers, e.g., • arrangement • number of petals, sepals • reproductive parts • seeds	Know the major physical structures that aid in the identification of weeds and desirable vegetation.	List the major physical structures of plants that aid in the identification of weeds and desirable vegetation.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- roots, e.g., • fibrous, • creeping, • tap.		
Identifying Leaf Stages		
Knowing how to identify the leaf stages of desirable plants and weeds is important because: - herbicide labels refer to weed and desirable plant leaf stages. - often herbicides are only effective when desirable plants and weeds are at certain stages of growth. There might not be enough leaf area for efficacy if herbicides are applied too early. When applied too late, weed control may not be achieved or desirable plants could be damaged.	Understand why it is important to know how to identify leaf stages of desirable plants and weeds.	Describe why it is important to know how to identify leaf stages of desirable plants and weeds.
Weed sizes and leaf numbers change rapidly. Avoid applying herbicides past the stage when they will be effective by regularly monitoring growth of weeds.	Understand why the growth of weeds should be regularly monitored.	Identify why the growth of weeds should be regularly monitored.
Leaf Stages of Broadleaf Plants		
The first leaves are the cotyledons. They are also called the seed leaves. They are usually a different shape than the true leaves and may dry up and disappear at an early stage. On a few plants they stay beneath the soil surface. Cotyledons are not counted when determining leaf number. True Leaves are the leaves that appear after the cotyledons. They can be used for identification of the species.	Know how to distinguish between true leaves and cotyledons of broadleaf plants.	Describe cotyledons and true leaves of broadleaf plants.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Leaves are arranged along the stem as: alternate, opposite, whorled or a combination of these patterns. Alternate leaves emerge from alternate sides of the stem and are not directly opposite each other. Opposite leaves are pairs of leaves coming from the same node on the stem and are situated across the stem from each other. Whorls leaves emerge as groups of three or more leaves coming from the same node of the stem.	Know how leaves can be arranged along the stem of broadleaf plants.	Describe the arrangements of leaves along the stems of broadleaf plants.
When counting leaf numbers, count each true leaf whether alternate, opposite or in a whorl, unless the recommendation refers to the number of whorls or pairs of leaves. Some plants have compound leaves (e.g., clover). Compound leaves are made up of several leaflets. Each compound leaf is counted as one leaf. Do not count each leaflet.	Know how to count leaves of broadleaf plants.	Describe how to accurately count the number of leaves on a broadleaf plant.
Leaf Stages of Grassy Plants The first leaf is a coleoptile (protective sheath). It usually stops growing when the tip breaks through the soil surface. The next leaves are the true leaves. They emerge alternately along the stem. They can be used for identification of the species.	Know the leaf stages of grassy plants.	Describe the leaf stages of grassy plants.
Tillers (or stools) are the secondary shoots of a grass plant. They emerge from a bud at the base of the leaves.	Know how to recognize tillers.	Describe tillers.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Count all the leaves on the main shoot. Generally, coleoptiles and tillers are not included in a leaf count, however some labels may include diagrams with tillers and tiller leaves being counted.	Know how to count leaves of grasses.	Describe how to accurately count the number of leaves on a grass plant.
Pest Management Methods For Weeds		
Weeds should be controlled following an integrated pest management (IPM) approach. Plan the IPM program by considering the pest, the environment, human and animal safety, the desirable vegetation, and available treatment methods.	Know that weeds should be controlled through an IPM approach.	Identify that weeds should be controlled through an IPM approach.
The components of an IPM program (prevention, identification, monitoring, injury and action thresholds, treatments and evaluation) are each discussed below.	Know the components of an IPM program that should be considered for weed control.	List the components of an IPM program that should be considered for weed control.
Prevention		
The key to long-term weed management is designing areas to prevent weeds from becoming a problem initially.	Know the key to long-term weed management.	Identify the key to long-term weed management.
Ways to prevent future weed problems in the landscape include: - designing landscapes which provide for good growing conditions; - installing thick mulches, or other barriers to stop weeds from growing; - filling in cracks in paving surfaces; - planting competitive ground covers; - growing vigorous turf that smothers weeds.	Know ways to prevent future weed problems.	List ways to prevent future weed problems.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Identification		
Many pest managers collect preserved or dried weed specimens to assist in identification. Assistance in weed identification may also be provided in government or industry publications.	Know ways to identify weeds.	Describe ways to identify weeds.
Monitoring		
Monitoring for weeds is usually done less often than for other types of pests. One to four inspections or counts per year are usually sufficient. On low maintenance sites, occasional visual inspections may be all that is necessary. On high maintenance turf, counts of broadleaf weeds may be done several times per year.	Know how often sites should be monitored for weeds.	Describe how often sites should be monitored for weeds.
Injury and Action Thresholds		
For weeds in landscapes, injury thresholds may involve: - the consequences of leaving weeds unmanaged, such as seeds blowing to other sites or impairing the growth of desirable ornamentals and turf; - safety of site users from slip or trip hazards, blocked sight lines or hidden signs or ditches; - potential for damage to structures, hard surfaces and foundations; - potential for fire hazards; - maximum reduction in aesthetics of the site that can be tolerated. Setting the action threshold is largely dependent on the use of the site, landscape management approach and the level at which plant growth is adversely affected. Acceptable level of	Know the factors that determine the injury and action thresholds.	Describe the factors that determine the injury and action thresholds.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
weed infestation will be less on high service areas than on low service areas. Commonly used ways to define injury levels in landscapes include: - number of complaints received from the public about weed presence; - number of weeds per square metre of turf (% weed cover) or shrub bed; - average height of vegetation around signs or sight lines; **Treatment Methods** The following IPM treatment methods (described in the core) should be evaluated and used (preferably in combination) where appropriate: cultural, biological, physical and chemical. **Cultural** This involves preventing pests from developing or spreading. Applicators may disrupt pests, or make the environment less favourable to survival of the pest or they may enhance the growth and development of desirable plants and includes: - nurse or companion plants; a fast growing plant planted with a slower growing plant competes with weeds and is mowed or removed when the slower plant is established; - increasing plants' ability to compete with weeds by using good cultural practises (adequate watering and maintenance of soil fertility); - soil improvement practises; - using certified seed; - controlling weeds in nearby areas;	Know cultural treatment methods for landscape weeds.	Describe cultural treatment methods for landscaped weeds.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- cleaning machinery and footwear before moving to another area; - using only well rotted manure; - use management (playing field).		
Biological		
This method includes releasing weed-specific insects or other natural agents.	Know biological treatment methods for landscape weeds.	Describe biological treatment methods for landscape weeds.
Physical/Mechanical		
This method involves using equipment or devices or the management of environmental factors to control weeds and includes: - cutting weedy tops prior to weed seed production; - cultivation; - hand pulling weeds; - mowing weeds; - using tractor blades to scrape weeds from sand or gravel surfaces; - using synthetic (geotextiles and plastics) or organic mulches to suppress seed germination. Where organic mulches are used, a 10 cm layer must be applied and replenished frequently to make an effective barrier; - applying heat to control weeds using propane flamers, hot water applicators and infra-red radiation generating equipment. This treatment controls top growth only and is more effective on annuals and germinating seeds.	Know physical/mechanical treatment methods for landscaped areas.	Describe physical/mechanical treatment methods for landscaped areas.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Chemical		
This method involves the use of herbicides to control weeds.	Know what chemical treatments involve.	Define chemical treatments.
Set action threshold for different types of treatments. Broadcast herbicide application should be used only when weeds are present in large numbers. Spot treat with a herbicide when there are only a few weeds.	Know that there are different action thresholds for different treatments.	Identify that there are different action thresholds for different treatments.
See the General Information Concept for a description of the chemical families/groups.		
Herbicide Groupings		
Herbicides are classified according to selectivity, mode of entry, timing of application and residual effectiveness.	Know the ways that herbicides may be classified.	List the ways that herbicides may be classified.
Selectivity describes whether a herbicide kills all plants or only some types of plants. Some herbicides are either selective or non-selective depending on the application rate.	Know what selectivity refers to. Know selective and non-selective herbicides.	Describe selectivity. Describe selective and non-selective herbicides. Identify selective and non-selective herbicides.
Selective herbicides only kill or damage certain plants.		
Non-selective herbicides kill or damage all plants in a treated area.		
Route of entry - explains how the herbicide acts on the plant. Herbicides can have contact (and therefore do not enter the plant) or systemic action.	Know what route of entry is. Know contact and systemic herbicides.	Describe route of entry. Describe contact and systemic herbicides.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Contact herbicides kill plant parts contacted by the herbicide. There is little or no movement of the herbicide in the plant. Contact herbicides are effective against annual weeds but they only "burn off" the tops of perennial weeds.		
Systemic herbicides enter the roots or above ground parts of plants. These herbicides move (i.e. are translocated) within the plant. Symptoms may not appear for a week or more after treatment. If the herbicide is too concentrated when it contacts the leaf or stem tissue, it may kill the cells too quickly. This will prevent translocation of the herbicide to the site of action in a plant and reduce or prevent the pesticide from having an effect.		
Timing of application - describes the stage of weed/desirable plant at which the herbicide is applied. Herbicides are classified as: pre-plant, pre-emergence and post-emergence.	Know to what timing of application refers. Understand pre-plant, pre-emergence and post-emergence herbicides.	Describe timing of application. Define pre-plant, pre-emergence and post-emergence herbicides. Describe pre-plant, pre-emergence and post-emergence herbicides.
Pre-plant herbicides are applied to the soil before seeding or transplanting plants/crops. Pre-plant treatments are usually incorporated into the soil.		
Pre-emergence herbicides are applied to the soil after planting but before the emergence of the specified crop or weed. Pre-emergence may refer to the germination of either the weed or the crop; check the pesticide label for instructions on specific herbicides. Pre-emergence herbicides control weeds before or soon after they emerge.		
Post-emergence herbicides are applied after the specified crop or weed has emerged. The application may be soon after		

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
emergence or up to a specific height or leaf number. Post emergence herbicides control established weeds.		
Residual effectiveness - refers to how long the herbicide is biologically active once applied. Herbicides are classed as residual or non-residual.	Understand residual effectiveness. Understand residual, non-residual and non-selective residual herbicides.	Describe residual effectiveness. Define residual, non-residual and non-selective residual herbicides. Identify residual, non-residual and non-selective residual herbicides.
Non-residual herbicides are quickly inactivated in the soil after application. They do not affect future plantings. **Residual herbicides** break down slowly and may control weeds for several weeks to several years. **Non-selective residual herbicides** are applied to the soil to prevent growth of all plants for a long period of time (a few months to many years). These are often called soil sterilants, however, they do not sterilize the soil of all micro-organisms or seeds.		
Special precautions are required when using residual herbicides. Ensure that the following items have been considered. Residual herbicides can damage trees and shrubs that have roots extending into the treatment area or damage trees and shrubs later when roots grow into a treated area after an application. A buffer zone between the application site and nearby woody vegetation should be indicated on the label. If not, the buffer width should not be less than two times the height of the woody vegetation.	Understand that special precautions need to be considered when using residual herbicides.	Identify why special precautions need to be considered when using residual herbicides.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Avoid applications of residual herbicides in areas with a high water table, especially when combined with coarse-textured soil. These conditions can lead to groundwater contamination.		
Residual herbicides can limit the future use of treated areas. A residual herbicide should only be used if the present use will continue for a period greater than the residual period of the herbicide.		
The persistence of residual herbicides can vary, depending on the product, rate, formulation, concentration, weather conditions and soil conditions.		
Avoid treating steep slopes or areas subject to erosion and runoff with residual herbicides, as movement of herbicide-containing soil can cause adverse effects where the soil is carried.		
Factors Affecting Herbicide Effectiveness		
The main factors that affect herbicide effectiveness are: shape and surface of leaves, age of the weed, weather, soil type and peculiarities, soil moisture, cultivation, and herbicide resistance.	Know the main factors that affect herbicide effectiveness.	List the main factors that affect herbicide effectiveness.
Shape and surface of leaves - Thin upright leaves are hard to cover with spray. Hairy or waxy plant surfaces may reduce the herbicide contact. Additives (surfactants or surface-active agents) can be added to the spray tank, if necessary to improve the herbicide's ability to adhere and penetrate the leaves. Additives may be added only if their use is indicated on the herbicide label.	Know how the shape and surface of leaves affect herbicide effectiveness.	Describe how the shape and surface of leaves affect herbicide effectiveness.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weather - Temperature, humidity, rain and wind may affect herbicide effectiveness. Moderate conditions are usually better than extremes. The herbicide label will 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 evaporate quickly from the weed leaves and therefore reduce effectiveness. Under high temperature, plant cells harden off; thereby making pesticide entry difficult. Rain 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 drift and prevent the herbicide from reaching the target.	Know how weather affects herbicide effectiveness.	Describe how weather conditions affect herbicide effectiveness.
Age of the weed - Herbicides are often more effective on young rapidly growing weeds. Systemic herbicides, which move with the food and water, can spread faster in rapidly growing younger weeds than in older plants. Herbicides are less likely to kill plants, which are in full flower or producing seed. Broadleaf perennial weeds often become more tolerant to herbicides as they grow older, but may become more susceptible again in the bud or early flowering stage. At this stage, the herbicide will move with the carbohydrates to be stored in the roots or spreading rhizomes and will more likely kill the entire plant.	Know how the age of the weed affects herbicide effectiveness.	Describe how the age of the weed affects herbicide effectiveness.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Grassy perennial weed controls are most effective in the spring when there are 4-5 leaves and the nutrient reserves are low or in the fall when the nutrients are being translocated to the underground parts of the plant.		
Soil type and characteristics - Higher herbicide application rates may be needed for soil active herbicides if they are applied to organic (peat or muck) or fine textured soils (clay or silt). These soils hold more herbicide on the soil particles and this reduces the amount available for weed control. Sandy soils usually need less herbicide. The label will state the minimum and maximum rates. There is an increased potential for lateral movement of water and herbicide in clay soils and compacted soils. The following soil characteristics could also affect the effectiveness of the herbicides: - pH extremes; - high sodium levels.	Know how the soil type and characteristics can affect herbicide effectiveness.	Describe how soil type and characteristics can affect herbicide effectiveness.
Soil moisture - Soil applied herbicides generally work best in a warm, moist soil. The moisture helps the herbicide move to the weeds. Good soil moisture levels are needed to keep weeds turgid. Systemic herbicides will be more effective in turgid weeds.	Know how soil moisture can affect herbicide effectiveness.	Describe how soil moisture can affect herbicide effectiveness.
Cultivation - Cultivating before a herbicide application can make herbicides more or less effective depending on the weed and the herbicide.	Know how cultivation can affect herbicide effectiveness.	Describe how cultivation can affect herbicide effectiveness.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Some weeds may be weakened by cultivation and become easier to control. Other weeds may be broken into pieces and be harder to control with systemic herbicides. Read label directions before cultivating to see if it will be beneficial. Cultivation can encourage weed seeds to germinate. These can then be controlled with a herbicide.		
Resistance - Weeds can develop resistance to herbicides. When the same herbicide or a member of the same herbicide group is used on consecutive applications, the possibility of resistance developing increases.	Know how resistance to a herbicide can develop.	Describe how resistance to a herbicide can develop.
The development of resistant weeds can be slowed by: - using a variety of chemical and non-chemical methods; - using a herbicide only when needed; - alternating herbicides from different chemical families/groups or modes of action (see the General Information Concept for a description of the chemical families/groups); - using registered tank mixes that will control weeds by two different modes of action.	Know how to slow the development of resistant weeds.	Describe how to slow the development of resistant weeds.
Evaluation		
The last step in an IPM program includes reviewing all aspects of the program; evaluating the results and where desired effectiveness has not been achieved, identify changes that can be made to improve the program's effectiveness.	Know the factors to include in the evaluation step of an IPM program.	List the factors to include in the evaluation step of an IPM program.
NOTE: When developing manuals: - **describe the weeds that are a significant problem in the province where the manual will be used.**	Know which weeds are problems in your province and be able to identify them.	List the weeds that are a problem in your province. Describe the weeds that are problems in your province.
- **describe approaches and treatment methods that**	Know the approaches and treatment methods that	

Category: LANDSCAPE

Concept: PEST MANAGEMENT - WEEDS

General Objective: To understand pest management principles required to carry out safe effective weed control

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
illustrate IPM principles for weeds that are significant problems in the province where the manual will be used	illustrate IPM principles for weeds that are significant problems in the province where the manual will be used.	Describe the approaches and treatment methods that illustrate IPM principles for weeds that are significant problems in the province where the manual will be used.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insects and Mites		
Insects are a group of animals that (as adults) have jointed bodies, 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 breathe through spiracles (pores) in their outer skeleton.	Know the general description 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 them.
Mites are a group of animals that (as adults), have jointed bodies, jointed legs and an outer skeleton like insects. Mites differ from insects in that they have only two main body parts: one consists of only the mouthparts and the other is the remainder of the body and parallels the head, thorax and the abdomen of insects. After hatching from the egg, the larva has three pairs of legs, whereas the older stages, the nymph and adult stages, have four pairs of legs. Mites do not have wings.		
There are many different insects and mites. Only a few are pests when they damage property, crops, food, feed, and livestock; and when they carry diseases affecting humans or animals. Insect and mites can vary from province to province.	Know when insects or mites are pests.	Identify when insects or mites are pests.
Insects and mites can do most of their damage with their mouthparts in the course of feeding. The mouthparts of these pests are adapted for one or more of the following: chewing, sucking, siphoning and lapping.	Know how the different type of mouthparts an insect or mite has, will affect the damage done.	List the ways that insects and mites use their mouthparts to feed.
Insect and Mite Life Cycles		
Insects and mites go through three to five different stages as they grow. The common stages are: egg, nymph, larva, pupa, and adult. These stages describe a change in size or form.	Know the stages of growth that insects and mites go through.	Describe the stages that mites and insects may go through.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
When an insect changes in form, they are said to undergo metamorphosis.	Understand the concept of metamorphosis.	Define metamorphosis.
Insect life cycles are made up of a series of specific stages. Typical insect life cycles include: - Egg to young to adult (no metamorphosis). The young look like the adult but are less developed (e.g., silverfish). All life stages live in the same habitat. The adult is the reproductive stage. - Egg to nymph to adult (gradual or incomplete metamorphosis). A nymph is similar in appearance to the adult but is wingless and lacking reproductive organs. The nymphs moult (shed their exoskeleton) three to five times to attain the size and development of the adult. They have compound eyes and externally developing wings (e.g., aphids and grasshoppers). All stages of the life cycle live in the same habitat. The adult is the reproductive stage. - Egg to larva to pupa to adult (complete metamorphosis). The larva is very different from the adult. It is grub-like and feeds extensively (e.g. caterpillars, loopers, grubs, and maggots). The larva goes through three to five stages (instars) where it sheds its exoskeleton to grow in size. The pupa is a non-feeding stage during which complete change of shape occurs. The adult is the reproductive stage and is usually winged. (e.g., mosquitoes, moths, beetles and flies). The larvae and adults may live in different habitats.	Know the typical life cycles of insects.	Describe the typical life cycles of insects.
Mites generally go through five stages in their life cycle: egg, larva, two nymphal stages and adult. The adult is the reproductive stage and all share the same feeding preferences. The larva, nymphs and the adult are all feeding stages. All stages are found in the same habitat.	Know the life cycle of mites.	Describe the life cycle of mites.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
A generation is the completion of all the stages in a particular insect/mite's life cycle. Some insects and mites may have more than one generation per year and may require management at each injurious stage. The number of generations per year is dependent on species and climate.		
Pest Management Methods for Insects and Mites		
The most effective control is usually achieved during the active immature stages (young, nymph, or larva). Adults can also be controlled but to a lesser extent. Most insecticides and miticides do not affect eggs and pupae.	Know the life cycle stages of growth during which the best control is usually achieved.	Identify the life cycle stages during which the best control is usually achieved.
Insect and mites should be controlled following an integrated pest management (IPM) approach. Plan the IPM program by considering the pest, the host, predators and parasites, the environment, human and animal safety and the available treatment methods.	Know that control of insects and mites should follow an IPM approach.	Identify that control of insects and mites should follow an IPM approach.
The components of an IPM program specific to the landscape certification category (prevention, identification, monitoring, injury and action thresholds, treatments and evaluation) are each discussed below.	Know the components of an IPM program to consider for insect and mite control.	List the components of an IPM program that should be considered for insect and mite control.
Prevention		
Landscapes must be designed to prevent unwanted pests from becoming a problem. Ways to prevent pest problems in landscapes include: - choosing plants that are not susceptible to common insect/mite pests; - choosing a diversity of plant families, species and cultures to avoid monocultures that can allow insect/mite populations to build to high levels;	Know ways that landscapes can be designed to prevent pests from becoming a problem.	Identify ways that landscapes can be designed to prevent pests from becoming a problem.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- choosing plants that attract beneficials (e.g., birds); - inspecting new plants for insect/mite presence prior to installing into the landscape; - preventing boring insects from entering trees by protecting trunks from injury by equipment.		
Identification		
Many pest managers collect preserved or dried pest specimens to assist in identification. Assistance in pest identification may also be provided in government or industry publications.	Know ways to identify pests.	Describe ways to identify pests.
Monitoring		
Most monitoring for insects/mites in high maintenance areas should involve weekly inspections or counts during the time the pests are expected to be present. Standard monitoring methods for insects or mites include counting the number of: - insects/mites per leaf or shoot; - leaves or shoots out of a total sample that have pests or beneficial insects/mites present; - insects or mites captured on sticky traps, pheromone traps or pitfall traps; - insects/mites that drop into a beating tray when the tree trunk or branch is jarred.	Know when and how to monitor pests in a landscape.	Identify when to monitor for pests in the landscape and describe how they can be monitored.
Injury and Action Thresholds		
Setting injury thresholds (the unacceptable level of damage) often involves considering the aesthetics of insect/mite damage, but may also involve economic damage (e.g., to nursery or ornamental plants).	Know how to set injury and action thresholds in landscapes.	Describe how to set injury and action thresholds in landscapes.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Setting action thresholds is largely dependent on the use of the site. Acceptable damage will be less on high service areas than on low service areas. Common ways to define injury levels include: - percentage of leaves damaged on a host; - percentage of insects/mites in a specific area; - percentage of plants damaged on a site; - number of complaints received from the public or client about the specific problem; - number of insects/mites counted in relation to the number of beneficial insects/mites found.		
Treatments The following IPM treatment methods (described in the core) should be considered and used (alone or in combination) where appropriate: cultural, biological, physical/mechanical and chemical.		
Use of cultural, biological, physical/mechanical treatments where possible helps protect native beneficial insects and mites that control pests.	Understand that the use of cultural, biological and physical/mechanical treatments help protect beneficial insects and mites.	Identify that the use of cultural, biological and physical/mechanical treatments help protect beneficial insects and mites.
Cultural		
This method is very important for managing insect and mite pests. Cultural treatments are discussed under prevention.	Know cultural treatment methods.	Describe cultural treatment methods.
Biological		
There are two aspects to using this method. The first is to avoid harming beneficial natural enemies of the pests including predatory insects and mites, birds, insect attacking nematodes, spiders and other organisms. The second includes	Know biological treatment methods.	Describe biological treatment methods.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
introducing new biological control organisms to supplement existing biological organisms. Some beneficial insects/mites are attracted to some ornamental plants. Planting them in the landscape will naturally increase the level of beneficials. Some predatory and parasitic insects, mites and nematodes are available commercially for release outdoors including: - predatory insects that feed on aphids; - insect parasitic nematodes for soil dwelling larvae; - parasitic wasps that feed on aphids; - predatory mites for control of pest mites and thrips. *Bacillus thuringiensis (Bt)* microbial agents are also used to control some larval insect pests, however these microbials are registered pesticides.		
Physical/Mechanical		
Treatment methods for insects and mites include: - washing them from plants with strong sprays of water; - pruning out and destroying infested foliage and branches; - using sticky tree bands or sticky traps to catch insects/mites; - using electrocuting devices to attract and kill flying insects.	Know physical/mechanical treatment methods.	Describe physical/mechanical treatment methods.
Chemical		
Chemical treatment methods involve the use of insecticides and miticides to control insects and mites.	Know what chemical treatments involve.	Define chemical treatments.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Set action levels for different types of treatments. Broadcast insecticide application should be used only when insects are present in large numbers or over a large area. Spot treat with insecticides when there are only a few insects or they are localized.	Know that there are different action thresholds for different treatments.	Identify that there are different action thresholds for different treatments.
See the General Information Concept for a description of each family/group.		
Insecticide/Miticide Groupings		
Insecticides and miticides are often grouped according to Mode of Action.		
Contact insecticides/miticides must contact the pest to be effective. They can be applied to the pest or to the surfaces pests touch. Some contact insecticides have a residual effect and can kill the pest for some time after application.	Understand what a contact insecticide/miticide means.	Describe a contact insecticides/miticide.
Stomach poisons must be swallowed by the pests to be effective. They are usually applied to the pests' food and taken in with the food. Sometimes stomach poisons are mixed with food to form poisonous baits.	Understand what a stomach poison is.	Describe a stomach poison.
Systemic insecticides/miticides are a specific group of stomach poisons. They are usually applied to the host plant and are translocated in the plants with sap or water. The pests suck the poisoned sap or eat the poisoned plant parts and are killed by the pesticide in it. Some pesticides are both systemic and contact.	Understand what a systemic insecticide/miticide is.	Describe a systemic insecticides/miticide.
Suffocating insecticides/miticides (usually oils) clog the breathing system and can also reduce egg survival.	Understand what a suffocating insecticide/miticide is.	Describe a suffocating insecticide/miticide.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insect Growth regulators act like the insect's own growth hormones. They disrupt the normal development of the insect causing it to die before it becomes an adult or before it can reproduce.	Understand what a growth regulator is.	Describe a growth regulator.
Silica dusts or gels kill crawling pests by abrading their bodies. This causes them to dehydrate and die. Contact insecticides/miticides are sometimes mixed with these silica products.	Understand how silica dusts work.	Describe how silica dusts work.
Attractants attract insects. They may attract female insects for egg laying or attract male for mating insects to sticky traps.	Understand what attractants are.	Describe attractants.
Repellents repel insects and will therefore keep them away from their hosts.	Understand what a repellent is.	Describe a repellent.
Sticky pastes are placed on traps that attract pests. Chemicals or colours are used to attract the insects/mites to the trap. The insects get stuck on the paste and die. Sticky pastes are also used as barriers to restrict the movement of crawling pests.	Understand where and how sticky pastes are used.	Describe where sticky pastes are used.
Toxicants are a general term to indicate pesticides that kill and include neurotoxins (organophosphate and carbamates), acute toxicants, *Bt* and fumigants. They affect the pest through a variety of modes of action.	Understand what toxicants are.	Describe toxicants.
Residual effectiveness - refers to how long the insecticide/miticide remains effective after application. Some insecticides/miticides have a short residual period of only a few hours. Others can have a long residual period of several weeks.	Understand residual effectiveness.	Describe residual effectiveness.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Selectivity - refers to which insects or mites will be affected by the insecticide/miticide.	Understand selectivity.	Describe selectivity.
Selective pesticides only control certain insects or mites. They generally do not harm non-target organisms.	Understand selective and non-selective insecticides and miticides.	Describe selective and non-selective insecticides and miticides.
Non-selective pesticides may control all insects, mites or both. They may also harm other non-target organisms. Extra caution should be taken when using these pesticides.	Understand that non selective pesticides harm non target organisms.	Identify that non selective pesticides harm non target organisms.
Factors Affecting Insecticide/Miticide Effectiveness		
Factors that affect the effectiveness of the insecticides/miticides include timing of application, pest resistance and weather conditions.	Know the factors that affect insecticide and miticide effectiveness.	List the factors that affect insecticide and miticide effectiveness.
Timing of application - insects/ mites may need to be present or in a susceptible stage of development for a pesticide to be effective. Generally, the younger the pest is, the easier it is to control with contact and stomach poisons.	Know how timing of application affects the effectiveness of insecticides and miticides.	Describe how the timing of application affects the effectiveness of insecticides and miticides.
Resistance - some insects/mites have developed resistance to specific pesticides or families/groups of pesticides.	Know that some insects and mites have developed resistance to specific pesticides or families/groups of pesticides.	Identify that some insects and mites have developed resistance to specific pesticides or families/groups of pesticides.
The development of resistant insects/mites can be slowed by: - using a variety of chemical and non-chemical methods; - using an insecticide/miticide only when needed; - alternating insecticides/miticides from different chemical families/groups; - alternating insecticides/miticides from different modes of action; - using registered tank mixes with pesticides with different chemical families/groups.	Know how to slow the development of resistance.	Describe how to slow the development of resistance.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weather conditions - Extremes of temperature and humidity can adversely affect the effectiveness of pesticides by increasing plant sensitivity or by decreasing the activity of the pesticide.	Know weather conditions that affect the effectiveness of pesticides.	Describe how weather conditions affect the effectiveness of pesticides.
Rain shortly after a pesticide application can wash the pesticide off the host. However, some soil-applied insecticides require irrigation or rain after application.		
Evaluation		
The last step in an IPM program includes reviewing all aspects of the program; evaluating the results and where desired effectiveness has not been achieved, identify changes that can be made to improve the program's effectiveness.	Know how to evaluate an IPM program for insect or mite control.	Describe how to evaluate an IPM program for insect or mite control.
Slugs and Snails (Molluscs)		
Slugs and snails belong to a large group of animals called molluscs. They are soft-bodied animals that move by means of a single lower "foot." They have a distinct head with two pairs of tentacles. Snails have shells - slugs do not.	Know the common physical characteristics of slugs and snails.	Describe the common physical characteristics of slugs and snails.
Slugs and snail problems can vary from province to province.		
Slugs and snails are pests when they damage plants, feed or food, when they are found on food (aesthetically unappealing) and when they carry diseases affecting humans or animals.	Know when slugs and snails are pests.	Identify when slugs and snails are pests.
Terrestrial slugs and snails are active mainly at night, on cool overcast days or immediately following a rain. They spend most of the day hiding under objects that rest on the soil surface and beneath damp refuse. Often they will return to the	Know when slugs and snails are active and where they can be found.	Identify when slugs and snails are active. Describe where slugs and snails can be found.

Category: LANDSCAPE

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General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
same hiding place repetitively, night after night, unless they are disturbed. The route taken is usually retraced on the return trip, leaving a "slime trail." They will avoid all dusty, dry or sharp objects.		
Life Cycle of Slugs and Snails		
Slugs and snails reproduce by laying eggs. They have three distinct stages in their life cycle: an oval translucent or slimy egg, an immature nymph stage and an adult stage.	Know the life cycle of slugs and snails.	Describe the life cycle of slugs and snails
Pest Management Methods for Slugs and Snails		
Slugs and snails should be controlled following an IPM approach. Plan the IPM program by considering the pest, the host, predators and parasites, the environment, human and animal safety and the available treatment methods.	Know that the control of slugs and snails should follow an IPM approach.	Describe the control of slugs and snails following an IPM approach.
The components of an IPM program specific to the landscape certification category (prevention, identification, monitoring, injury and action thresholds, treatments and evaluation) are each discussed below.	Know the components of an IPM program to consider for slug and snail control.	List the components of an IPM program that should be considered for slug and snail control.
Prevention		
Landscapes should be designed to prevent unwanted slugs and snails from becoming a problem. Ways to prevent future problems in landscapes include: - removing objects and refuse on the soil under which the pest can hide; - allowing soil surface to dry between waterings; - inspecting new plants for slug/snail presence prior to installing into the landscape; - installing plants that slugs and snails are not attracted to;	Know ways that landscapes can be designed to prevent slugs and snails from becoming a problem.	Identify ways that landscapes can be designed to prevent slugs and snails from becoming a problem.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- attracting toads; - using copper bands.		
Identification		
Many pest managers collect preserved specimens to assist in identification. Assistance in pest identification may also be provided in government or industry publications.	Know ways to identify slugs and snails.	List ways to identify slugs and snails.
Monitoring		
Most monitoring for slugs and snails in high maintenance areas should involve weekly inspections or counts during the time the pests are expected to be present. Standard monitoring methods for slugs and snails include counting the number of: - slugs or snails per square metre; - slugs and snails found beneath boards installed to monitor the numbers of slugs and snails in an area.	Know when to monitor slugs and snails in a landscape. Know how to monitor slugs and snails in a landscape.	Identify when to monitor for slugs and snails in the landscape. Describe how slugs and snails can be monitored.
Injury and Action Thresholds		
Setting injury thresholds (the unacceptable level of damage) often involves considering the aesthetics of slug or snail presence or the damage they cause, but may also involve economic damage (e.g., to nursery or ornamental plants). Setting action thresholds is largely dependent on the use of the site. Acceptable damage will be less on high service areas than on low service areas. Commonly used ways to define injury levels include: - percentage of plants damaged on a site; - number of complaints received from the public or client about the specific problem.	Know how to set injury and action thresholds in landscapes.	Describe how to set injury and action thresholds in landscapes.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Treatments		
The following IPM treatment methods (described in the core) should be evaluated and used (alone or in combination) where appropriate: cultural, biological, physical/mechanical and chemical.		
Use of biological, physical/ mechanical treatment methods help protect natural predators of slugs and snails.	Understand that the use of biological or physical/mechanical treatments will help protect the natural predators of slugs and snails.	Identify that the use of biological or physical/mechanical treatments will help protect the natural predators of slugs and snails.
Cultural		
Cultural treatments are discussed under prevention.		
Biological		
This method includes avoiding harm to beneficial natural enemies of slugs and snails. Some birds are attracted to some ornamental plants. Planting them in the landscape will naturally increase the level of these beneficial species. Some predatory nematodes are available commercially for release outdoors.	Know biological treatment methods.	Describe biological treatment methods.
Physical/Mechanical		
This method includes: - using attractants (e.g., beer or yeast in water) to lure the pests to water traps; - salt in a dish or tray (abrade skin and causes dehydration and death);	Know physical/mechanical treatments for slugs and snails.	Describe physical/mechanical treatments for slugs and snails.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - INSECTS, MITES AND MOLLUSCS

General Objective: To understand pest management principles required to carry out safe and effective insect/mite/mollusc control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- hand picking and destroying them.		
Chemical		
This involves the use of molluscicides to control slugs and snails. The pest is first attracted to the molluscicides by odour and then dies after eating the stomach poison or contacting the pesticide.	Know what chemical treatments involve.	Define chemical treatments.
Evaluation		
The last step in an IPM program for slugs and snails includes reviewing all aspects of the program; evaluating the results and where desired effectiveness has not been achieved, identify changes that can be made to improve the program's effectiveness.	Know how to evaluate an IPM program for slugs and snails.	Describe how to evaluate an IPM program for slugs and snails.
NOTE: When developing manuals: - **describe insects, mites and molluscs that are a significant problem in the province. Refer to appropriate pest regulations if applicable.** - **describe approaches and treatment methods that illustrate IPM principles for selected insects, mites and molluscs that are a significant problem in the province.**	Know which insects, mites and molluscs are problems in your province and be able to identify them. Know the approaches and treatment methods that illustrate IPM principles for insects, mites and molluscs that are significant problems in the province where the manual will be used.	List the insects, mites and molluscs that are a problem in your province. Describe the insects, mites and molluscs that are problems in your province. Describe the approaches and treatment methods that illustrate IPM principles for insects, mites and molluscs that are significant problems in the province where the manual will be used.

Category: LANDSCAPE

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. Disease symptoms are caused by environmental stress or infection by micro-organisms.	Know what can cause disease symptoms.	List the major causes of disease symptoms.
Diseases are often hard to diagnose because similar symptoms may be caused by: - different diseases; - insect damage (e.g., gall forming insects); - herbicide damage; - physical problems caused by poor growing conditions.	Know what other things can cause disease-like symptoms.	List other things that can cause disease-like symptoms.
It is usually necessary to examine affected plant parts under a microscope to diagnose diseases. It may be necessary to have a plant pathologist diagnose the problem	Know how to diagnose a disease.	Describe how to properly diagnose a disease.
It is essential to correctly identify the cause of the symptoms so that an effective treatment can be chosen.	Understand why it is important to correctly identify the cause of disease symptoms.	Identify why it is important to correctly identify the cause of disease or disease-like symptoms.
Environmental Stress		
Unfavourable environmental conditions which stress plants and cause abnormal growth or disease-like symptoms include air pollutants, toxic chemicals, and extremes of light, temperature, water or soil nutrients levels. Plants weakened by environmental stress are also more likely to be infected by pests and sustain greater damage than healthier plants. Recognizing and relieving the stress will help prevent infectious diseases.	Know environmental conditions that can stress plants and cause abnormal growth or disease-like symptoms. Understand why it is important to recognize and relieve stress on plants.	Describe the environmental conditions that could stress plants and cause abnormal growth or disease-like symptoms. Identify why it is important to recognize and relieve environmental stress on plants.
Knowledge of previous weather conditions may help in determining whether a disease was caused by environmental factors or a pathogen.	Know that previous weather conditions may help determine whether a disease is caused by environmental factors or a pathogen.	Identify that previous weather conditions may help determine whether a disease is caused by environmental factors or a pathogen.

Category: LANDSCAPE

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 caused by environmental stress cannot be spread from plant to plant.	Understand 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 Micro-organisms		
Diseases symptoms caused by micro-organisms are called infectious diseases. These diseases can be spread from plant to plant.	Know what an infectious disease is.	Define an infectious disease.
	Understand that diseases caused by micro-organisms can spread from plant to plant.	Identify that diseases caused by micro-organisms can spread from plant to plant.
Micro-organisms are pests when they cause unacceptable damage to desirable plants and animals.	Know when micro-organisms are pests.	Identify when micro-organisms are pests.
Fungi		
Fungi are the largest group of organisms, which cause plant diseases. They are organisms that do not contain chlorophyll. This group includes moulds, mushrooms, and rusts.	Know about fungi that cause plant diseases.	Describe what a fungus is.
		List the types of 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. Symptoms that may be caused by fungi include cankers, dieback, plant death, galls, leaf spots, rots and wilts.	Know how fungi reproduce and cause disease symptoms.	Describe how fungi reproduce and cause disease symptoms.
	Know disease symptoms that can be caused by fungi.	List the disease symptoms that can be caused by fungi.
Fungi Classification		
Many fungi feed on dead or dying plants (saprophytic fungi) and are beneficial decomposers. Some that feed on living plants (parasitic fungi) are pests.	Know when fungi are pests.	Describe saprophytic fungi.
		Describe parasitic fungi.
		Identify which group of fungi are pests.

Category: LANDSCAPE

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
Fungi Life Cycles		
Fungi life cycles are made up of specific life stages and may require reproduction on one, several (e.g., rusts) or alternate hosts to complete their life cycle. A generation is the completion of all the life stages in a particular fungus's life cycle. Fungi may have more than one generation per year and may require management at each infection. The number of generations per year is dependent on species and environment.	Know that most fungi have one host and a few require alternate hosts.	Identify that most fungi require one host and a few require alternate hosts.
The life cycles of most fungi follow a similar sequence. Normally, a fungus stays on a diseased leaf over winter. As the weather becomes warmer in spring, the fungi grow and produce spores. The spores are released into the environment and they are moved by wind or water. Some may land on other plant tissue of susceptible plants. This step is called inoculation.	Know the life cycle of a typical fungus.	Describe the life cycle of a typical fungus.
If environmental conditions are poor for spore germination the spores may die, be washed off, or remain dormant. Spores are quite resistant to fungicides.	Know that poor environmental conditions can cause spores to die, be washed off by rain or remain dormant.	Identify that poor environmental conditions can cause spores to die, be washed off by rain or remain dormant.
	Know that spores are quite resistant to fungicides.	Identify that spores are quite resistant to fungicides.
If environmental conditions are good, the fungi spores will germinate. It is at this stage (incubation) that the fungi are most vulnerable to fungicides or unfavourable growing conditions. Infection begins when the fungus enters the plant tissues. Inside the plant, the fungi are protected and difficult to control. A systemic fungicide may control the disease if applied before the infection is too severe. Spores or tiny pieces of the fungus spread fungi. Infected plants, plant parts, tools, machinery, people, animals and soil may also spread the fungi.	Know how fungi infect plants.	Describe how fungi infect plants.
	Know when fungi are most vulnerable to fungicides or unfavourable growing conditions.	Identify when fungi are most vulnerable to fungicides or unfavourable growing conditions.
	Know how fungi spread.	Describe how fungi spread.

Category: LANDSCAPE

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
Bacteria		
Bacteria are one-celled organisms, which can only be seen with a microscope. They usually enter a plant through natural openings or wounds.	Know what bacteria are. Know how bacteria infect plants.	Describe bacteria. Describe how bacteria infect plants.
Bacteria have a very simple life cycle. Under favourable conditions, they enter a susceptible organism and reproduce very quickly, using the plant as a source of food. Environmental conditions that affect reproduction include temperature and humidity.	Know the simple life cycle of bacteria. Understand how environmental conditions affect the reproduction of bacteria.	Describe the simple life cycle of bacteria. Describe environmental conditions that affect the reproduction of bacteria.
Bacteria are spread by wind and rain, ground or surface water, or by contact with contaminated plant material, animals, insects or equipment.	Know ways that bacteria can be spread.	List ways bacteria could be spread.
Bacteria cause some blights, wilts, leaf spots, galls and rots. Very few bacterial diseases are controlled with the use of bactericides.	Know that very few bacterial diseases are controlled with the use of bactericides.	Identify bacterial diseases that are controlled with the use of bactericides.
Virus		
Viruses (including phytoplasmas) are extremely small. They cannot be seen with an ordinary microscope. Viruses cause diseases, which often reduce plant vigour.	Know that viruses are so small they cannot be seen with an ordinary microscope and that they can cause diseases that often reduce plant vigour.	Describe that viruses are so small they cannot be seen with an ordinary microscope and that they can cause diseases that often reduce plant vigour.
Viruses have an extremely simple life cycle. They are capable of injecting themselves into susceptible organisms and use these cells as an energy source to reproduce very quickly. Virus can only replicate by infecting other living cells.	Know how viruses reproduce.	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	Know the ways that viruses can be spread.	Identify the ways that viruses can be spread.

Category: LANDSCAPE

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
and/or fungi that are not infected with the viruses but physically spread the viruses).		
No pesticides are available to control viruses directly. However, some pesticides may be used to control virus vectors.	Know that there are no chemical controls for viruses.	Describe how viruses can be controlled.
Some plant cultivars may be more resistant to viruses, allowing control of the virus to be achieved through prevention.	Identify that resistant plant cultivars can control viruses through prevention.	Identify that resistant plant cultivars can control viruses through prevention.
Nematodes		
Nematodes are small thread-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 that may allow fungi or bacteria to enter.	Understand what nematodes are. Know how nematodes can cause diseases.	Describe nematodes. Describe how nematodes can cause diseases.
Most plant-feeding nematodes spend their lives in the soil though some live part of their lives inside plant roots. The female lays eggs that hatch into larvae. The larvae pass through four moulting periods to become adults.	Know how nematodes reproduce.	Describe how nematodes reproduce.
Nematodes spread by movement through soil, plant material and water. They may be transported with contaminated soil and water containers or equipment.	Know how plants can be infected by nematodes.	Describe how nematodes spread.
Nematodes can cause wilting, leaf drop, stunting, lack of vigour, and growth deformities.	Know the symptoms of nematode infection.	Describe the symptoms of nematode infection.
Pest Management Methods For Diseases		
Given good care, plants can often defend themselves against infection and even recover from disease infection.	Know that plants can defend themselves against or recover from an infection.	Identify that plants can defend themselves against or recover from an infection.

Category: LANDSCAPE

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 should be controlled following an integrated pest management (IPM) approach. Plan the IPM program by considering the pest, the environment and human safety, the desirable vegetation or animal and available treatment methods.	Know that diseases should be controlled through an IPM approach.	Identify that diseases should be controlled through an IPM approach.
The components of an IPM program specific to the landscape certification category (prevention, identification, monitoring, injury and action thresholds, treatments and evaluation) are each discussed below.	Know the components of an IPM program that should be considered for disease control.	List the components of an IPM program that should be considered for disease control.
Prevention		
Landscapes must be designed to prevent diseases from becoming a problem. Ways to prevent future pest problems in landscapes include: - choosing plants that are not susceptible to common disease causing pests; - choosing a diversity of plant families, species and cultures to avoid monocultures that can allow pest populations to build to high levels; - use planting practises that give plants the best start; - rake leaves to remove over wintering sites for disease organisms; - prune out infected plant material and remove and dispose of infected plants.	Know how to prevent diseases from becoming a problem.	List ways to prevent diseases from becoming a problem.
Identification		
Proper identification of diseases is essential before considering any treatments. Diseases with similar symptoms may need to be positively identified by a plant pathologist.	Know how diseases can be identified.	Describe how diseases can be identified.

Category: LANDSCAPE

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
To aid in proper diagnosis of the disease, knowledge of the following environmental conditions in the preceding weeks is important: - weather conditions; - fertilizer and soil amendments used; - irrigation amounts and timing; - type and frequency of pesticides used; - activity surrounding the host (e.g., wear and use patterns on turf, adjacent area activity); - physical characteristics of the site (e.g., low lying areas, north facing slope, etc.).		
Accurate diagnosis requires careful collection of the entire affected host where possible and must include plant material that contains live or active pathogens.		
Comparing host symptoms with photographs in identification guides using signs (fruiting bodies, spores, etc.) or symptoms (wilting, leaf colour, shape of affected areas, etc.) of the disease may also assist in identification of the pathogen.		
Monitoring		
Monitoring for diseases should involve inspections or counts during the time the pests are expected to be present.	Know when plants should be inspected for diseases.	Identify when plants should be inspected for diseases.
In high maintenance areas, inspections or counts should occur weekly. In medium or low maintenance areas, inspections or counts would be performed occasionally.		
Standard counting methods for disease organisms include: - counting the number of infected leaves per plant; - counting the number of infected leaf blades per area of turf;	Know standard counting methods.	Describe standard counting methods.

Category: LANDSCAPE

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
- measuring an increase in size of spread or disease rings in turf. Scoring systems are a way to assign a number value to a visual estimate of damage. A picture in a score guide showing the different levels of damage associated with each number score. The total number of leaves with each score can be compared with past results to find whether damage is increasing or not.		
Monitoring for diseases may also include keeping records of temperature, humidity and rainfall, which would show when conditions are favourable for disease development.	Know the environmental records that should be kept while monitoring.	List the environmental records that should be kept while monitoring.
Injury and Action Thresholds		
Setting injury thresholds (the unacceptable level of damage) often involves considering the aesthetics of pest damage, but may also involve economic damage (e.g., to nursery or ornamental plants). Setting action thresholds is largely dependent on the use of the site. Acceptable damage will be less on high service areas than on low service areas. Commonly used ways to define injury levels include: - percentage of leaves damaged on a host; - percentage of plants damaged on a site; - number of complaints received from the public or client about the specific problem.	Know the factors that determine the injury and action threshold.	Describe the factors that determine the injury and action threshold.

Category: LANDSCAPE

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
Treatments		
The following IPM treatment methods (described in the core) should be evaluated and used (alone or in combination) where appropriate: cultural, biological, physical and chemical.		
Cultural		
Three things must be present for an infectious disease to develop. They are: - a disease causing organism (pathogen); - a host susceptible to the pathogen; - an environment favourable to the disease organism and/or unfavourable to the host.	Know the three components that must be present for an infectious disease to develop.	List the three components that must be present for an infectious disease to develop.
Taking away or changing any one of these three things will control the disease. For example, a disease problem can be prevented by:	Understand that removal of any of the three components will control the disease.	Identify that removal of any of the three components will control the disease.
- keeping the organism out of an area; - using strains of plants that are resistant or are not affected by the disease; - using certified disease-free seed; - removing alternate disease hosts; - rotating crops; - manipulating the environment to favour the host but not the pathogen.	Know ways to prevent a disease problem.	Identify ways to prevent a disease problem.
Biological		
There are beneficial micro-organisms found on leaves and in the root zone that attack or suppress pathogens. A few are sold in commercial products, but many more are naturally present in healthy soils and composts.	Know biological treatments	Describe biological treatments.

Category: LANDSCAPE

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
Minimizing the use of pesticides helps protect naturally occurring micro-organisms.		
Mechanical/Physical		
Diseases can be physically or mechanically controlled by: - removing and destroying the diseased host plant or the affected portions of the host plant (e.g., pruning affected branches, mowing and removal of turf clippings); - using water washes to remove powdery mildew spores from leaves; - burying or burning infected plant residues.	Know physical controls.	Describe physical controls.
Chemical		
Chemical treatments involve the use of fungicides and bactericides to control disease causing organisms. Herbicides may also be used on weed species that harbour or are secondary hosts of the pathogen.	Know what chemical treatments involve.	Define chemical treatments.
Fungicide Groupings		
Fungicides kill fungi or prevent the spread of fungi to new hosts.	Know that fungicides are used for control of fungi.	Identify that fungicides are used for control of fungi.
	Know fungicides that are used for the control of landscape fungal diseases.	List fungicides that are used for the control of landscape fungal diseases.
Fungicides are grouped as contact or systemic. They will kill the fungus and/or protect the plant from infection.	Know how fungicides are classified.	List how fungicides are classified.
Contact fungicides provide a protective film of fungicide on or around the host to prevent fungus spores from germinating. Contact fungicides are sometimes called protectant fungicides. These fungicides must be used before the fungi	Understand how a contact fungicide can control a fungal organism. Understand the limitations of a contact fungicide.	

Category: LANDSCAPE

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
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 that appears after treatment is not protected. Therefore, re-application is required. Contacts can be applied to seeds, foliage, fruit or roots.		
Systemic fungicides are absorbed by plants and move within them. Once inside the plant, systemic fungicides move to new areas of plant growth. Systemic fungicides usually act as protectants. If they kill fungi that have not become well established within the plant they are sometimes called eradicants.	Understand how a systemic fungicide can control a fungal organism.	
Factors Affecting Fungicide Effectiveness		
Fungicide effectiveness can be influenced by the timing of application, the fungus life cycle, the rate of plant growth, weather and whether the fungus has established any resistance to the fungicide.	Know the factors affecting fungicide effectiveness.	List the factors that can affect the effectiveness of fungicides.
Timing of Application - The fungicide should be on or in the plant (in effective concentration) prior to or during the early stages of the infection period of the fungus.	Know the best time to apply fungicide for the most effectiveness.	Describe the best time to apply fungicide for the most effectiveness.
Fungus life cycle - The frequency of applications varies depending on the type of fungus. If the fungus has a short life cycle, it can have many infection periods in a growing season and frequent applications may be needed.	Know how the fungus life cycle is important in determining the frequency of fungicide applications.	Identify how the fungus cycle is important in determining frequency of fungicide application.
Rate of plant growth - Plant growth rate affects the frequency of application as well. If new leaves grow, applications may need to be repeated.	Know how plant growth rate can affect the frequency of fungicide applications.	Describe how plant growth can affect the frequency of fungicide applications.

Category: LANDSCAPE

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
Weather - The frequency of applications can vary with environmental conditions. If the weather conditions are poor for fungal growth few applications may be needed. Rain might wash off the fungicide application and another fungicide application may be needed. If the fungicide breaks down quickly, applications may need to be repeated.	Know how the weather can affect the frequency of fungicide applications.	Describe how the weather can affect the frequency of fungicide applications.
Resistance - Some disease organisms are resistant to certain fungicides or families/groups of fungicides.	Know how resistance can affect the effectiveness of fungicides.	Describe how resistance can affect the effectiveness of fungicides.
The disease organism may also develop resistance after repeated applications of a fungicide. The development of resistant disease organisms can be slowed by: - using a variety of chemical and non-chemical methods; - using a fungicides only when needed; - alternating fungicides from different chemical families/groups; - using registered tank mixes with pesticides from different chemical families/groups.	Know how to prevent or delay the onset of resistance to a fungicide.	Describe how to prevent or delay the onset of resistance to a fungicide.
See the General Information Concept for a description of the chemical families/groups.		
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.
	Know bactericides that are used for the control of landscape bacterial diseases.	List the bactericides that are registered for control of landscape bacterial diseases.
Factors Affecting Bactericide Effectiveness		
Timing of applications, the weather and amount of bacteria present will affect the bactericides effectiveness.	Know factors affecting the effectiveness of bactericides.	List the factors that affect the effectiveness of bactericides.

Category: LANDSCAPE

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 bacteria may develop resistance after repeated applications of a bactericide. The development of resistant bacteria can be slowed by: - using a variety of chemical and non-chemical methods; - using a bactericide only when needed; - alternating bactericides from different chemical families/groups.		
Evaluation		
The last step in an IPM program includes reviewing all aspects of the program; evaluating the results and where desired effectiveness has not been achieved, identify changes that can be made to improve the program's effectiveness.	Know how evaluate an IPM program.	Describe how evaluate an IPM program.
Pest Management Methods for Nematodes		
Nematodes should be controlled following an integrated pest management (IPM) approach. Plan the IPM program by considering the pest, the host, the environment, and the available treatment methods.	Know that nematodes should be controlled through an IPM approach.	Identify that nematodes should be controlled through an IPM approach.
The components of an IPM program specific to this category (prevention, identification, monitoring, injury and action thresholds, treatments and evaluation) are each discussed below.	Know the components of an IPM program that should be considered for nematode control.	List the components of an IPM program that should be considered for nematode control.
Prevention		
Landscapes must be designed to prevent nematodes from becoming a problem. Ways to prevent nematode problems in landscapes include: - choosing plants that are not susceptible to nematodes; - choosing a diversity of plant families, species and cultures	Know how nematode infections can be prevented.	List ways that nematode infections can be prevented.

Category: LANDSCAPE

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
to avoid monocultures that can allow nematode populations to build to high levels; - buy nematode free planting material; - only use nematode free soil amendments.		
Identification		
Most nematodes are microscopic (0.2-0.4 mm) in size so most suspected infestations should be referred to a specialist for identification. Proper identification of nematodes is essential as most nematodes do not cause damage or may be beneficial. Accurate identification requires careful collection of the entire affected host (including roots and soil surrounding roots) where possible.	Know how nematodes can be identified.	Describe how nematodes can be identified.
Monitoring		
Most monitoring for nematodes should involve inspections during the time the pests are expected to be present.	Know when plants should be inspected for nematodes.	Describe when plants should be inspected for nematodes.
Standard monitoring methods for nematodes include counting the number of: - plants exhibiting nematode infestation; - lesions, knots, galls or root tip swellings on the roots of each infected plant.	Know standard monitoring methods for nematodes.	Describe standard monitoring methods for nematodes.
Monitoring for nematodes may also include keeping records of temperature, humidity and rainfall, which would show when conditions are favourable for nematode growth and development.	Know the environmental records that should be kept while monitoring for nematodes.	List the environmental records that should be kept while monitoring for nematodes.

Category: LANDSCAPE

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
Injury and Action Thresholds		
Setting action thresholds (the unacceptable level of damage) for nematodes generally involves considering the economic damage (e.g., to nursery or ornamental plants) though in cases of nematode infestation on turf, aesthetics may be a consideration. Setting injury thresholds is largely dependent on: - percentage of plants damaged on a site; - reduction in yield; - number of complaints received from the public or client about the specific problem.	Know the factors that determine the injury and action threshold for nematodes.	Describe the factors that determine the injury and action threshold for nematodes.
Treatments		
The following IPM treatment methods (described in the core) should be evaluated and used (alone or in combination) where appropriate: cultural, biological, physical and chemical.		
Cultural		
These types of treatments have been discussed in the Prevention section above.	Know cultural treatments.	Describe cultural treatments.
Biological		
There are beneficial micro-organisms found in the root zone that attack or suppress nematodes. Minimizing the use of pesticides helps protect naturally occurring micro-organisms.	Know that there are beneficial micro-organisms that attack or suppress nematodes.	Identify that there are beneficial micro-organisms that attack or suppress nematodes.

Category: LANDSCAPE

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
Mechanical/Physical		
Removing and destroying the diseased host plants (including roots), or ploughing out the host plant roots, can physically control nematodes.	Know that removing or destroying host plants can control nematodes.	Identify that removing or destroying host plants can control nematodes.
Chemical		
Nematodes are covered with a tough outer skin that provides them with considerable protection. For this reason, most nematicides are fumigants. Because of this completion of the fumigation category is required.	Know that fumigants are used for nematode control.	Identify that fumigants are used for nematode control
Evaluation		
The last step in an IPM program includes reviewing all aspects of the program; evaluating the results and where desired effectiveness has not been achieved, identify changes that can be made to improve the program's effectiveness.	Know how to evaluate an IPM program.	Describe how to evaluate an IPM program.
NOTE: When developing manuals:		
- **describe landscape diseases caused by fungi, bacteria, viruses and nematodes that are a significant problem in the province.**	Know which diseases and nematodes are problems in your province and be able to identify them.	List the diseases and nemotodes that are a problem in your province.
- **describe approaches and treatment methods that illustrate IPM principles for selected fungi, bacteria, viruses and nematodes that are a significant problem in the province.**	Know the approaches and treatment methods that illustrate IPM principles for diseases and nematodes that are significant problems in the province where the manual will be used.	Describe the diseases and nematodes that are problems in your province. Describe the approaches and treatment methods that illustrate IPM principles for diseases and nematodes that are significant problems in the province where the manual will be used.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - VERTEBRATE PESTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Vertebrate Pests		
Vertebrate animals such as rodents and deer are pests when they damage the landscape.	Know when vertebrate animals are pests.	Identify when vertebrate animals are pests.
When planning a control program, consider: - benefits versus the damage caused by the pests; - whether they are a protected species in Canada or in your province; - hazards of the control program to non-target organisms; - whether they are above the minimum threshold level (that can be tolerated).	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 (e.g. placement of traps or poisoned baits).	Understand why it is important to know about the behaviour and biology of vertebrate pests.	Identify why it is important to know about the behaviour and biology of vertebrate pests.
The choice of control methods will depend upon the following characteristics of the pest: - population density; - mobility; - habitat; - preferred foods; - behavioural attributes (climbing, burrowing, flying, perching, etc.); - sharing food; - wariness of humans and foreign objects; - predators (place in food chain); - impact on non-target species, and; - availability of food for the pest.	Know the characteristics of the pest that should be considered when selecting a vertebrate pest control method.	List the characteristics of the pest that should be considered when selecting the vertebrate pest control method.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - VERTEBRATE PESTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The best time to implement a control method will depend upon: - the availability of food; - when migration takes place; - when the young are born. Population numbers are 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 hibernates.	Know what should be considered when selecting the timing for controlling vertebrate pests.	List the factors that should be considered when selecting the time for controlling vertebrate pests.
The best locations to control a vertebrate pest can depend upon finding the: - burrow or nests; - regularly travelled routes; - feeding areas.	Know what should be considered when selecting the location for a vertebrate control program or method.	List the locations that should be considered when selecting the location for a vertebrate control program or method.
Pest Management Methods For Vertebrates		
Vertebrates should be controlled following an integrated pest management (IPM) approach. Plan the IPM program by considering the pest, the commodity, plant or animal that is being affected, the environment, and the available treatments methods.	Know that vertebrates should be controlled through an IPM approach.	Identify that vertebrate should be controlled through an IPM approach.
The components of an IPM program specific to the landscape category (prevention, identification, monitoring, injury and action thresholds, treatments and evaluation) are each discussed below.	Know the components of an IPM program.	List the components of an IPM program.
Prevention		
Vertebrate pest problems can be prevented by: - excluding them from a feeding or breeding location;		

Category: LANDSCAPE

Concept: PEST MANAGEMENT - VERTEBRATE PESTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- destroying or changing the habitat; - removing potential sources of food; - fencing to exclude them; - encouraging natural predators.	Know how vertebrate pest problems can be prevented.	Identify how vertebrate pest problems can be prevented.
Identification		
Assistance in pest identification may be provided government officials, or government/industry publications.	Know ways to identify vertebrate pests.	List ways to identify vertebrate pests.
Monitoring		
Most monitoring for vertebrate pests where pests are expected to be present should involve inspections for signs of vertebrate presence. Inspection involves searching for evidence of an infestation, such as actual pest sightings, droppings, and damage (e.g., chewed bark, eaten vegetation/flowers, mounds of soil on turf, etc.), during the time the pests are expected to be present. Monitoring for pests in high maintenance areas should involve daily inspections. Medium and low maintenance areas would receive substantially fewer inspections. Monitoring would consist of regularly scheduled inspections to get an indication of the extent and location of a pest population. Detailed written reports should be kept.	Know how to monitor for vertebrate pests in a landscape.	Describe how to monitor for vertebrate pests in the landscape.
Injury and Action Thresholds		
Setting injury thresholds (the unacceptable level of damage) often involves considering the aesthetics of vertebrate pest damage, but may also involve economic damage (e.g., to nursery or ornamental plants) or health effects.	Know how to set injury and action thresholds in landscapes.	Describe how to set injury and action thresholds in landscapes.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - VERTEBRATE PESTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Setting action thresholds is largely dependent on the use of the site. Acceptable damage will be less on high service areas than on low service areas. Commonly used ways to define injury levels include: - percentage of plants damaged on a site; - extent of aesthetic effects on the landscape; - number of rodent mounds on the turf; - number of complaints received from the public or client about the specific problem; - damage to structures, hard surfaces and foundations.		
Treatments The following IPM treatment methods (described in the core) should be considered and used (alone or in combination) where appropriate: cultural, physical, mechanical and chemical.		
Cultural These treatment methods have been discussed under prevention.	Know cultural management treatments for controlling vertebrate pests.	Describe the cultural management treatments for controlling vertebrate pests.
Physical These treatment methods can include fencing, using spikes on eaves troughs or other barriers/deterrents to the pests to keep pests away.	Know physical treatments for excluding vertebrate pests.	Describe physical treatments for excluding vertebrate pests.
Mechanical These treatments use machines or devices to control pests and include: - frightening away or repelling the pest such as using	Know mechanical treatments for controlling vertebrate pests.	Describe mechanical treatments for controlling vertebrate pests.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - VERTEBRATE PESTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
devices that flap in the wind, plastic owls, ultrasonic sound repellent devices (rodent control); - trapping the pest including use of glueboards and sticky pastes (rodent control), and live trapping for large vertebrates.		
Chemical		
Chemical treatments involve the use of rodenticides and repellents to control vertebrate pests. See the General Information concept for a description of each chemical family/group.	Know what chemical treatments involve.	Define chemical treatments.
Only multiple dose anticoagulants can be used for rodent control in the landscape. These present a low risk to non targets.	Understand why only multiple dose anticoagulants can be used for rodent control in the landscape.	Describe why only multiple dose anticoagulants can be used for rodent control in the landscape.
Evaluation		
The last step in an IPM program includes reviewing all aspects of the program; evaluating the results and where desired effectiveness has not been achieved, identify changes that can be made to improve the program's effectiveness. Approaches and treatment methods for IPM principles can vary from province to province.	Know how to evaluate an IPM program for vertebrate control.	Describe how to evaluate an IPM program for vertebrate control.
Legal Status of Pest Management 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.	Describe how laws may affect the control of vertebrate pests. Identify laws that may affect proposed vertebrate control programs.

Category: LANDSCAPE

Concept: PEST MANAGEMENT - VERTEBRATE PESTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Shooting, trapping and the use of pesticides may be limited to specific times of the year or specified provinces or geographic locations.		
Check with provincial authorities about laws that could affect vertebrate control programs before controlling vertebrate pests.	Know whom to contact for information on provincial laws.	Identify whom to contact for information about the laws.
NOTE: When developing manuals: - **describe vertebrates that are a significant problem in the province. Refer to appropriate pest regulations if applicable.**	Know which vertebrate pests are problems in your province and be able to identify them.	List the vertebrate pests that are a problem in your province.
- **describe approaches and treatment methods that illustrate IPM principles for selected vertebrates that are a significant problem in the province.**	Know the approaches and treatment methods that illustrate IPM principles for vertebrate pests that are significant problems in the province where the manual will be used.	Describe the vertebrate pests that are problems in your province. Describe the approaches and treatment methods that illustrate IPM principles for vertebrate pests that are significant problems in the province where the manual will be used.

Category: LANDSCAPE

Concept: APPLICATION TECHNOLOGY - DEFINITIONS

General Objective: To know the terms used to describe application equipment, their components and aspects of calibration.

Application Technology Terms

The following terms **must be defined in training manuals:**

Nozzle output
Describes the volume of spray produced by each nozzle per minute.

Average nozzle output
The total nozzle output from the sprayer divided by the number of nozzles.

Total nozzle output
The sum of the nozzle output from every nozzle on the spray equipment.

Travel speed
The speed you drive the application sprayer or walk with a hand held sprayer.

Nozzle spacing
The spacing between two or more nozzles.

Spray width
(a) For broadcast sprays using a boom with evenly spaced nozzles: the width between nozzles multiplied by the number of nozzles;
(b) For broadcast sprays using a boom with multiple nozzles per crop row, covering several crop rows per pass: the width from the center of one pass to the center of the next (can use row width × number of rows sprayed with one pass of the boom if adjacent passes do not direct spray onto the same row at the end of the boom);
(c) For broadcast sprays using a single nozzle or nozzle cluster (boomless): the width from the center of one pass to the center of the next;

Pesticide rate
The amount of pesticide (g or l) stated on the label applied per unit of area for example mL/ha or g/ha mixed per volume of water applied per plant, per pot, to runoff, to wet or area.

Category: LANDSCAPE

Concept: APPLICATION TECHNOLOGY - DEFINITIONS

General Objective: To know the terms used to describe application equipment, their components and aspects of calibration.

Liquid Applications

Recommended sprayer application rate
The amount of spray mix applied per unit of area as stated on a pesticide label, for example L/ha.

Sprayer application rate
The amount of spray mix applied per unit of area as conducted under field conditions, for example L/ha.

For Granular Applications

Equipment Application Rate
The amount of granular pesticides applied per unit of area as stated on a pesticide label, for example kg/ha.

Calibrated Equipment Application Rate
The amount of granular pesticide applied per unit of area as determined from calibration procedure conducted under field conditions, for example kg/ha.

Treatment width
Actual width treated.

Volume of spray mix
The volume (litres) of pesticide(s), PLUS diluent, (such as water), PLUS other additives, (such as adjuvants) prepared in the spray tank for application to an area to be treated.

Power Hose Sprayer
A boomless sprayer that uses a power-driven pump to provide the pressure to the hose, for example spray gun.

Strainers, Straining, Screens (instead of filters and filtering - all manufacturers use the term strainers)
A device for retaining solids while liquids pass through.

Category: LANDSCAPE

Concept: APPLICATION TECHNOLOGY

General Objective: To know the types of application equipment available for landscape pest management.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Equipment Selection		
The type of equipment selected to apply pesticides depends on: - crop/host; - the rate and pesticide formulation; - the recommendation of the label; - the size and location of the treatment area; - the proximity of sensitive areas and - the pest.	Understand the factors that determine what equipment should be chosen.	List the factors that determine what equipment should be chosen.
Application equipment can be divided into two common types of equipment according to the type of formulation applied: - liquid; - granular. Different types of equipment exist for applying different types of formulations.	Understand that application equipment can be commonly divided into sprayers and granular application equipment.	Identify that sprayers apply liquids or dusts and granular application equipment apply granular pesticides.
NOTE: Training manuals should describe common application equipment.	Know the types of sprayers that are used in landscape operations.	List the types of sprayers used in landscape operations.
Liquid Application		
Hand Held Pressure Sprayers		
Hand held pressure sprayers are commonly used to treat small areas. The sprayer contains a small tank. Applications are made from a small hose/single nozzle assembly by pumping the sprayer handle to build up pressure in the tank. Droplet size and density vary depending on the pressure achieved in the tank.	Know the differentiating characteristics of hand-held pressure sprayers.	Describe hand-held pressure sprayers.

Category: LANDSCAPE

Concept: APPLICATION TECHNOLOGY

General Objective: To know the types of application equipment available for landscape pest management.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Backpack Sprayers		
Backpack sprayers are commonly used to treat small areas. The sprayer contains a small tank that is strapped to the applicator's back. Applications are made from a small hose/single nozzle assembly. The applicator pumps the sprayer handle to build up pressure in the tank. Some backpack sprayers have small motors that generate the pressure. Droplet size and density vary depending on the pressure achieved in the small pressure chamber.	Know the differentiating characteristics of backpack sprayers.	Describe backpack sprayers.
Boom Sprayers		
Boom sprayers have multiple nozzles spaced over the length of the boom. Most boom sprayers have horizontal booms, however, some plants may be sprayed with vertical booms. A pump generates pressure to deliver the spray mix to the boom. Nozzles are mounted in regularly spaced intervals on the boom. The pressure and nozzle type control droplet size and density.	Know the differentiating characteristics of boom sprayers.	Describe boom sprayers.
Power Hose Sprayers		
These sprayers have components that are similar to a motorized boom sprayer, without the spray boom. A hose spray gun used to direct spray onto vegetation. The hose is usually stored on a reel mounted on the spray vehicle. Such sprayers may be equipped with high-pressure pumps capable of sending spray to tree heights or through thick foliage.	Know the differentiating characteristics of hydraulic sprayers.	Describe hydraulic sprayers.
Wick Application Equipment		
Wick application equipment is used in areas or sites where selective application or no drift is desired. The equipment has a tank connected to a wick that absorbs and holds the spray mix until it is wiped off onto the pest species by the applicator. Often	Know the defining characteristics of wick application equipment and where they are likely to be used.	Describe wick application equipment.

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it is used to apply non-selective pesticides to selectively control weeds where non-target sensitive species co-exist.		
Tree Stem Injectors		
There is a variety of equipment developed to inject pesticide into a tree stem. The objective is to inject enough pesticide under the bark and into the tissues that will transport the pesticide up into shoots or down to roots. Injector equipment usually involves either a tool to cut through the bark plus a manually operated sprayer (e.g., hatchet and backpack mounted pressure sprayer) or a lance that both cuts through the bark and injects the pesticide into the tree, just below the bark.	Know the defining characteristics of tree stem injectors and where they are likely to be used.	Describe tree stem injectors.
Chemigation		
Chemigation is the application of chemicals such as pesticides and fertilizers to crops through an irrigation system (e.g., sprinkler, flood, furrow, drip or trickle) by mixing them with the irrigation water.	Understand chemigation.	Describe chemigation.
Brush Saw Application Equipment		
This equipment has a small herbicide reservoir that attaches to the bottom of the brush saw. A pump and a dispensing system are activated during the brush cutting action of the saw. Brush is cut and sprayed at essentially the same time for improved herbicide translocation through the cambium layer. This application equipment is very selective and does not produce drift.	Know the defining characteristics of brush saw application equipment.	Describe brush saw application equipment.

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Granular Application Equipment		
Granular application equipment is used to apply granular pesticides. The types of granular application equipment include: - gravity broadcast; - centrifugal. They are described below.	Know the types of granular application equipment.	List the types of granular application equipment.
Gravity Broadcast		
Pesticide granules are metered out by a paddle through adjustable slots and delivered to the ground by gravity. Application uniformity is affected by: granule size, ground speed, humidity level, turns, and rough ground conditions.	Know the defining characteristics of gravity broadcast application equipment. Know the factors that affect application uniformity.	Describe gravity broadcast application equipment. List the factors that affect application uniformity.
Centrifugal		
Pesticides granules are metered out through a rotary paddle distributor. Application uniformity is affected by ground speed and wind.	Know the defining characteristics of centrifugal application equipment.	Describe centrifugal application equipment.
	Know the factors that affect application uniformity.	List the factors that affect application uniformity.
Other Pesticide Application Equipment		
Several other types of application equipment are used 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 /movement.	Understand the main objectives of using other types of application equipment used in your province.	Identify the main objectives of other types of application equipment used in your province.

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Basic Components of Motorized Sprayers		
Sprayer components include: - spray tank; - pumps; - agitators; - strainers; - controls; - pressure gauge; - plumbing; - structural framework (including boom design); - nozzles; - clean water tank (for decontamination).	Know the various components of motorized boom sprayers.	List the main components of motorized boom sprayers.
Spray Tanks		
Spray tanks hold the spray mixture and are available in a variety of shapes, sizes and materials. Tanks should be: - corrosion resistant; - strong; - shaped to aid agitation; - easy to fill and shaped to drain completely; - easy to clean; - labelled with graduated markings; - equipped with baffles to prevent sloshing; - non-reactive with pesticides and adjuvants.	Know the desirable features of a spray tank.	List the desirable features of a spray tank.
The most common tank shapes are oval and cylindrical. Rectangular tanks and flat-bottomed tanks are more difficult to agitate and clean.	Know the most common tank shapes. Understand that rectangular and flat bottomed tanks are more difficult to agitate and clean.	List the most common tank shapes. Identify that rectangular and flat bottomed tanks are more difficult to agitate and clean.

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Tank size should be proportional to the sprayer boom width and sprayer output.	Understand that tank size should be proportional to the boom width and sprayer output.	Identify that tank size should be proportional to the boom width and sprayer output.
Pumps		
Pumps must 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. *Carriers are liquid or solid materials that are added to the pesticide spray mix and/or pesticide product to permit the pesticide to be delivered to the target site through the appropriate application equipment. A carrier added to a pesticide product to dilute it, is usually called a diluent.	Know the factors to consider in selecting a 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.		
The pump flow capacity should be 20% greater than the capacity needed. This will maintain proper pressure and flow: - as the pump wears; - if nozzle size increases; - if the number of nozzles on the boom increases. - if travel speed increases.	Understand why the pump flow capacity should be 20% greater than needed.	Identify that the pump flow capacity should be 20% greater than needed. Describe the benefits from having the extra pump flow capacity.
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.	Know that there are special requirements and limitations associated with different pump types.	Identify the special requirements or limitations that may be associated with different types of pumps.

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Roller pumps can wear quickly and are not recommended when using abrasive formulations.		
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 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. Hydraulic agitation requires greater pump capacity.	Know the differences between mechanical and hydraulic agitation systems.	Compare mechanical and hydraulic agitation systems.
Strainers		
Strainers prevent any debris and un-dissolved pesticides in the spray mixture from damaging the pump or plugging the nozzles.	Know why strainers are required.	Identify why strainers are required.
Strainers can be installed: - in the tank opening to prevent objects and 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 strainers can be installed.	Describe where strainers can be installed.

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Strainers should range in mesh size from the coarsest at the tank opening, to the finest at the nozzle. Smaller nozzles require finer strainers. Be sure the strainers are coarse enough when using wettable powders or flowable formulations.	Know how to select the correct strainer size.	Describe how to select the correct strainer size.
Follow manufacturer's recommendations for the specific size of strainers required to protect their nozzles and pumps.	Know where to obtain information on correct strainer size.	Identify where to obtain information on correct strainer size.
Controls		
Two common control systems are: - pressure control systems; - volume control systems.	Know the common control systems and how they work.	List the common control systems
Pressure control systems use a pressure-regulating valve (PRV) to maintain a constant operating pressure. These are usually found on hand-held and backpack equipment.		Describe pressure control systems.
Volume control systems (volumetric) allow the operating pressure/nozzle output to vary according to travel speed/engine RPM. These are most commonly found on boom sprayers.		Describe volume control systems.
Control systems can be manually or electronically operated. Items such as spray monitors may improve the application of pesticides by supplying the applicator with more information.		Identify that control systems can be manually or electronically operated. Identify the benefit of spray monitors.
Plumbing		
The size of hoses and fittings affects system capacity and the pressure. Under-sized hoses and fittings can severely reduce the capacity of any pump. Suction hose diameter should be at least as large as the pump intake opening. Flow restrictions can create a drop in pressure, resulting in a non-uniform nozzle output and	Understand how plumbing can affect the pressure.	List common plumbing problems that affect the pressure. Describe how these problems affect pressure.

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irregular spray pattern. Varied flow or hose length to different portions of the boom can result in non-uniform nozzle output as well.		List sources of flow restrictions.
Common sources of flow restrictions are: - under-sized boom plumbing; - under-sized controls or fittings; - kinked hoses; - under-sized or clogged strainers.		
Hoses and fittings on the pressure side of the pump must be able to handle the maximum pressure the pump can develop and withstand pressure surges.	Understand that hoses and fittings on the pressure side of the pump must be able to handle the maximum pressure from the pump.	Identify that hoses and fittings on the pressure side of the pump must be able to handle the maximum pressure from the pump.
Structural Framework		
Boom Design		
The boom supports and supplies spray mix to the nozzles. The boom should have end caps for easier flushing of the boom and nozzles. The design/operation of the boom can affect the uniformity of application.	Understand the importance of boom design on uniform applications.	Describe the importance of boom design on uniform applications.
Excessive boom movement, either vertically or horizontally during application, will reduce the uniformity of spray coverage and can damage the boom. Booms should be properly supported. Sprayers should be operated at a travel speed that minimizes boom movement. Suspension systems supporting the sprayer chassis and/or boom assist in reducing boom movement. When spraying row crops, the nozzles should be aligned to cover the crop uniformly and arranged to avoid skips or excessive overlaps between successive passes of the sprayer.		

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Pressure Gauge		
The pressure gauge measures the operating pressure. A pressure gauge is used to initially set the sprayer at the desired pressure. During the application, it should be monitored for changes in pressure as an indicator of problems. Gauges should measure the pressure as near to the nozzles as possible and should be checked for accuracy. Adapters are available to attach pressure gauges to nozzle bodies to carry out spot checks of nozzle pressure and to measure pressure drop along the sprayer's plumbing.	Know why a pressure gauge is used.	Identify why a pressure gauge is used.
Gauges are available as either liquid filled or dry. A liquid filled gauge dampens pressure pulsations resulting in a steadier reading, but is also slower to respond to changes in pressure. Pulsation dampers are available for dry gauges. Gauges should identify pressure in commonly used units (psi, Kpa). The maximum pressure indicated on the gauge should be approximately twice the intended operating pressure to enable accurate reading of the pressure. If the pump is capable of higher pressures than the gauge, ensure that there is sufficient pressure relief to prevent pressures rising above the gauges maximum pressure to avoid damaging the gauge.	Know the types of pressure gauges available and how to select a gauge with the appropriate range.	Describe the types of pressure gauges available. Describe how to select a gauge with the appropriate range.
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 the functions of a nozzle.	List the functions of a nozzle.
The nozzle body holds the strainer and tip in the proper position. The cap is used to secure the strainer and the tip to the body. The	Know the components of a nozzle.	List the components of a nozzle.

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nozzle screen or strainer is placed in the nozzle body to strain out debris, which may clog the nozzle opening. The nozzle tip affects the spray pattern. Rubber washers are used to prevent leaking.		
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.	Identify how nozzles are classified.
ASIDE: Nozzles on some hand-held or backpack sprayers can be adjusted for flow rate, droplet size and spray pattern. Most other sprayers use non-adjustable nozzles, where nozzles must be exchanged to obtain different flow ratings or patterns.		
Pesticide labels may recommend specific types and sizes of nozzles and droplet sizes. Follow label directions.	Know that pesticide labels may recommend specific types and sizes of nozzles.	Identify that pesticide labels may recommend the type and size of nozzles to use.
NOTE: Nozzles common to the landscape industry should be discussed.	Know the most common nozzle types for the category.	List the most common nozzle types for the category.
The most common nozzle types are: - conventional flat fan (tapered edge or even); - low drift flat fan (pre-orifice); - air induced flat fan; - boomless (off-centre); - hollow cone; - full cone; - solid stream; - deflector.		
Nozzle types are available in various nozzle outputs (L/min) and spray angles.	Know that nozzle types have various nozzle outputs and spray angles.	Identify that nozzle types have various nozzle outputs and spray angles.

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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 angle specified by the manufacturer is obtained when pressure is in the range of the pressure recommended by the manufacturer. The most common flat fan nozzle angles are 65°, 80° and 110°.	Know what the nozzle spray angle refers to.	Define nozzle spray angle.
For a given nozzle type, (providing pressure and nozzle output remain constant) wider angles decrease droplet size. Wider nozzle angles can give a uniform application with lower boom heights. Correct boom height depends on the spray angle and nozzle spacing.	Understand the factors that determine the correct boom height.	Identify the factors that determine the correct boom height.
Refer to nozzle manufacturer's recommendations or provincial recommendations for the required amount of overlap to achieve a uniform application.	Know the sources of information for the amount of spray overlap to use.	List the sources of information for the amount of spray overlap.
Nozzle Type		
Flat Fan Nozzles		
Flat fan nozzles are generally used for herbicide applications. Properly operated flat fan nozzles can provide a high level of application uniformity.	Know that flat fan nozzles provide a high degree of uniformity.	Identify why flat fan provide a high degree of uniformity.
Flat fan nozzles are used at low pressures (usually between 140 and 400 Kpa or 20-60 psi).	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 edge flat fan nozzles are the most common type of flat fan nozzles. Tapered edge flat fan nozzles produce an oval pattern	Know how to position tapered flat fan nozzles on a boom.	Describe how to position tapered flat fan nozzles on a boom.

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with tapered edges. 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, which reduces uniformity.		
Other types of flat fan nozzles are available. Even flat fan nozzles are available for banding applications. These nozzles should not be overlapped with other nozzles.	Know that other types of flat fan nozzles are available.	Describe other types of flat fan nozzles.
Low pressure, pre-orifice, or air-induced flat fan nozzles are available. These nozzles operate on the principle of increased operating pressure and liquid turbulence, which create coarser sprays. Such nozzles reduce drift by 50 to 90%. Minimum operating pressures are typically higher than for conventional nozzles.		
Boomless Nozzles		
Off-centre nozzles produce a wide flat spray that is off to the side of the nozzle. The spray is relatively uniform along its width. They are often mounted on the side of trucks or short booms for spraying along roadsides, roadside ditches, and places where there are many obstacles such as brush and fences. These nozzles provide coverage up to 10 metres depending on nozzle size, pressure and wind conditions.	Know how boomless nozzles are used. Know the different types of boomless nozzles and where they are used.	Identify how boomless nozzles are used. List the different types of boomless nozzles Describe their use.
Full (Solid) and Hollow Cone Nozzles		
Full and hollow cone nozzles are used to apply fungicides and insecticides because they produce finer spray droplets and provide greater coverage.	Know where full and hollow cone nozzles are used.	Describe where full and hollow cone nozzles are used.

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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 or 30-300 psi).		
Nozzle Pressure		
Generally, lower pressures will produce larger sized droplets without a high percentage of fine droplets that easily drift. For standard flat fan nozzles, pressures above 350 kPa (50 psi) produce finer sized droplets. Obtain drop size information (spray quality) from the nozzle manufacturer.	Know that nozzles are designed to be used at specific pressure ranges. Know where to obtain drop size information.	List the common pressures used. Identify when each is used. Identify where to obtain drop size information.
Herbicides are usually applied between 140-275 kPa (20-40 psi) to keep drift at a minimum. Insecticides and fungicides are applied at higher pressures, usually between 275-2000 kPa, (40-300 psi) to obtain finer sprays. Different nozzle arrangements require different pressures.		
Spray pressure also affects nozzle output and spray patterns. Pressure should only be used to achieve small changes in nozzle output as the pressure must be increased four times to double the nozzle output. Low pressures generate narrower fan angles and may cause non-uniform patterns.	Understand how spray pressure affect nozzle output and spray patterns.	Describe how spray pressure affect nozzle output and spray patterns.
Spray Droplet Size		
A nozzle can produce a range of droplet sizes from very small to large. The number of fine droplets increases as the spray pressure is increased or as the size of the nozzle orifice is decreased.	Know that a nozzle produces a range of droplet sizes and that droplet size is affected by pressure and size of the nozzle orifice.	Identify that a nozzle produces a range of droplet sizes. Identify what affects droplet size.
Spray from nozzles is classified using an International classification scheme based on droplet size. Droplets are measured by their diameter in units called microns (1 micron equals	Know that there is a nozzle international classification scheme based on droplet size.	Identify the nozzle international classification scheme.

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1/1000 mm). Volume Median Diameter (VMD) is a droplet size where one-half of the spray volume is comprised of droplets smaller than this size and one-half larger than this size. The international classification is as follows: - very fine (VF) – VMD less than 100 microns; - fine (F) – VMD 100-175 microns; - medium (M) – VMD 175-250 microns; - coarse (C) – VMD 250-375 microns; - very coarse (VC) – VMD 375-450 microns; and - extremely coarse (XC) – VMD greater than 450 microns. Nozzle manufacturers normally report the spray quality produced by their nozzles over a range of pressures and flow rates in their product catalogues. Newer nozzles follow an International Standards Organization (ISO) standard colour coding system that identifies the nozzle output in U.S. gallons per minute at 40 psi, as follows: - orange (0.1 gal/min); - green (0.15 gal/min); - yellow (0.2 gal/min); - turquoise (0.25 gal/min); - blue (0.3 gal/min); - red (0.4 gal/min); - brown (0.5 gal/min); - grey (0.6 gal/min); and - white (0.8 gal/min).		
Nozzle Materials The rate of nozzle wear depends on: - nozzle material; - pesticide formulation;	Know the factors that affect nozzle wear rates.	List the factors that affect nozzle wear rates. Describe how these factors affect nozzle wear rates.

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- operating pressure; - nozzle size; - the amount of use (time).		
Nozzle wear increases with softer nozzle materials, more abrasive formulations, higher operating pressures, smaller nozzle size, and longer use.		
The harder the nozzle material, the longer the nozzle will last but the higher the initial 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.		
Replace nozzles when they are worn out. The nozzle output and spray pattern change, reducing application uniformity. To determine the amount of wear, compare: - worn nozzle output to manufacturer's specifications of a new nozzle output; and - uniformity across the boom.	Understand why nozzles must be replaced.	Identify why nozzles must be replaced.
Replace nozzles that deviate from the mean output of the other nozzles by more than 5%, or if the mean output of the nozzles exceeds their manufacturer's specified output by more than 10%.	Know when to replace nozzles.	Identify when nozzles should be replaced.
Clean Water Tank		
All motorized sprayers should be equipped with a clean water tank. They provide a source of clean water for emergencies and to perform routine tasks such as nozzle and hand cleaning.	Know why sprayers should be equipped with clean water tanks.	Describe why sprayers should be equipped with clean water tanks..

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Additional Components Additional components are available to enhance the operation of the sprayer. Electronic controls, hydraulic or electric booms, induction systems, injection systems, and enclosed cabs are methods that reduce exposure and increase convenience. Components such as hoods, perforated screens, air-assistance, and electrostatic systems may also be used to improve sprayer performance and reduce potential for drift. Individual nozzle hoods protect the top portion of the spray. With hoods, you must keep a near perfect seal at the front and back of the shields to prevent air movement underneath. Some boom hoods prevent visual inspection of nozzles and require a monitoring system. Perforated screens reduce the air speed passing over the spray. Small droplets hit and stick to the screen, combine with others, and fall to the target. These screens may affect how the boom folds for transportation. Air Assist or air curtain sprayer systems use an air stream to carry small droplets down to the target. The air gives the droplet momentum and prevents it from hanging in the air, thus reducing the potential to be affected by prevailing air currents. Electrostatic systems apply a charge to the spray solution before it exits the nozzle assembly. The charge on the droplet is attracted to the oppositely charged plant material, helping to improve coverage and prevent drift. All hoods and screens must be carefully cleaned to prevent contamination to other crops and sensitive plants.	Understand that there are additional sprayer components.	Describe additional components that enhance sprayer operation.

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Items such as spray monitors and controllers may improve the application by supplying the operator with more information and maintaining a constant application rate. **NOTE: Drift control agents may change fluid viscosity that will affect distribution patterns, spray monitors and controllers.**		
Calibration Objectives For Liquid Application Equipment		
The five objectives when calibrating a sprayer are: - to ensure that the sprayer and its components are functional; - to ensure that the sprayer will apply the spray mixture uniformly; - to ensure that the nozzle pressure combination produces a droplet size that provides good coverage and limits spray drift; - to determine the sprayer application rate and adjust the sprayer to meet the label requirements; - to 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.	Know when sprayers should be calibrated.	Describe when sprayers should be calibrated.
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.		
The basic steps for sprayer calibration are: 1. Set-up the sprayer.	Know the steps required to calibrate application equipment.	Describe the steps required to calibrate application equipment.

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2. Measure the sprayer application rate. 3. Make adjustments, if necessary to meet the recommended sprayer application rate. 4. Determine the amount of formulated pesticide to add to the spray tank.		
1. Sprayer Setup		
Sprayer setup includes: first, determining the recommended sprayer application rate, then making adjustments to deliver this rate, and finally checking to determine that the sprayer is operating properly.	Know the steps in sprayer setup.	Describe the factors that affect the recommended sprayer application rate.
1a. Determining the recommended sprayer application rate. The recommended application rate may be given as a range. When this occurs the applicator must determine the best rate depending on the factors present at the application site. These factors include: the crop, stage of growth, the pest, the pesticide, weather, soil conditions, and method of application.	Know the factors that affect the recommended sprayer application rate	
1b. Adjustment of factors affecting sprayer application rate. Once the recommended sprayer application rate has been determined, the sprayer must be setup to deliver this amount. The sprayer application rate will depend on three factors: - spray width (or nozzle spacing); - total nozzle output (or average nozzle output); - travel speed. For broadcast spraying, with regularly spaced nozzles on a horizontal boom, nozzle spacing and average nozzle output can be used. Otherwise the spray width and total nozzle output is used.	Know the factors that affect sprayer application rate.	Describe the factors that affect the sprayer application rate.

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Factor #1 - Spray Width or Nozzle Spacing: When **broadcast spraying** with a horizontal boom, the swath width of the sprayer is equal to the number of nozzles multiplied by nozzle spacing. For **band spraying** with even flat fan nozzles, the total swath width is the spray width of each nozzle multiplied by the number of nozzles. When calculating the sprayer application rate, understand that the rate is for the treated area only. When using a **single nozzle** (e.g., hand sprayers), spray width is the actual width sprayed with each pass. For vertical boom sprayers, spray width is the row width multiplied by the number of rows sprayed. The spray width should equal the distance between sprayer passes measured center to center. The nozzle arrangement on the sprayer and sprayer movement through the crop affects application uniformity.	Know to what spray width refers.	Describe how spray width is determined for different types of sprayers.
Factor #2 - Total and Average 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). Total nozzle output refers to the nozzle output from every nozzle on the spray equipment. Measure nozzle output by running the sprayer with water at the selected pressure and collecting the spray from each nozzle in a measuring cup for a specific time (e.g., 30 seconds). Divide the total nozzle output by the number of nozzles to calculate the average nozzle output.	Know to what nozzle output refers.	Define nozzle output Describe how nozzle output is measured. Calculate average nozzle output.
Nozzle output depends on the nozzle size and operating pressure. Increasing nozzle size and/or operating pressure increase the nozzle output. Nozzle type, size and pressure will affect droplet size and in turn the spray coverage and drift potential. Some	Understand the factors affecting nozzle output.	List the factors affecting nozzle output.

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pesticide labels carry specific nozzle recommendations.		
Manufacturer catalogues provide nozzle outputs in either metric or U.S. units. Nozzle catalogues do not commonly use Imperial units, but there are exceptions. Always ensure that it is clear which units are being used. 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.
Factor #3 - Travel Speed: The travel speed of the sprayer affects the sprayer application rate. For a given nozzle output, increasing travel speed will decrease the sprayer application rate. Typical travel speeds for pull type boom sprayers are between 8 and 13 km/h (5-8 mph) and for self-propelled sprayers between 15 and 30 km/h (10-20 mph).	Know how to measure travel speed.	Identify the importance of travel speed of the sprayer.
Excessive travel speed causes boom movement, resulting in non-uniform application. Select a travel speed that will minimize boom movement. Travelling up and down hills can result in significant changes in speeds resulting in different application rates.		
If walking, walk at a steady pace. Walking speed will vary with different applicators.		
Measure travel speed: - in the area where you will be spraying; - with the sprayer half full of water; - repeat in both directions, then average the results.	Know how to measure travel speed.	Describe how to measure travel speed.
Calculate travel speed by using the following equation: Travel Speed = Test distance ÷ Time × Constant. Metric Units: km/h = metres ÷ seconds × 3.6. Imperial Units: mph = feet ÷ seconds × 0.68	Know how to calculate travel speed.	Calculate travel speed.

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Concept: APPLICATION TECHNOLOGY

General Objective: To know the types of application equipment available for landscape pest management.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The travel speed required to use existing nozzles can be calculated if the recommended sprayer application rate, nozzle output and spray width are known. Travel speed (single nozzle sprayers) = total nozzle output ÷ (recommended sprayer application rate x spray width) × constant. Travel speed (boom sprayers) = average nozzle output ÷ (recommended sprayer application rate x nozzle spacing) × constant. Values of constants: Metric: km/h = L/min ÷ (L/ha x cm) ÷ 60,000. U.S.: mph = U.S. gpm ÷ (U.S. GPA x inches) × 5,940. Imperial: mph = Imperial gpm ÷ (Imperial GPA × inches) × 5,940		
The travel speed required to use existing nozzles can be calculated if the recommended sprayer application rate, nozzle output and spray width are known. Travel speed = total nozzle output ÷ (recommended sprayer application rate x spray width) × constant. Travel speed (boom sprayers) = average nozzle output ÷ (recommended sprayer application rate × nozzle spacing) × constant. Values of constants: Metric: km/h = L/min ÷ (L/ha x cm) ÷ 60,000. U.S.: mph = U.S. gpm ÷ (U.S. GPA x inches) × 5,940. Imperial: mph = Imperial gpm ÷ (Imperial GPA × inches) × 5,940		

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1c. Checking the sprayer operation		
The final process in sprayer setup is to ensure the sprayer is operating properly and will apply the pesticide uniformly. Non-uniform application will result in areas of over and/or under application possibly causing crop/plant damage or 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 in application across the width of the boom are caused by: - variations in nozzle outputs caused by mismatched nozzles; - worn or plugged nozzles; - pressure variations across width of boom; - improperly aligned flat fan nozzles; - variations in nozzle spacing; - incorrect boom height.		
Variations over the total application area can be caused by: - variations in sprayer output caused by fluctuating travel speed or pressure; - excessive boom movement; - skips or excessive overlaps between successive passes of the sprayer; - inadequate mixing or agitation of the pesticide; - malfunctioning spray monitor.		
To ensure uniform application the following checks should be performed during calibration.	Understand what checks should be taken to ensure application uniformity during sprayer setup and calibration.	List the checks to be made during sprayer setup (calibration) to ensure uniform application.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Before starting the sprayer, check: - all strainers and screens (including filters and check valves); - all nozzle strainers for mesh size, holes and cleanliness; - all the nozzles for the correct type, size, spacing and alignment on the boom; - boom for height above spray target and that the height is level across the boom; - pressure gauge condition and pulsation damper air pressure. With the sprayer running (with water): - set engine throttle at appropriate rpm to obtain correct travel speed; - flush lines with nozzles removed (if required); - check for leaks and that valves, agitation, and bypass flow are working; - clean nozzles (and nozzle strainers) with distorted patterns and discard damaged nozzles; - adjust pressure regulator, check pressure gauge and measure pressure drop using second pressure gauge (use nozzle adapter to connect to the boom). Boom pressure should be uniform for uniform nozzle output; - check for nozzle wear by measuring output of each nozzle; - calculate the average nozzle output, replace nozzles with outputs that are 5% greater or less than the average, replace all the nozzles when average output is more than 10% of a new nozzle; - check that the nozzles and boom are arranged to provide uniform coverage of the target. - determine the effective swath width of the sprayer.		

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Concept: APPLICATION TECHNOLOGY

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
2. Measuring Sprayer Application Rate		
Sprayer application rate can be measured by two basic methods – the test area method and the timed output method. The test area method uses fewer calculations however, it can take longer to carry out. If an entire acre or hectare is used as the test area, the measured discharge of water is the application rate per acre or hectare and no further calculations are required. The most common problem with the test area method is measuring the amount of spray water discharged. If too small a test area is used or it is not covered with enough passes, the actual amount of water discharged is too small to accurately measure in the tank. The tractor and sprayer tank should be parked in the exact same location and the water must settle in the tank after stopping, before measuring the tank level again. The timed output method avoids these problems. For broadcast sprayers with evenly spaced nozzles the average nozzle output is used instead of total nozzle output and the nozzle spacing is used instead of the spray width (nozzle spacing equals the spray width for one nozzle).	Know the methods of measuring sprayer application rate and the advantages and disadvantages of each.	Identify the methods of measuring sprayer application rate. List the advantages and disadvantages of each.
Test Area Method 1. Mark out a test strip. 2. Fill the tank about half full with water and start sprayer nozzles and agitation. Adjust the pressure regulator to the desired pressure using the same engine rpm for the desired travel speed. Record the volume of water in the tank before the test. Mark the location and direction that the sprayer is parked to enable returning to the same position to measure the water sprayed (level ground is best). 3. Choose the tractor gear to obtain the desired travel speed.	Know the Test Area method to determine the sprayer application rate.	Describe the Test Area method to determine the sprayer application rate.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
4. Drive towards the first stake at the correct speed and open the boom valve as you pass it. Check the sprayer pressure again. Close the boom valve as you pass the second stake. Repeat as necessary until at least 10% of a full tank is sprayed. Record the number of "runs". 5. Return to the starting location to measure the volume of water sprayed. 6. Calculate the test area. 7. Calculate the sprayer application rate.		
Test Area = strip length × spray width × number of runs Metric Units: m^2 = m × m × number of runs U.S. Units: ft^2 = ft × ft × number of runs	Know how to calculate the test area.	Calculate the test area.
Sprayer Application Rate = volume of water sprayed ÷ test area × constant Metric Units: L/ha = L ÷ m^2 × 10,000 m^2/ha Per Acre Units: L/acre = L ÷ ft^2 × 43,560 ft^2/acre U.S. Units: GPA = U.S. gal. ÷ ft^2 × 43,560 ft^2/acre Imperial Units: GPA = Imp. Gal ÷ ft^2 × 43,560 ft^2/acre	Know how to calculate sprayer application rate using the Test Area method.	Calculate sprayer application rate using the Test Area method.
Timed Output Method		
1. Measure the travel speed of your sprayer with the sprayer tank half full with water in field conditions (see sprayer setup). 2. Measure total nozzle output (L/min) by spraying for a set time (e.g., 10 min) or use the total nozzle output from measuring individual nozzle uniformity (see sprayer setup). 3. Calculate the sprayer application rate.	Know the Timed Output method to determine the sprayer application rate.	Describe the Timed Output method to determine the sprayer application rate.
Sprayer Application Rate (single nozzle sprayers) = total nozzle output ÷ (travel speed × spray width) × constant.	Know how to calculate sprayer application rate using the Timed Output method.	Describe how to calculate sprayer application rate using the Timed Output method.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Sprayer Application Rate (boom sprayers) = average nozzle output ÷ (travel speed x nozzle spacing) × constant. Metric Units: L/ha = L/min ÷ (km/h × cm) × 60,000 Per Acre Units: L/acre = L/min ÷ (mph × inches) × 5,940 U.S. Units: GPA = U.S. gpm ÷ (mph × inches) × 5,940 Imperial Units: GPA = Imp gpm ÷ (mph × inches) × 5,940		
3. Adjusting Sprayer Application Rate		
If the sprayer application rate is different than the recommended sprayer application rate, it can be adjusted in three ways:	Know how to adjust sprayer application rate.	Describe how to adjust sprayer application rate.
- **Nozzle size** should be changed if large changes in application rate are needed. Obtain assistance from the nozzle supplier or application equipment specialist if required. Nozzle catalogues are available which list nozzle outputs in litres per minute (L/min). Desired output of new nozzles can be calculated if the application rate and travel speed are known (see sprayer setup-nozzle selection).		
- **Travel speed** changes will adjust the sprayer application rate. Slower speeds increase the rate and faster speeds reduce the rate. Travelling faster may cause the sprayer boom to bounce too much or prevent the proper coverage of the target.		
Calculate the required speed with the following formula: Required speed = present speed × sprayer application rate ÷ recommended sprayer application rate.	Know how to calculate the required speed.	Describe how to calculate the required speed.
Calculate the sprayer application rate again if another tractor/truck gear and speed is chosen (rpm may be fixed due to pump):		

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- **Spray pressure** should be set for the correct droplet size. Changing pressure is recommended only for small changes in sprayer application rate for most nozzle types. Otherwise the droplet size will change and cause drift or runoff problems. Since pressure must be increased four times to double the delivery, this is generally not a good way to adjust sprayer application rate.		
4. Pesticide Use Calculations For Liquid Application Equipment		
Pesticide use calculations require the following information: - size of the treatment area; - correct amount of pesticide required for the total treatment area; - amount of pesticide to add to the spray tank; - area covered by the spray tank; - total number of tanks required; - volume of spray mix required for the final load; - amount of pesticide required for the final load. These calculations are based on the pesticide rate that the applicator selects from the label.	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.

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Before making a pesticide application, perform the following calculations:

- Determine the size of the treatment area. It can be obtained by measuring or from other sources such as property maps or deeds.

  Area of a rectangular or square shape = length × width.
  Any area that is not to be treated should be subtracted from the total area.
  Metric: Hectares = Length (m) × Width (m) ÷ 10000 m^2/ha.
  Imperial: Acres = Length (ft) × Width (ft) ÷ 43560 ft^2/acre.

- Total pesticide required = treatment area × pesticide rate.

Litres = Hectares × Litres/hectare.
Litres = Acres × Litres/acre.
Litres = square metres × litres/100 m^2.

- Area covered per tank = tank size ÷ sprayer application rate.

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

- Pesticide to add to the spray tank.
  - When pesticide rate is expressed as a rate per area.
    - Pesticide per tank = pesticide rate × area covered per tank.

    - Litres = Litres/hectare × hectares/tank.
    - Litres = Litres/acre × acres/tank.
    - Litres = litres/100 m^2 × 100 m^2/tank.

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- When the pesticide rate is expressed as a dilution factor.
  - Pesticide per tank = tank size × dilution factor.
  - Litres = Litres × Litre/Litres.

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

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

  Total number of tanks may include a partial tank

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

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

- Volume of spray mixture for partial tank = treatment area left to be sprayed × sprayer application rate.

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

- Pesticide for partial tank = treatment area left × pesticide rate.

  Litres = Hectares × Litres/hectare.
  Litres = Acres × Litres/acre.
- Total volume of spray mix (pesticide + water) = volume of spray mix per unit area × total area.

  Litres = Litres/square metre × square metre.
  Gallons = Gallons/square foot × square foot.

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NOTE: **When developing a training manual, sample calculations are required to improve understanding.**		
Before any application, evaluate environmental conditions at the application site especially if sensitive non-target areas are nearby. Spray drift and vapour drift must be minimized. Water quality could affect the pesticide or the application equipment.		
Buffer Zones		
Pesticide labels may contain statements about buffer zone distances from sensitive areas. A buffer zone is defined as the distance from the downwind edge of direct pesticide application to the nearest upwind edge of the sensitive area. Buffer zones are intended to protect sensitive non-target environments from damage by pesticides. In some cases, buffer zones may depend on certain weather, application methods, provincial or municipal regulations.	Understand buffer zones.	Define buffer zones. Describe buffer zones.
Spray and Vapour 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.	Know what weather conditions must be considered when applying pesticides.	List weather factors to consider when applying pesticides.
Also consider site specific factors that may make areas surrounding the application site more susceptible to effects of drift, such as proximity to: - surface water; - sensitive plants;	Know what site specific factors are affected by drift.	List site specific factors that are affected by drift.

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- people or animals; - other sensitive areas.		
Minimize spray drift by only spraying under favourable weather conditions. The combination of high temperature and low humidity increases evaporation and results in smaller droplets, and smaller droplets are more prone to drift off target. The higher the wind speed, the greater the potential drift in the direction of the wind. Note that maximum acceptable wind speeds for application may be referenced on the label or by provincial recommendations or legislation. Wind speed indicators (anemometers) and pictorial comparisons are available to determine wind speed. It is highly recommended that applicators obtain accurate hand-held anemometers to determine the wind speed and direction at the time of spraying. If spray drift occurs, stop the application, even if wind speeds are acceptable. Avoid wind conditions that are unpredictable (e.g., gusting, no wind conditions), as these conditions could lead to droplets blowing onto non-target sensitive plants/organisms.	Know how spray drift can be minimized.	List methods of minimizing spray drift.
If spray drift is a concern, consider: - increasing droplet size by lowering pressure; - selecting a low drift nozzle; - using a coarser spray quality (droplet size); - lowering boom height or holding the spray gun closer to the target (nozzles may be tilted forward to maintain recommended boom height for proper overlap and uniform application) Note. Lowering the boom by using nozzles with wider spray patterns, and finer droplets, may not reduce drift; - using a spray guard or shroud; - using other equipment that reduces or eliminates drift (e.g., wick application equipment); - using drift control agents.		

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Minimize vapour drift potential by: - selecting the least volatile pesticide (e.g., Amine versus ester formulation); - applying the pesticide under favourable wind conditions. No-wind conditions can cause vapours to remain in the air and damage nearby non-target areas. A 2 km/h wind, blowing away from non-target areas is generally adequate to minimize risk; - applying the pesticide under favourable temperature and humidity conditions. High temperatures and low humidity increases volatilization; - do not spray during temperature inversions. Temperature inversions can cause spray or vapour drift to stay concentrated, increasing their potential impact when downwind movement occurs. Pesticide application is not recommended during inversions because wind directions are unpredictable during this time. It is best to apply during sunny days in the presence of a low wind with consistent and predictable direction.	Know how to minimize vapour drift potential.	Describe how to minimize vapour drift potential.
Increase Droplet Size		
Applicators can reduce spray drift by increasing the droplet size being produced by the nozzles on the sprayer. Droplet size increases as nozzle orifice size increases and pressure decreases.	Know how applicators can reduce spray drift by increasing droplet size.	Identify how applicators can reduce spray drift by increasing droplet size.
A nozzle with a small orifice 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 nozzle with small orifices. Increasing the spray angle on nozzles will decrease droplet size at the same pressure. There are nozzles designed to provide larger droplet as well (e.g., low-drift, drift guard and air induction) Switching nozzle types may increase droplet size for	Know how to maintain sprayer application rate when nozzle size is increased.	Describe how to maintain sprayer application rate when nozzle size is increased

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the same nozzle flow rate and pressure. For standard nozzles, if a nozzle with a larger orifice is selected and the same pressure is used, there will be a higher nozzle output. It would then be necessary to increase the travel speed, or to accept a higher sprayer application rate or a bit of both. Travel speed must not be excessive and the application rate must not exceed the maximum sprayer application rate, if specified on the label. For all nozzles, pressures should be consistent with manufacturer's recommendations.		
NOTE: Insecticides and fungicides are generally applied with a finer (smaller) 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 droplets that are too large when applying insecticides and fungicides can reduce pesticide performance. Application of insecticides and fungicides may require a compromise between drift reduction and pesticide performance.	Know that when applying insecticides and fungicides, droplet size may need to be reduced to increase efficacy but that it is a compromise between drift reduction and pesticide performance.	Identify that when applying insecticides and fungicides, droplet size may need to be reduced to increase efficacy but that it is a compromise between drift reduction and pesticide performance.
Water Quality and Pesticide Effectiveness		
Temperature, sediment, pH, and presence of mineral ions 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 that could adversely affect the performance of the pesticide.
High pH can cause breakdown of some insecticides, and can decrease the solubility of some herbicides.	Know the factors that affect the rate of pesticide breakdown.	List the factors that could affect pesticide breakdown.
The rate at which pesticide 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.		

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Silt and organic matter in the water can cause: - premature pump wear; - plugging of screens; - decreased pesticide effectiveness.	Know the effects of silt and organic matter in the water.	List 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.
Maintenance		
Proper maintenance of application sprayer minimizes the chance of a breakdown, increases the service life and minimizes the chance of accidental leaks and spills.	Understand the importance of maintaining application equipment.	Identify the importance of properly maintaining application equipment.
Rinse the sprayer thoroughly at the end of each spraying day by flushing clean water through the pump, hoses, and nozzles. Check all screens, strainers 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.	Understand how to maintain application equipment.	Describe how to maintain application equipment.
Decontaminate the sprayer when changing from one type of pesticide to another (i.e., herbicides to insecticides). Decontamination procedures vary depending on the pesticides	Know when and how to decontaminate the sprayer.	Identify when to decontaminate the sprayer. Identify where to find specific recommendations for decontamination.

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being used. Consult the pesticide label or manufacturer's representative for specific recommendations.		
Temporary Storage of Spray Vehicles		
Evaluate parking site carefully when parking spray vehicles. Take the following precautions: - do not park near susceptible vegetation as release of herbicide vapours or movement of spray solution off the vehicle deck may occur due to rainfall; - do not park where drainage of pesticides into storm sewers - do not park where vandalism may occur; - avoid parking in urban areas, particularly when the spray tank is full.	Know what precautions should be taken when temporarily storing spray vehicles.	Describe the precautions to take when temporarily storing spray vehicles.
If parking near susceptible vegetation or parking in urban areas is unavoidable, take these precautions: - lock all valves that could allow spray solution to escape during any unauthorized access; - secure pesticide containers to prevent tampering or theft; - inspect spray systems daily (before application) to check for tampering; - ensure that contaminated clothing is stored in a secured location well away from clean clothing until the contaminated clothing is cleaned or disposed of; - ensure all spills on decks have been cleaned appropriately.		
Provincial Legislation and/or Regulations may prohibit leaving pesticides, spray solutions and loaded sprayer unattended. Refer to provincial legislation and be aware of restrictions in your province.		

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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, insects or rodents; - store the sprayer where it will not be damaged by other equipment, livestock or weather. Store polyethylene tanks under cover to prevent deterioration by sunlight and galvanized steel tanks away from moisture to prevent rusting.	Know how to prepare a sprayer for storage.	Describe the steps in preparing a sprayer for storage.
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;	Know the desirable features of storage hoppers.	List the desirable features of a storage hopper.

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- be shaped to improve granule flow; - be easy to fill; - be easy to clean; - have graduated markings.		
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 (type, shape and size of formulated granule); - the shape of the hopper; - air temperature and humidity.	Know the function of agitators. Know the causes of bridging.	Identify why agitators are installed in hoppers. List the causes of bridging.
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.	Know the function of course screens on hoppers.	Identify the function of course screens on hoppers.
Metering Mechanism		
Gravity flow and positive metering mechanisms are commonly used.	Know the types of metering mechanisms.	List the types of metering mechanisms.
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. A ground driven wheel usually powers positive metering mechanisms. They provide greater accuracy than gravity flow metering mechanisms.		Describe positive metering mechanisms. Contrast the two mechanisms.

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Distribution System		
Granular application equipment is classified according to the type of distribution system used. Broadcast and banding are two common types of distribution systems.	Know the common types of distribution systems.	Describe the common types of distribution systems.
Broadcast application equipment applies granules over the entire field surface. Broadcast application equipment commonly uses 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 applying pesticides only to the area requiring treatment.		Describe band application equipment. Contrast the two types of 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.		
Calibration Objectives For Granular Application Equipment		
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.

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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 outputs; - variations in travel speed; - variations in discharge heights when banding; - improper overlap between successive passes.	Know the reasons for non-uniformity.	List the reasons for non-uniformity.
Equipment Application Rate		
The equipment application rate depends on: - the granule flow rate; - the travel speed; - the treatment width.	Know the factors that determine equipment application rate.	Identify the factors that determine equipment application rate.
Granule Flow Rate		
Granule flow rate (weight per time) is the rate at which granules flow from the hopper. Granular flow rate depends on: - the size of opening; - the granule size and density; - formulated pesticide 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 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.
Larger or less dense granules will flow more slowly through the same sized opening.	Know how size and weight of granules affects flow rate.	Identify how size and weight of granules affects flow rate.

Category: LANDSCAPE

Concept: APPLICATION TECHNOLOGY

General Objective: To know the types of application equipment available for landscape pest management.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
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.	Identify 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.	Know how to adjust the flow rate of gravity flow mechanisms.	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.	Know how to adjust the flow rate of positive metering mechanisms.	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. Sloping fields may also affect 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 application equipment. Measurements should be made in field conditions.	Know how to ensure uniform application over the total width of the application equipment.	Describe how to ensure uniform application over the total width of the application equipment.
Travel Speed		
The travel speed will affect the equipment application rate.	Know how the travel speed affects equipment application rate.	Identify how travel speed affects equipment application rate using gravity flow metering.
For granular application equipment using gravity flow metering mechanisms, increasing travel speed will decrease the application rate for a given setting.		

Category: LANDSCAPE

Concept: APPLICATION TECHNOLOGY

General Objective: To know the types of application equipment available for landscape pest management.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
For granular application equipment using positive metering mechanisms, small changes in travel speed do not significantly alter the equipment application rate when the metering mechanism is ground driven.		Identify how travel speed affects equipment application rate using positive metering mechanisms.
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 equipment application rate and depends on the type of distribution system used.	Understand treatment width and how it varies with the type of distribution system.	Describe how treatment width varies with the type of distribution system.
For broadcast application equipment, the treatment width equals the total width that granules are applied in each pass.	Understand how to calculate the treatment width for broadcast application equipment.	Describe the treatment width for broadcast application equipment.
For band application equipment, the treatment width equals the total of all the individual bandwidths for one pass.	Understand how to calculate the treatment width for band application equipment.	Describe the treatment width for band application equipment.
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		
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 equipment application rate changes.	Know when and how to calibrate granular application equipment.	Describe when to calibrate granular application equipment. Describe the steps for calibrating granular application equipment.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
1. Determine a suitable travel 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 representative area, mark a test distance of at least 50 metres in length. 3. Fill the hoppers approximately half full for average weight conditions. 4. Consult the operator's manual for the recommended setting of the metering mechanism. Note: The operators manual recommended flow rate may need to be altered 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 airflow and catch the granules at the metering mechanism. 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		

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
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. Calculate the equipment output and compare to the pesticide rates on the label. Also, 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.
The calculations required for a granular applicator are: - the calibration area; - total amount collected; - treatment area; - total amount of pesticide product required.		
Granular Application Equipment Calculations		
- Treatment area = length × width. Kg = Hectares × Kg/hectare Kg = Acres × Kg/acre	Know how to perform the field calculations for granular application equipment.	Calculate - area, - application equipment output, and - total pesticide required.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES

- Total granules discharged = sum of the weights of individual openings discharged over test area.
 	
- Amount of pesticide to use/unit area
 	
  - Broadcast (kg/ha): Equipment Application Rate = total granules discharged ÷ treatment area. Record this in the operators' manual for future reference.
 	
  Kg = Hectares × Kg/hectare
  Kg = Acres × Kg/acre
 	
  - Banding (kg/m): Equipment Application Rate = total granules discharged × number of bands ÷ distance.
 	
- Total pesticide required = treatment area × label pesticide rate.
 	
  Kg = Hectares × Kg/hectare
  Kg = Acres × Kg/acre		

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 equipment application rate.	Know the environmental conditions that may influence a granular application.	Identify the environmental conditions that may influence a granular application.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Non-targets		
Granular pesticides should be incorporated into the soil where appropriate to prevent ingestion by children or non target animals. Refer to the pesticide label for specific instructions.	Know how to minimize the impact of granular insecticides on children and wildlife.	Identify how to minimize the impact of granular insecticides on children and wildlife.
Maintenance		
Proper maintenance of the application equipment minimizes the chance of a breakdown and increases the service life.	Understand the importance of 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.	Understand how to maintain granular application equipment.	Describe how to maintain granular application equipment.
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 for ground-driven equipment. 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.		
To prepare the equipment for storage: - thoroughly clean the equipment; - lubricate all moving parts.	Know how to prepare the equipment for storage.	List the steps in preparing the equipment for storage.

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Concept: APPLICATION TECHNOLOGY

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Follow the manufacturer's recommendations; - check and replace worn equipment parts; - store the equipment where it will not be damaged by other equipment, livestock or weather.		

Category: LANDSCAPE

Concept: PROFESSIONALISM

General Objective: To understand the importance of communication with the public in matters concerning the use of pesticides in the landscape.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Conducting pest management in the landscape industry with an IPM approach requires a thorough knowledge of pest biology and the different types of controls. New control methods are continually being developed. Professional applicators must continue to expand their knowledge beyond the basic certification requirements to learn about new methods and products by consulting credible sources of information including: - journals; - government or industry publications; - Pest Management Regulatory Agency website www.hc-sc.gc.ca/pmra-arla; - Healthy Lawns website www.healthylawns.net; - seminars; - information exchanges with members of local associations; and - provincial and national associations.	Know sources of new information.	List sources of new information.
Good communications with clients is a vital part of a professional approach. This includes: - making certain the requirements of the client are determined; - providing a clear indication to the client about what you can do and what you have done; - ensuring that people who live or work in or near treated areas are notified and given information they want to know; - ensuring signs are posted indicating; product used, contact telephone numbers, and pests controlled. This may be required by regulations in some provinces; - promote a reasonable pest tolerance approach with the client.	Understand what good communication with clients includes.	List examples of good communication with clients.

Category: LANDSCAPE

Concept: PROFESSIONALISM

General Objective: To understand the importance of communication with the public in matters concerning the use of pesticides in the landscape.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The applicator must demonstrate professionalism to his clients and the public by: - practicing and promoting IPM; - avoiding regularly scheduled application programs; - preventing bystander exposure; - preventing contamination of outside items such as lawn furniture, children's toys, sandboxes, pets and pet dishes; - recommending homeowners' and neighbours' windows be closed during application, recommending homeowners' shut own air intake systems; - reducing pesticide use by using spot treatments where appropriate.	Know how applicators can demonstrate professionalism to his clients and the public.	List ways that an applicator can demonstrate professionalism to his clients and the public
The applicator must convey and demonstrate competence to be applying pesticides. Failure to do so leaves the public with concerns about the risk of exposure to themselves and their family, plus the possibility of damaging their personal belongings.	Understand why the applicator must convey and demonstrate competence to be applying pesticides around populated areas.	Identify why the applicator must convey and demonstrate competence to be applying pesticides around populated areas.
Landscape applications are primarily done in proximity to people, animals and sensitive areas. Applicators must consider sensitive areas such as: - Daycares and schools; - Playgrounds; - Aquatic sites; - Multi-family dwellings; - Nursing homes and hospitals.	Understand that applicators must consider sensitive areas.	List examples of sensitive areas.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
There are issues that make pesticide application in urban areas more challenging than applications in more isolated areas including: - the public concerns regarding the use of pesticides around their homes; - the public want to have perfect looking lawns; - the public is largely misinformed about the safety of pesticides.	Understand the issues that make pesticide application more challenging than applications in more isolated areas.	List the issues that make pesticide application more challenging than applications in more isolated areas.
Site Planning		
Educate consumers about the importance of site development before planting a lawn or garden to avoid long-term issues with pesticides, including: - soil quality and quantity requirements; - drainage; - plant cultural requirements; - plant suitability.	Know the importance of educating consumers about site development.	List the types of things that effect site development in a garden or lawn.
Inform consumer about the amount of maintenance involved with certain plant species or varieties. Be prepared to offer suitable alternatives that meet the needs of the site and the consumer.	Understand that consumers should be aware of the high amount of maintenance involved with some plant species.	Identify the need to inform consumers of the high amount of maintenance involved with some plant species.