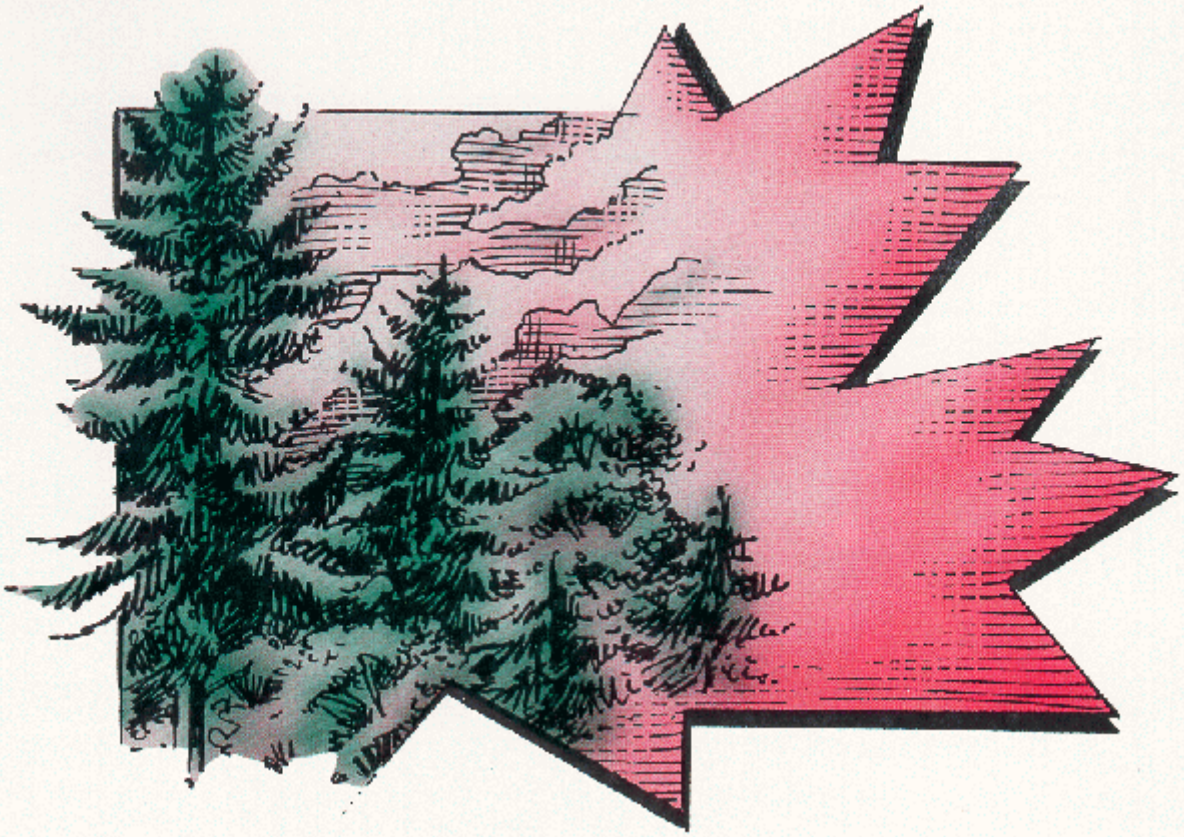

FORESTRY MODULE | **MODULE – FORESTIER**

BASIC KNOWLEDGE REQUIREMENTS FOR PESTICIDE EDUCATION IN CANADA

CONNAISSANCES FONDAMENTALES REQUISES POUR LA FORMATION SUR LES PESTICIDES AU CANADA

CAPCO

Health Canada Santé Canada

FORESTRY MODULE

BASIC KNOWLEDGE REQUIREMENTS

FOR

PESTICIDE EDUCATION IN CANADA

AUSSI DISPONIBLE EN FRANÇAIS

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

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

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BASIC KNOWLEDGE REQUIREMENTS
FOR PESTICIDE EDUCATION IN CANADA
FORESTRY MODULE

This module of the national standard for pesticide applicators covers the knowledge requirements specific to the forestry category. This category includes application of herbicides, insecticides, fungicides, and animal repellents in forest management and in forest seedling nurseries and seed orchards. This category includes only ground application and does not cover aerial application, which is contained in a separate category.

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

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

In addition to the Applicator Core, modules of knowledge requirements have been developed for the following ten pesticide categories:

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

FORESTRY MODULE

CONTENTS

Category: FORESTRY

Concept: LABELLING - INTERPRETATION

General Objective: To identify, define and be able to use information on forestry pesticide labels.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pesticides used in forestry are divided into the following product categories as defined by Agriculture Canada and specified on labels:	**Develop an awareness and general understanding of federal categories of forestry use pesticides.**	**Describe the meaning of the following product categories specified on labels for pesticide use in forestry:** **- Forest Management uses;** **- Woodlands Management uses;** **- Ornamental uses;** **- Rights-of-way uses.**

Forest Management - Restricted

These products can be used for treatment of more than 500 hectares of a wooded area or of a site to be planted to forest and may include aerial application. All products with direction for "forest" or "forest management" uses are classified as Restricted. The labels of these products bear the statement: "This product is to be used only in the manner authorized; consult provincial pesticide regulatory authorities about use permits which may be required". This applies to all crown, leased and private lands.

Woodlands Management

These products can be used for the treatment of not more than 500 hectares of a wooded area or of a site to be planted to forest. A site is defined as a continuous monoculture without a break in cultural practice or management stage. A site of 1,000 ha cannot be divided into blocks of 500 ha to be treated individually under the Woodlands Management category. Products with directions for Woodlands Management can be applied by air if they have a Restricted classification or have aerial application as a Restricted Use. The Restriction instructs the user to consult provincial pesticide regulatory authorities about use permits that may be required.

Category: FORESTRY

Concept: LABELLING - INTERPRETATION

General Objective: To identify, define and be able to use information on forestry pesticide labels.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Products for Woodlands Management with commercial classification can be used for treatment of no more than 500 hectares of a wooded area, as follows: **1. Application of pesticides to woodlands only by ground equipment.** **2. Application of pesticides in tree nurseries or seed orchards by ground or aerial equipment.** **3. Application of pesticides in treed areas such as municipal parks only by ground equipment.**		
Ornamentals **Application of pesticides in treed areas of less than one hectare are designated as ornamental uses and may include single trees. These products are generally classified as Commercial or Domestic pesticides.**		
Rights-of-way (Brush Control) **Products with directions for rights-of-way (ROW) can be used for ROW in forest lands and can be applied by ground or aerial equipment within the Commercial label classification. Aerial application is not permitted in urban areas.**		
Notes: **1. The application rate for insecticides may vary among the Forest Management, Woodlands Management and Ornamental use categories for the same pest and tree species because the degree of control required may be different.**	**Understand that the application rates may vary among some categories for the same pest and tree species.**	**Identify why application rates for the same active ingredient may vary between forest pesticide categories for the same pest and tree species.**

Category: FORESTRY

Concept: LABELLING - INTERPRETATION

General Objective: To identify, define and be able to use information on forestry pesticide labels.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
2. Products for use in any of the above-described areas may be given a Restricted classification if the product is highly toxic (i.e., acute oral LD_{50} < 50 mg/kg or dermal LD_{50} < 100 mg/kg).	**Know that forestry products of any use will be in the Restricted category if highly toxic.**	**Identify that forestry products may have a Restricted classification because of their toxicity.**

Category: FORESTRY

Concept: HUMAN HEALTH

General Objective: To know the importance of cholinesterase testing.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Organophosphates or carbamate pesticides which may be used in pest management programs inhibit cholinesterase. Cholinesterase is an enzyme in the blood which affects the nervous system and the way the brain sends messages to different parts of the body.	**Know that cholinesterase testing is important when applying organophosphates or carbamate insecticides on a regular basis.**	**Identify the blood test applicators should have when handling organophosphates or carbamates on a regular basis and describe why.**
Cholinesterase levels can vary widely between individuals and therefore it is important to know an individual's level of cholinesterase before handling these pesticides.		
Applicators who handle these pesticides on a regular basis should have:		**Identify when an applicator should have the blood test.**
1. A baseline test to determine cholinesterase enzyme levels before exposure.		
2. A regular blood test to check cholinesterase levels during the exposure period.		

Category: FORESTRY

Concept: PESTICIDE SAFETY - STORAGE

General Objective: Know how to store pesticides safely and legally in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Temporary Storage		
The nature of many forestry pesticide applications often requires that a temporary storage location be established. Many of the principles that apply to permanent pesticide storage apply to temporary pesticide storage.	**Know how to store pesticides temporarily.**	**List and describe requirements of a temporary pesticide storage area for field operations in forestry.**
Temporary storage locations should be away from watercourses and on ground that is flat and not highly permeable. The floor of a storage facility should be constructed to contain spills. It may be necessary to dig a ditch around the storage area to contain any spills and to prevent contamination of the surroundings.		
Transport trailers or vehicles may be used for temporary storage. If portable trailers are used, natural ventilation may be relied upon, provided all containers are tightly sealed. The trailer must be locked to prevent entry by unauthorized people. If no trailer is available, the containers must be in a securely fenced off area so that only authorized persons have access to the pesticides.		
A sign must be put on each site entrance or storage vehicle warning of pesticide storage.		
Guard against pesticide container deterioration by the use of pallets, appropriate ground sheets, or a tarpaulin, if the type of container warrants it.		
An area separate from, but close to the pesticide storage area should be available for the storage of personal protection equipment.		
Spill emergency equipment, fire extinguishers (if necessary), a first aid kit, eyewash station, and an adequate supply of water for washing should also be located at the site.	**Know what safety equipment and supplies should be available at a temporary storage facility.**	**List the safety equipment and supplies which should be available at a temporary storage facility.**

Category: FORESTRY

Concept: PESTICIDE SAFETY - PROTECTIVE CLOTHING AND EQUIPMENT

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Protective Clothing for Forestry Operations		
The following recommendations apply to forestry operations, unless otherwise directed by label instructions. In general, protective clothing/equipment must ensure that applications are not exposed to harmful quantities of pesticides due to spray drift, contact with sprayed foliar surfaces, spillage, or other sources.	**Know that the type of activity affects the protective clothing/equipment needed, and know the minimum protective equipment required for each activity.**	**Describe how the application method affects the protective clothing/equipment needed, and identify what protective gear is required for the following activities:** **- backpack spraying in low bush;** **- spot gun applications;** **- backpack spraying in high bush;** **- tree injections;** **- mounted fixed boom spraying;** **- spraying with a handgun on a hose;** **- using more toxic pesticides;** **- mixing and loading pesticides;** **- applying pesticides in enclosed spaces.**
The minimum protective clothing required for medium volume backpack spraying of herbicides in low bush situations, for herbicide spot gun applications, and hack and squirt applications are the following: **- coverall or pants and jacket made of cotton/polyester mix;** **- chemically resistant boots and gloves.**		
Additional protection may be required if the applicator may be wetted with spray such as in high-bush backpack treatments. A face shield or goggles and a chemically- resistant hat are not essential, but are desirable for these operations.		
Lance or capsule tree injection methods result in low potential exposure. A jacket is not essential for these methods. Also, chemically resistant boots are not essential for capsule injection.		
Spraying with a mounted fixed boom on a truck or tractor (where a person is not in an enclosed cab and may be wetted with spray), or spraying with a handgun and hose pulled by the operator, or using more toxic pesticides, requires additional essential equipment, including chemically resistant pants and jacket, hat and goggles or faceshield.		

Category: FORESTRY

Concept: PESTICIDE SAFETY - PROTECTIVE CLOTHING AND EQUIPMENT

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
If labels require "avoiding inhalation" of pesticide vapours, respirators should be used when mixing and loading pesticides, when applying pesticides in enclosed spaces, or when using highly toxic products. Also, respirators should be worn where there may be considerable exposure to spray or fumes such as when operating a vehicle mounted fixed boom (where the operator is not in an enclosed cab), or when using a powered sprayer with a single nozzle, where the operator is directing the hose.	**Know when to wear a respirator.**	**Identify when to wear a respirator.**
Chemical Cartridge Respirators are the most common type of respirators used for forestry field applications.	**Know that a chemical cartridge respirator is the most common type used.**	**Identify that a chemical cartridge respirator is the most common type used.**

Category: FORESTRY

Concept: ENVIRONMENT - AQUATIC IMPACT

General Objective: To know how to prevent pesticides from contaminating water in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fish and other aquatic organisms can be harmed directly by contamination of lakes, streams and wetlands through incorrect applications (e.g., overspray) or spills. Fish can be harmed indirectly if pesticides reduce food organisms or aquatic or streamside vegetation. Herbicide use, such as site preparation, conifer release or roadside brush control may result in loss of the vegetation canopy over streams. The vegetation canopy provides cover for fish, protects the stream against temperature extremes and erosion, and contains insects and plants that are important to the stream ecosystem and the fish food supply.	**Know how fish and other aquatic organisms can be harmed by pesticides.**	**Describe how fish and other aquatic organisms can be harmed indirectly by pesticides.**
Protect fish by preventing contamination of water sources and/or destruction of streamside vegetation. An important way to do this is to maintain a buffer zone during mixing and application. Pesticide should not be applied in the buffer zone. The buffer zone is used to catch any spray drift or runoff to minimize any toxic hazard to fish, fish food or habitat. The buffer zone may be established to prevent pesticide getting into the water body or to prevent damage to streamside vegetation. The required width of the buffer zone will vary with terrain, forest cover, method of application and the pesticide. Check with provincial authorities for buffer zone requirements or guidelines. Flagging, or other markers, may be required to identify the boundary of waterbodies or buffer zones during pesticide applications.	**Know how to protect fish.**	**Describe how a buffer zone is used to protect aquatic organisms.**

Category: FORESTRY

Concept: ENVIRONMENT - LAND IMPACT

General Objective: To know how to prevent pesticides from harming the land environment and its inhabitants in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Multiple Use Areas		
Forestry pesticide applications often take place in areas that are valuable for wildlife habitat and recreation. Forestry pesticide applicators should identify such uses of forest land and ensure that the various uses are protected as may be required by permits or land managers.	**Know that multiple use of some forest lands requires extra caution with pesticide use.**	**Identify that forestry pesticide applicators should be aware of all the kinds of land use in areas to be sprayed.**
A site inspection should be made prior to pesticide application to identify and locate sensitive natural areas that are not to be treated, such as areas valuable for wildlife habitat, waterways and recreational areas (e.g., snowmobile trails, ski trails). Areas where wild berries are profuse should be identified. These areas should not be sprayed, or signs should be set up, when the berries are ripening to ensure that contaminated berries will not be picked for human consumption.	**Know the need for site inspections before pesticide use in forestry.**	**Identify why site inspections are required before pesticide use in forestry.**
Animals		
Applicators should confirm that proposed pesticide treatments have been reviewed with provincial wildlife management agencies.	**Know that proposed pesticide treatments should be reviewed by provincial wildlife agencies.**	**Identify that proposed pesticide treatments should be reviewed by provincial wildlife agencies.**
Use of some insecticides in forestry, especially over large areas may have an effect on animals. Insecticides such as organophosphates and carbamates may have a direct toxic effect on birds by pesticide landing on nests or birds contacting treated foliage. These insecticides may have an indirect effect by altering bird behaviour. Insecticides may also remove insects important as food sources and as pollinators.	**Know how forest insecticide use programs can harm animals and birds.**	**List possible effects that forest insecticide use can have on animals and birds.**
Herbicide use in forestry site preparation, stand tending, brushing or conifer release programs may cause loss of habitat for birds, ungulates, and carnivores.	**Know how forest herbicide programs can harm animals and birds.**	**List possible effects that forest herbicide programs can have on animals and birds.**

Category: FORESTRY

Concept: ENVIRONMENT - LAND IMPACT

General Objective: To know how to prevent pesticides from harming the land environment and its inhabitants in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Herbicide applications to control deciduous brush in wildlife browse and forage areas, especially if large areas are involved, may seriously affect food sources of animals such as ungulates. Most deciduous plants are wildlife food sources. Therefore both target and non-target plants may be important for wildlife. It may be particularly important to protect browse vegetation in winter ranges of some animals.		
Options for protecting browse vegetation include the following: **1. Set aside certain areas within a treatment block to provide wildlife forage, particularly where target and key forage vegetation are the same. The size of the reserved areas will depend on the value of the wildlife habitat and the availability of alternate food sources in the site. Areas set aside may be treated with herbicide at a later date when alternate forage becomes available.** **2. Leave key wildlife food plant species intact by selective treatment of target vegetation such as one or more of the following:** **- timing to minimize the herbicide effect on browse species or other sensitive habitats;** **- a reduced concentration rate that is less effective on desired non-target vegetation;** **- a method of application that selectively protects browse species (e.g., spot herbicide treatment of target species).**	**Know options for protecting wildlife browse.**	**List ways to protect wildlife browse.**
Wildlife trees (e.g., some snags), provide critical habitat for the maintenance of wildlife. Such trees can be critical for various reasons including their use as food, shelter, nesting, dens, hunting perches, or foraging sites. Many species depend on wildlife trees including birds, mammals and amphibians. If removal of such trees is considered during herbicide projects, wildlife habitat staff should be consulted.	**Know the importance of snags to wildlife.** **Understand that wildlife staff should be consulted before snags are removed.**	**Describe the importance of wildlife trees (snags).** **Identify that wildlife staff should be consulted before snags are removed.**

Category: FORESTRY

Concept: ENVIRONMENT - LAND IMPACT

General Objective: To know how to prevent pesticides from harming the land environment and its inhabitants in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Streamside vegetation is extremely important habitat for wildlife. Such areas provide corridors for ungulates in winter, and habitat for furbearers, bears, and birds. A no-treatment zone, adjacent to watercourses, for fisheries habitat protection may also serve to protect wildlife habitat. However, depending on site specific considerations, additional protection of a wider area may be required.	**Know the importance of streamside habitat for wildlife and know how this habitat can be protected.**	**Describe the importance of streamside vegetation for wildlife.** **Identify how this habitat can be protected.**
Areas of ongoing wildlife research should be identified. Researchers should be contacted about proposed herbicide use projects in such research areas.	**Understand that areas of wildlife research should be identified and researchers consulted.**	**Describe what should be done to protect wildlife research areas.**

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pest management in forestry includes control of vegetation and insect, fungi and vertebrate pests.		
Vegetation Management in Forestry		
Forestry vegetation management activities include:	**Know the main types of vegetation management activities in forestry.**	**List the main types of vegetation management activities in forestry.**
1. Site preparation - improvement of a site for planting and seeding. This may include vegetation management as well as clearing debris. The objective may be to improve planter access, to create sufficient numbers of well spaced growing sites for newly established seedlings, to remove or reduce competing vegetation, to increase soil temperatures, or to reduce the hazard from fire.	**Know the objectives of vegetation management in site preparation.**	**Describe site preparation. List the objectives of vegetation management in site preparation.**
2. Stand tending - the improvement of survival, growth and form of crop trees. These activities may include vegetation management as well as fertilization and pruning. Stand tending may include the following types of vegetation management:	**Know the objectives of vegetation management in stand tending.**	**Describe stand tending. List the objectives of vegetation management in stand tending.**
- brushing is to remove or reduce vegetation that competes with crop trees for light, moisture and nutrients. The aim is not to kill all non-crop vegetation;	**Understand the practice of brushing.**	**Define brushing.**
- crop tree release is more specifically to manage vegetation that is overtopping or crowding crop trees to promote crop growth to a "free-to-grow" stage (when they have overgrown competing plants);	**Understand the practice of crop tree release.**	**Define crop tree release.**

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- thinning (or spacing) reduces the number of crop trees growing per hectare to allow the remaining trees adequate room to grow without competition for light, nutrients and moisture. The objective can be to improve diameter growth and form and health of the remaining trees. Thinning can also be referred to as a "stand improvement" operation.	Understand the practice of thinning.	Define thinning.
3. Right-of-way vegetation management - the removal of vegetation encroaching on forest roads.	Know what forestry right-of-way vegetation management is for.	Know the objective of forestry right-of-way vegetation management.
4. Weed control in forest tree nurseries and seed orchards - the removal of vegetation to improve the germination rate, growth rate and survival of nursery seedlings and also to reduce weed competition around seed orchard conifers.	Know why weeds are controlled in forest seed orchards and seedling nurseries.	Describe why weeds are controlled in forest seed orchards and seedling nurseries.
Types of Vegetation		
Plants are classified according to how long they live.	Know how plants are classified according to how long they live and know the difference between annual, biennial and perennial plants.	Describe how plants are classified according to how long they live. Describe the difference between annual, biennial and perennial plants.
Annual plants complete their life cycle within one year. Most annuals produce many seeds to ensure their survival. Annuals can be divided into two groups: "summer annuals", which germinate in the spring, and "winter annuals", which germinate in the fall.		
Biennial plants 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, then dies.		

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Perennial plants live more than two years. Often seed is not produced in their first year; thereafter seeds may be produced every year for the life of the plant. Most perennial plants spread by seeds. Many also spread vegetatively by producing creeping stems, stolons, creeping roots, rhizomes (a root-like underground stem), underground bulbs or a broken piece of root. There are shallow-rooted and deep-rooted perennials.		
Plants are also classified according to structural similarities, including the following types:	**Know how plants are classified according to structural similarities.**	**Describe how plants are classified according to structural similarities.**
Conifers have needles or scale-like leaves and produce seeds in cones. Most are evergreen. They are referred to as softwood trees in contrast to some hardwood broadleaf trees.	**Know the difference between conifers and flowering plants.**	**Describe the difference between conifers and flowering plants.**

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Flowering plants produce seed from flowers. They include herbaceous (soft-stemmed) plants such as grasses, thistles and dandelions, and woody plants such as various brush, shrub and tree species. Woody plants are classified as evergreen or deciduous. Many deciduous shrubs and trees produce suckers, which are new growth from just below cut stems or trunks. For these plants manual cutting may not be an effective control method.		

Plant Identification Characteristics

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The following plant characteristics will aid in the identification of problem and desirable vegetation: **- leaves, e.g.,** **compound or simple** **shape** **margins** **surface (smooth or hairy)** **arrangement along the stem** **(opposite, alternate, whorled)** **- stems, e.g.,** **branching habit** **woody or herbaceous** **upright or spreading** **- flowers, e.g.,** **arrangement** **number of petals, sepals** **reproductive parts** **seeds** **- roots, e.g.,** **fibrous, creeping, or tap**	**Know plant characteristics that aid in the identification of weeds and desirable vegetation.**	**List plant characteristics that aid in the identification of weeds and desirable vegetation.**
Integrated Vegetation Management **An integrated pest management approach should be used for vegetation control in forestry. Treatment thresholds may be established by determining percent vegetation cover or density of stems that interferes with crop trees. It** **is important to know the growth habit of plants being treated and to monitor site characteristics to determine when and how to treat. Consider a range of control options and develop a long term strategy to minimize impact on people and the environment.**	**Know that an integrated vegetation management approach should be used and how it is used in forestry.**	**Describe how integrated vegetation management is used in forestry.**
Vegetation Control Methods - Forest Management		

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Vegetation control methods in forest management (i.e., managed forests) include: **Manual methods, such as hand cutting (usually manually operated or powered cutting tools) and girdling.** **Mechanical methods use heavy equipment, such as crawler tractors, low ground pressure tractors, mowing attachments, crushing and chipping equipment, and brush cutters. Such mechanical methods can be used for site preparation, conifer-release, and thinning of conifers.** **Burning methods. Prescribed burns (planned and controlled) may be used for site preparation to reduce the fire hazard, and improve a site for planting.** **Biological methods use living organisms to manage vegetation and include prescribed grazing (e.g., sheep for conifer release), and release of insects that feed on specific weeds.** **Chemical methods involve the use of herbicides to control unwanted vegetation.** **Combination of methods. Any of the techniques listed could be used in combination to control vegetation. For example, herbicides may be used to desiccate weeds, followed by burning (known as a "brown and burn" method).**	**Know the main methods used for vegetation control in forest management.**	**List and describe methods used for vegetation control in forest management.**

Vegetation Control Methods - Conifer Seedling Nurseries and Seed Orchards

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Weed control methods in nurseries and seed orchards include the following: **Sanitation emphasizes prevention and includes:** **- cleaning machinery before moving it between locations;** **- controlling weeds in nearby ditches, fencelines, pathways, roads, etc.;** **- weeding or cultivating production areas regularly to ensure that no weeds set seed.** **Cultural control emphasizes competition to discourage weeds, and includes:** **- increasing the crop plants' ability to compete against weeds by using good cultural practices (e.g., optimum fertilizer rates, watering, etc.);** **- planting companion crops that suppress weeds but do not interfere with crop plants;** **- rotation of planting to leave sites fallow.** **Physical controls include use of ground cover, sheeting or mulches to inhibit weed growth.** **Manual methods include hand pulling, raking and hoeing.** **Mechanical methods use cultivators.** **Chemical methods involve the use of herbicides. They should be incorporated in a weed control program that includes other methods.**	**Know methods of weed control for conifer seedling nurseries and seed orchards.**	**List and describe methods for weed control in conifer seedling nurseries and seed orchards.**

Types of Herbicides

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Herbicides are classified according to selectivity, mode of action, timing of application and residual effectiveness.	**Know the ways that herbicides are classified.**	**List the ways that herbicides are classified.**
Selective herbicides only kill or damage certain plants. **Non-selective herbicides kill or damage all plants in a treated area. Some herbicides can be selective or non-selective depending on the application rate.**	**Know the difference between selective and non-selective herbicides.**	**Describe selective and non-selective herbicides.**
Mode of action explains how the herbicide kills a plant and includes: **1. 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.** **2. Systemic herbicides enter the roots or above ground parts of plants. These herbicides move or are translocated within the plant. Effects may not show for a week or more after treatment. Too much herbicide on the leaves may kill the leaf cells too quickly and prevent translocation to the site of action in a plant.**	**Know the difference between contact and systemic herbicides.**	**Describe contact and systemic herbicides.**
Timing of application classifies herbicides according to when they are applied (stages of plant growth), and includes: **1. Preplant herbicides are applied to the soil before seeding or transplanting. Preplant treatments are usually incorporated into the soil. These are called preplant soil-incorporated treatments.** **2. Pre-emergence herbicides are applied to the soil after planting but before the emergence of the crop or weed. Pre-emergence may refer to the germination of either the weed or the crop; check the pesticide label for instructions for specific herbicides. Pre-emergence herbicides control weeds before or soon after they emerge.**	**Know the difference between preplant, pre-emergence, and postemergence herbicides.**	**Describe preplant, pre-emergence, and postemergence herbicides.**

Category: FORESTRY

Concept: PEST MANAGEMENT - VEGETATION

General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
3. Postemergence herbicides are applied after the crop or weed has emerged. The application may be soon after emergence or up to a specific height or leaf number. Postemergence herbicides control established weeds.		
Residual effectiveness refers to how long the herbicide is biologically active once applied, and includes:		
1. Non-residual herbicides are quickly inactivated in the soil after application and do not affect seedlings which germinate after treatment.	Know the terms residual herbicide, non-residual herbicide, and soil sterilant.	Define non-residual herbicide.
2. Residual herbicides do not breakdown quickly and may control weeds for several weeks to several years. Non-selective residual herbicides are applied to soil to prevent growth of plants for a long period of time (a few months to many years). This type of herbicide has been called a soil sterilant, however, they do not sterilize the soil of all microorganisms or seeds and should be called a non-selective residual herbicide.		
NOTE: Special precautions are required when using residual herbicides. Ensure that the following items have been considered:	Know the special precautions that need to be considered when using residual herbicides.	List and describe special precautions that need to be considered when using residual herbicides.
Residual herbicides are present for extensive periods of time, so they have a greater chance of being moved off-site through leaching, erosion, and/or movement with water.		
Residual herbicides can damage trees and shrubs with roots that extend into the treatment area or damage trees and shrubs later when roots grow into a treated area after an application. A buffer zone between application site and nearby woody vegetation may be indicated on the label. If not, then a rule of thumb, is that the buffer width should not be less than 1/2 times the height of the woody vegetation.		

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The height of the water table, especially when combined with coarse textured soil, can lead to groundwater contamination. One indication of a high water table is presence of aquatic vegetation such as sedges or cattails/ bulrushes.		
Residual herbicides can limit the type of vegetation to be planted in a treated area.		
The presence of residual herbicides can vary substantially depending on the product, rate, formulation, concentration, weather conditions and soil conditions.		
Avoid steep slopes or areas subject to erosion and runoff as movement of herbicide containing soil off an application site can cause adverse effects where the soil is carried.		
Factors Affecting Herbicide Effectiveness		
Many factors affect herbicide effectiveness. Some of these are: shape and surface of leaves, weather, age of the plant, nutrition, soil type, soil moisture, cultivation, and resistance.	**Know the main factors that affect herbicide effectiveness.**	**List the main factors that can 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. Surfactants or surface active agents can be added to the herbicide formulations to increase the wetting ability of the spray so it won't bead, or to cut through waxy surfaces and aid penetration into the leaf. They should be added only when indicated on the label.		**Describe how leaf shape and surface affect herbicide action.**

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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.		**Describe weather conditions that may affect herbicide action.**
Cool or dry conditions slow the production and movement of nutrients in the plant and may reduce the movement of systemic herbicides. Hot dry weather may make the herbicide or herbicide carrier evaporate quickly from the weed leaves, and therefore reduce effectiveness.		
Rain during or shortly after an application can wash the herbicide off plants. However some soil-applied herbicides required irrigation or rain after application.		
Wind can cause drift and prevent the herbicide from reaching the target.		
Age of the plant - herbicides are often more effective on young rapidly growing plants. Systemic herbicides, which move with the food and water, can spread faster in rapidly growing younger plants than in older plants. Herbicides are less likely to kill plants that are in full flower or producing seed.		**Describe how the age of a plant may affect herbicide action.**
Perennial plants often become more resistant to herbicides as they grow older, but may become more susceptible again in the bud or early flowering stage. In this stage, food is being stored in roots or rhizomes. Certain herbicides are also translocated to these sites with the food and so kills the entire plant.		
Soil type (for soil active herbicides) - higher herbicide application rates may be needed for organic (peat or muck) or fine-textured soils (clay or silt). These soils adsorb more herbicide onto soil particles, which reduces the amount available for weed control. Sandy soils usually need less herbicide. Some labels will state the minimum and maximum rates. Do not exceed label rates. Some herbicide labels do not allow use on sandy soils. Follow label directions.		**Describe how soil type can affect herbicide action.**

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Soil moisture - soil-applied herbicides generally work best in warm, moist soil. The moisture helps the herbicide move through the soil to the roots.		**Explain how soil moisture can affect soil-applied herbicides.**
Resistance - some plants have developed resistance to certain pesticides. The development of resistance can be slowed by: **- using a variety of chemical and non-chemical control methods;** **- using a herbicide only when needed;** **- alternating herbicides from different chemical families or mode of action.**		**Describe how resistance can affect herbicide action.**
Herbicide Use in Forest Management		
Herbicide programs have the following advantages over other methods: **- less resprouting of target species than with other brush control methods;** **- little or no disturbance of the soil mantle, which is desirable when sites are located on slopes with fragile soils;** **- generally less costly than other methods.**	**Know the main advantages of using herbicides for forest management.**	**List the main advantages of using herbicides to control vegetation in forest management.**
Herbicide programs have the following disadvantages: **- potential effects on fish or wildlife or contamination of domestic water if improper equipment or application techniques are used;** **- lack of registered herbicides suitable for some site conditions;** **- public concern about the use of chemicals in the environment.**	**Know the main disadvantages of herbicide use for forest management.**	**List the disadvantages of using herbicides to control vegetation in forest management.**
The following should be taken into account when selecting a herbicide: **- treatment objectives (i.e., site preparation or brushing);** **- compatibility with the environment (i.e., minimum effect on the environment);** **- timing of application (i.e., season);** **- efficacy (consider composition of brush community);**	**Know what should be taken into account when selecting a herbicide.**	**List what to consider when selecting a herbicide.**

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General Objective: To understand pest management principles in forestry that are required to carry out effective vegetation control.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
- costs; - legal aspects; - site characteristics; - selectivity and crop tree resistance; - practicality; - safety.		
For site preparation, a high degree of control is required. For brushing, only weeds that compete with seedlings must be controlled.	Know the different objectives for site preparation and brushing.	Identify the different objectives for site preparation and brushing.
When considering vegetation species composition, herbicide choice should be keyed to maximum control of one to five dominant problem species (composing over 75 per cent of cover).	Know how to use vegetation species composition (brush community) in selecting a herbicide.	Describe how to use vegetation species composition (brush community) in selecting a herbicide.
Some herbicide formulations can be used with either water or oil or mixtures of water and oil carriers. The choice of carrier (oil or water) is determined by the main site of herbicide uptake (e.g., leaves or stems).	Know how the appropriate carrier is determined.	Describe how the appropriate carrier is determined.
When selecting a herbicide, environmental considerations include: - persistence in soil; - potential to runoff or leach; - toxicity to fish and wildlife.	Know the main environmental considerations in selecting a herbicide.	Identify the main environmental considerations in selecting a herbicide.
Cost considerations include the pesticide cost per litre, the recommended application rate, and the resulting pesticide cost per hectare, as well as application costs for manpower and equipment.	Know the cost considerations when selecting a herbicide.	Describe the cost considerations when selecting a herbicide.
Season of Application for Forest Management		
Herbicides should be applied when the dominant problem species is most susceptible to the herbicide, and when desirable species are relatively resistant or will sustain the least damage.	Know when to apply a herbicide.	Identify when a herbicide should be applied.

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Budbreak sprays (late winter or early spring) require the following considerations: **1. Herbicide absorption is mainly through the bark of stems and branches. New leaves of target species are just beginning to form.** **2. Target species are susceptible to herbicides in oil carriers just after budbreak, while conifers are relatively resistant.**	**Know the factors to consider for budbreak sprays.**	**Describe the considerations for budbreak sprays.**
Early foliar sprays (late spring) require the following considerations: **1. Most plant species are susceptible to herbicides during active growth.** **2. Poor time for conifer release (unless conifers are protected).** **3. Effective time for site preparation. An oil-in-water emulsion carrier is frequently used.**	**Know the factors to consider for early foliar sprays.**	**Describe the considerations for early foliar sprays.**
Late foliar sprays (mid-late summer) require the following considerations: **1. Less effective on shrubs than early foliar sprays.** **2. Conifer resistance to herbicide increases after growth cessation and new bud formation. (But a herbicide may kill conifers if there is a second flush of conifer growth).** **3. Water carriers are generally used.**	**Know the factors to consider for late foliar sprays.**	**Describe the considerations for late foliar sprays.**

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COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fall sprays (late August to mid October) require the following considerations: **1. Conifers are generally resistant to some herbicides.** **2. Good time for control of some deciduous brush species as herbicides are translocated to roots along with food reserves.** **3. Less effective time for control of many herbaceous species as growth may have ceased.**	**Know the factors to consider for fall sprays.**	**Describe the considerations for fall sprays.**
Herbicide Use in Nurseries and Seed Orchards		
Considerations for herbicide selection and use include: **- stage of weed and conifer growth;** **- resistance of crop trees;** **- soil type;** **- weeds present.**	**Know the main considerations for selection and use of herbicides in nurseries and seed orchards.**	**List the considerations for selection and use of herbicides in nurseries and seed orchards.**
Plant leaf stage may be important for timing of herbicide use.		
Some labels for herbicides used in nurseries specify use on a specific weed leaf stage (e.g., for control of grassy weeds). There might not be enough leaf area for efficacy if herbicides are applied too early. If applied too late, weed control may not be achieved or desirable plants may be damaged. Weed size and leaf number change rapidly. Avoid applying herbicides past the stage when they will be effective by regularly monitoring growth of weeds and surrounding plants. Check with the local weed control specialist if	**Know why weed leaf stage may be important for herbicide use.**	**Describe how weed leaf stage may be important for herbicide use.**
you are not sure how to count leaves (e.g., true leaves vs. tiller leaves in grasses).		**Identify the source of information for determining leaf number.**

Category: FORESTRY

Concept: PEST MANAGEMENT - INSECTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insect Management in Forestry		
Insect management strategies vary and include the following: **- attempted eradication;** **- suppression of an insect epidemic;** **- protection of trees while letting an epidemic run its course;** **- harvest of damaged trees (e.g, attacked by bark beetles);** **- use of trap trees to prevent infestation of an entire stand of trees by sacrificing a few.**	**Know major strategies of insect control in forestry.**	**List major strategies of insect control in forestry.**
Only a few insect species become severe pests in forests, but some can cause significant economic losses. Insects that become pests can be native or introduced species.	**Know that only a few species of insects are severe pests in forestry.**	**Identify that only a few insect species are severe pests in forestry.**
Many native insects that become pests are present in low numbers for most of the time until conditions allow populations to expand rapidly. They may multiply so fast that for a while natural controls such as birds, predator insects, and diseases cannot contain the population levels. After several years, their natural controls increase and reduce the pest population to low levels. Outbreaks of these pests are often cyclic, occurring at intervals of several to many years. These are said to be cyclic attacks.	**Understand why populations of native species of insects occasionally increase to become severe pests.**	**Describe why populations of native species of insects occasionally increase to become severe pests.**
Introduced species may become pests because they have been transported from other geographic areas without their natural predators. In the new location introduced populations may expand rapidly and continue for many years because there are no natural controls.	**Know why introduced insect species may be significant pests.**	**Describe why introduced species may be significant pests.**
Insect and Mite Characteristics		

Category: FORESTRY

Concept: PEST MANAGEMENT - INSECTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Insects are a group of animals that (as adults) have jointed bodies, 6 jointed legs and an outer skeleton. The adult insect body has three main sections: head, thorax and abdomen. Three pairs of legs and one or two pairs of wings (if present) are attached to the thorax. Insects breathe through spiracles (pores) in their outer skeleton.	**Know the general descriptions of an insect and a mite and be able to distinguish between them.**	**Describe the body parts of an insect and mite. List the major differences between the two.**
Mites are a group of animals that (as adults) have jointed bodies, 8 jointed legs and an outer skeleton. Mites differ from insects in that their bodies are not divided into obvious sections and they have only two main body parts: a fused head and thorax and an abdomen. The adult has four pairs of legs, the larval stage generally has three pairs of legs. Mites do not have wings. They are generally extremely small (less than 1 mm in length).		
Insect and Mite Life Cycles		
Insects and mites change as they grow. Insects go through 3 or 4 different stages. Two common sequences of insect stages are: **1. Egg to young to adult (gradual development). The young are similar in appearance to the adult but are wingless and lack reproductive organs; for example, aphids and grasshoppers.** **2. Egg to larva to pupa to adult (complete metamorphosis). The larva is very different from the adult (e.g., caterpillars, loopers, grubs, maggots); the pupa is a non-feeding stage during which a complete change of shape occurs; the adult is the reproductive stage and is usually winged. Examples: mosquitoes, moths, beetles, and flies.**	**Know the most common sequences of growth that insects may go through.**	**Describe the most common sequences of growth that insects may go through, and provide an example of each.**
Mites generally go through three stages: egg to nymph to adult. The adult is the reproductive stage. Mites are generally not a major pest in forestry, except in nurseries.	**Know the stages of growth that mites generally go through.**	**List and describe the sequence of growth that mites go through.**

Category: FORESTRY

Concept: PEST MANAGEMENT - INSECTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The best insect pest control is usually achieved during the early stages (young, nymph, or larva). Eggs and pupae are not affected by most insecticides and miticides.	**Know the stages of growth during which the best control is usually achieved.**	**Identify when the best control is usually achieved in the life cycle of insects.**
Insect pests in forestry can be divided into the following groups: woody tissue feeders (including bark beetles), defoliators, sucking insects, and cone and seed insects.		
Woody Tissue Feeders		
The most damaging woody tissue feeders are bark beetles, which cause very high losses to mature and overmature stands. These insects bore through the bark of trees and chew out galleries in which to lay their eggs.	**Know that bark beetles are the woody tissue feeders which cause the most damage.**	**Describe typical behaviour of bark beetles.**
Typically, eggs are laid in the galleries and hatch in about two weeks, but the larvae stay in the tree until the following year. When the new beetles emerge, they bore their way out and fly on to attack new trees.		
Some adult beetles introduce a fungus that penetrates the inner bark and sapwood, cutting off the flow of nutrients.		**Describe the damage caused by bark beetles.**
The boring dust that gathers at the entrance holes and in bark crevices is evidence of the attack. Some trees try to "drown" out the beetles with a heavy flow of pitch that is evident on the bark.	**Be able to recognize the evidence of attack by bark beetles.**	
Susceptibility of trees to some beetles is largely dependent on bark thickness, which in turn is mostly dependent on tree age. By scheduling harvesting of some species before the stand reaches maturity, the chances of beetle attack can be greatly reduced. Some beetle infestations can also be reduced by planting a mixture of species for reforestation, where economically and ecologically suitable.	**Know how control of bark beetles attracted to older trees can be achieved.**	**Describe controls for bark beetles that attack older trees.**

Category: FORESTRY

Concept: PEST MANAGEMENT - INSECTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Some tree species blown down by wind also attract bark beetles, which then spread to green trees nearby. Good sanitation is the key to management - including prompt pickup of cut trees, clean logging, elimination of high stumps and removal of materials along roads. However, if an outbreak does occur, a well-executed trap tree project can help to hold and eliminate the problem.	Know how control of bark beetles attracted to blow downs can be achieved.	Describe controls for bark beetles attracted to blow downs.
Trap trees are trees used to attract an infestation of beetles. The trap trees may be injected with a systemic insecticide to kill the beetles, or are destroyed before emerging adults spread to adjacent trees.	Know how trap trees are used to control bark beetle pests.	Describe how trap trees are used to control bark beetle pests.
Defoliators		
Defoliators are the group of insects that feed on and damage the leaves or needles of trees. The larvae (caterpillars) of moths and sawflies are defoliators that cause the most damage to conifers. Eggs laid by adults hatch into caterpillars which feed on new or old foliage,	Understand what a defoliator is.	Define what a defoliator is.
	Know which insects are in this category and know their life cycle.	Describe the life cycle of moths and sawflies.
depending on the species. When adult moths and some flies emerge, they can fly and be carried by winds one hundred kilometres or more away.		
Unlike bark beetles, defoliators usually do not kill trees immediately. Often the needles on the branches of the crown turn brown, the trees develop a scorched appearance and normal growth is reduced. This lessens the economic value of a tree and makes it more susceptible to other insects and diseases. If several attacks occur during the life of a tree, growth loss can be substantial.		Describe how defoliators may affect a crop tree and why they become pests.

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Concept: PEST MANAGEMENT - INSECTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
An infestation can spread very rapidly, from a patch of trees to thousands of hectares in a couple of years. After a period of little or no activity, populations can suddenly "explode", lasting two to ten years, followed by a slow decline. Most of the insects that defoliate trees are native pests.		
Defoliators are vulnerable to parasites and diseases. The eggs and larvae of defoliators are also vulnerable to extreme temperatures.	**Know the natural controls for defoliators.**	**Identify the natural controls for defoliators.**
In forest management, control of defoliators is difficult. Objectives are to control the spread of the defoliator or to protect a stand of conifers until an infestation has declined. A key factor in management is early detection and an appraisal of the course an infestation will take. When direct control is chosen, it should be carried out early in the outbreak, when the area to be treated is small.	**Know the objectives of control.**	**Identify the objectives of control.**
	Know that ideally a defoliator outbreak should be controlled when it is small.	**Describe when a defoliator outbreak should be controlled.**
In seedling nurseries and seed orchards, defoliators can be a serious problem, but may be controlled more effectively than in forest management because of the smaller and more accessible areas.	**Know that defoliator control is easier in seedling nurseries and seed orchards than in forest management.**	**Identify why defoliator control is easier in seedling nurseries and seed orchards.**

Sucking Insects

Category: FORESTRY

Concept: PEST MANAGEMENT - INSECTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Sucking insects, primarily aphids, affect foliage, branches, or the main stem. Foliage attacks result in chlorotic mottling or needle drop due to removal of sap during feeding. Stem or branch attacks can result in galls, deformities or growth reduction. Life cycles of most species are complex and require alternate hosts for completion. Epidemics are generally sporadic and short-lived. Control is very difficult.	**Know how sucking insects affect trees.**	**Describe how sucking insects affect trees.**
Cone and Seed Insects		
Seed orchards have been developed in the past 40 years to produce large amounts of seed of genetically superior stock for extensive reforestation - a large investment that must be protected. Insect pests of seed cone trees include the defoliators and woody tissue feeders of forest stands plus insects that feed on the seed cones, reducing seed production. The damage is caused when larvae tunnel into or feed on cone scales or seeds. Insecticides may be applied by air-blast sprayers or spraygun applicators to control these pests.	**Know about cone and seed insects.**	**Describe how cone and seed insects damage trees.**
Approaches to Insect Control		
There are a variety of methods to reduce losses from insect pests. These methods include: **Mechanical methods - e.g., falling and burning trap trees for bark beetle control.** **Cultural - e.g., removal of debris, planting mixed crop tree species, removal of alternate hosts of some insects.** **Biological controls - release of predators.** **Insecticides - including chemical insecticides, biological and viral control agents, pheromones and growth regulators.**	**Know the main approaches to insect control in forestry.**	**List and describe the main approaches to insect control in forestry.**

Category: FORESTRY

Concept: PEST MANAGEMENT - INSECTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Usually a combination of approaches should be selected. In most cases, both long- and short-term solutions to pest problems should be pursued.		
Contact local government forest agencies for literature and recommendations on pest identification, biology and management.	**Know who to contact for pest management assistance.**	**Identify who to contact for pest management assistance.**
Insecticides and Miticides		
Insecticides and miticides are often classified according to how they act on (mode of action) or enter the pest.	**Know how insecticides and miticides work.**	
Contact pesticides must come in contact with 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.		**Describe how contact insecticides work.**
Systemic pesticides enter plants and flow in the sap. Pests that suck the sap are killed by the pesticide in it. Some pesticides are both systemic and contact.		**Describe how systemic insecticides work.**
Stomach poisons must be swallowed by the pests to be effective (e.g. they may be applied to foliage and ingested by defoliating caterpillars).		**Describe how stomach poisons work.**
Suffocating pesticides (usually oils) clog the breathing system and can also affect egg survival.		**Describe how suffocating insecticides work.**
Fumigants are pesticides that work in a gaseous form. They may be used to kill pests in enclosed spaces or in soil (e.g., on seedling nurseries).		**Describe how fumigants work.**
Growth regulators act like the insect's own growth hormones. They disrupt the normal development of the insect and it dies before it becomes an adult or before it can reproduce.		**Describe how insect growth regulators work.**

Category: FORESTRY

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Desiccants or gels are inert powders that kill crawling pests by abrading their bodies. This causes them to dry out (e.g., silica dusts).		**Describe how desiccants work.**
Attractants are chemicals that may attract insects to traps (e.g., male insects may be attracted to artificial female pheromone).		**Describe how attractants work.**
Sticky pastes are placed on traps that attract pests. Attractants or colours are used to attract the insects to the trap. Once trapped the pest will not cause damage. Sticky pastes are also used as barriers to restrict the movement of crawling pests.		**Describe how sticky pastes work.**
Microbial insecticides contain microbes (tiny organisms including bacteria and viruses). After they are eaten, the microbes or a poison that the microbe produces kills the insects. They are sprayed on plants and are only poisonous to certain insects (e.g., the microbial insecticide *Bacillus thuringiensis* has been used successfully on some defoliator larvae). The time of applications with respect to larval development, foliage development and weather is critical).		**Describe how microbial insecticides work.**
Factors Affecting Insecticide/Miticide Effectiveness		
Timing of application - insects/mites may need to be present or in a specific stage of development for a pesticide to be effective. Generally the younger the pest, the easier it is to control with contact and stomach poisons.	**Know factors affecting insecticide/miticide effectiveness.**	**List and describe factors that can affect the effectiveness of insecticides/miticides.**
Resistance - some insects/mites have developed resistance to specific pesticides or groups of pesticides.		
Weather Conditions - temperature, humidity and rain can affect how a pesticide works by increasing pest sensitivity or by decreasing the residual period of pesticide effectiveness. For example, a pesticide may only be effective above or below a certain temperature.		

Category: FORESTRY

Concept: PEST MANAGEMENT - DISEASES

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

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

Category: FORESTRY

Concept: PEST MANAGEMENT - DISEASES

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fungi are the largest group of organisms that cause plant diseases. They are organisms that feed on living or decaying organic matter. This group includes moulds, mushrooms, and rusts. Some disease symptoms that may be caused by fungi include cankers, dieback, galls, leaf spots, rots, rusts, and wilts.	**Know about fungi that cause plant diseases.**	**Describe what a fungus is.** **List organisms that are fungi.**
Most fungi reproduce by tiny spores. The spores are released into the environment and are usually moved by wind or water. Some may land on a host plant. If environmental conditions are poor, spores may remain dormant and they are fairly resistant to fungicides in this state. If environmental conditions are good, the fungus spores germinate. When spores germinate, they usually produce threadlike filaments that can infect the host, absorb nutrients and give off toxins that cause disease symptoms. Movement of infected plants, plant parts and soil may spread fungus. **The fungus is most vulnerable to fungicides between germination, and infection. Infection begins when the fungus enters the plant tissues. When the plant responds to infection by growing abnormally it is said to be diseased.** **Inside the plant the fungus is protected and difficult to control. A systemic fungicide may control the disease if applied before the infection is too severe.**	**Know how most fungi reproduce and cause diseases.**	**Describe how most fungi reproduce and cause diseases.**
Some fungi (e.g., rusts) need 2 different hosts to survive and reproduce.		**Describe how a fungus can be spread.**

Category: FORESTRY

Concept: PEST MANAGEMENT - DISEASES

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Bacteria cause some major plant diseases such as some blights, galls and rots. Bacteria are one-celled organisms that can only be seen with a microscope. They usually enter a plant through natural openings or wounds. Under favourable conditions, bacteria reproduce very quickly, using the plant as a source of food.	Know about bacteria which cause diseases.	Describe what bacteria are and how they cause diseases.
Bacteria are spread by wind and rain, ground or surface water, or by contact with contaminated animals or equipment.	Understand how bacteria are spread.	List ways bacteria can be spread.
Viruses are extremely small. They cannot be seen with an ordinary microscope. Viruses cause diseases that often reduce plant vigour and crop yields. Mosaics, ringspot and leaf roll are examples of diseases caused by viruses.	Know about viruses which cause diseases.	Describe what a virus is and how it causes diseases.
Viruses reproduce only within living cells. They can be spread by mechanical means (e.g., during pruning or harvesting), in propagation material (seeds, tubers and other plant parts), or by vectors (insects, mites, nematodes, fungi).		List ways viruses can be spread.
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.	Identify the fact that there are no chemical controls for viruses.
Nematodes are very small "worm-like" organisms that may feed on plant roots, 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	Know about nematodes which cause diseases.	Describe what nematodes are and how they cause diseases.
enter. Some disease symptoms that can be caused by nematodes are wilting, stunting, lack of vigour, and growth deformities.		
Nematodes multiply by producing eggs.	Know how nematodes reproduce.	Describe how nematodes reproduce.
Nematodes spread by movement of infected plants, animals, seeds, and contaminated soil and water.	Understand how nematodes are spread.	List ways nematodes spread.
Approaches to Disease Management		

Category: FORESTRY

Concept: PEST MANAGEMENT - DISEASES

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Three things must be present for a pathogenic disease to develop. They are: **1. A disease-causing organism (pathogen).** **2. A host susceptible to the pathogen.** **3. An environment favourable to the pathogen and/or unfavourable to the host.**	**Know the three conditions that are necessary before a disease can develop.**	**List the three conditions that are necessary before a disease can develop.**
Taking away or changing any one of these 3 things will control or avoid the disease. For example, a disease problem can be prevented by: **- keeping the organism out of an area;** **- using strains of plants that are resistant to, or are not affected by the disease;** **- reducing the population of disease-causing organisms;** **- manipulating the environment to favour the host but not the pathogen.**	**Understand how diseases can be controlled.**	**Describe how diseases can be controlled.**
Disease Management in Forestry		
Diseases caused by micro-organisms are responsible for significant forest timber losses. They can reduce growth or kill susceptible tree species. Diseases can also reduce production of healthy seedlings in nurseries and reduce seed production in seed cone orchards.	**Know that tree diseases cause significant forest timber losses and losses in seedling nurseries and seed orchards.**	**Identify that diseases cause timber losses and problems in seedling nurseries and seed orchards.**
Forest diseases include the following disease groups: root diseases, dwarf mistletoes, branch/stem rusts, cankers and diebacks, and needle casts, blights and rusts.	**Know examples of forest tree disease types.**	**List forest tree diseases.**

Category: FORESTRY

Concept: PEST MANAGEMENT - DISEASES

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Losses in actual and potential wood volume and wood quality occur slowly and in a non-cyclical manner, unlike damage from insect infestations. When forest managers implement silvicultural programs, losses due to disease or other agents are considered to be inevitable and tolerable within certain defined limits. However, forest management practices have a significant long term effect on whether or not a serious disease problem will occur over a normal rotation. Poor procedures, such as the reestablishment of susceptible species on root rot-infected sites or failure to remove all dwarf mistletoe-infected trees at time of harvest, may favour the occurrence of unacceptable damage levels in the future.	Know that forest management practices can affect forest disease conditions.	Describe how forest management practices can affect forest disease conditions.
Thus, early implementation of strategies that limit losses is extremely important. These strategies include: - selection of non-susceptible species; - selection programs for resistant cultivars; - branch pruning; - spacing operations; - stump and root extraction; - site preparation; - harvest scheduling.	Know the strategies that limit losses due to disease.	List the strategies that limit losses due to disease.
Pesticides are not generally used in forest disease management. Cultural and manual methods of disease control are favoured (i.e., removal of infected stumps to control root rots, top story removal to control mistletoe, or planting non-susceptible species of crop trees).	Know that cultural and manual methods are mainly used for disease control in forest management.	Describe disease control methods that are mainly used in forest management.
Pesticides may be used in seedling nurseries and seed orchards.	Know that pesticides are used in seedling nurseries and seed orchards.	Identify that pesticides are used for disease control in seedling nurseries and seed orchards.
Pesticides used to control disease causing organisms include fungicides, bactericides and nematicides.	Know the types of pesticides used to control pathogens.	List the types of pesticides used to control pathogens.

Category: FORESTRY

Concept: PEST MANAGEMENT - DISEASES

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fungicides		
Fungicides are often described according to how they work (mode of action).		
Protectant fungicides provide a protective film of fungicide on or around the host to prevent fungal spores from germinating. Protectant fungicides must be used before a fungus reaches the infectious stage. After the plant is infected the fungicide will not kill the fungus inside the plant, but it can protect the plant from more infection. New plant growth that appears after treatment is not protected. Therefore reapplication is required. Protectants can be applied to seeds, foliage, flowers, fruit or to roots. Most control programs use protective fungicides.	**Understand how protectant fungicides work.**	**Describe how protectant fungicides work.**
Eradicant fungicides kill fungal organisms that have infected, but not become well established within the plant. Eradication fungicides have limited value for fungi that are well-established in plants.	**Understand how eradicant fungicides work.**	**Describe how eradicant fungicides work.**
Systemic fungicides are absorbed by plants and move within them. They may act as protectants, eradicants, or both. Once inside the plant, systemics move to new areas of plant growth.	**Understand how systemic fungicides work.**	**Describe how systemic fungicides work.**
Factors Affecting Fungicide Effectiveness		
Timing of application - the fungicide should be on or in the plant (in effective concentration) prior to or during the infection period of the fungus.	**Know the factors that affect fungicide effectiveness.**	**List and describe the factors that affect fungicide effectiveness.**

Category: FORESTRY

Concept: PEST MANAGEMENT - DISEASES

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Fungus life cycle and weather - the frequency of applications varies depending on the type of fungus, the fungicide, and the weather. If the fungus has a short life cycle and there are good conditions for its growth it can have many infection periods and many applications may be needed. If conditions are unfavourable for its growth, few applications may be needed. Moisture, rate of plant growth, and type of fungicide also affect the frequency of applications. If the fungicide is washed off, if new leaves grow or if the fungicide breaks down quickly, applications may need to be repeated.		
Resistance - some disease organisms are resistant to certain fungicides or groups of fungicides. The disease organisms may develop resistance after repeated applications of a fungicide.		
Bactericides		
Bactericides are chemicals that are toxic to bacteria. They kill bacteria on contact and must be used before the bacteria infect a plant.	**Understand how bactericides work.**	**Describe how bactericides work.**
Factors Affecting Bactericide Effectiveness		
Timing of applications, the weather, and the amount of bacteria present will affect the bactericide's effectiveness.	**Know factors affecting the effectiveness of bactericides.**	**List factors that affect how well a bactericide works.**
Nematicides		
Pesticides used for nematode control move through the soil as a gas or in soil water and depend on the presence of spaces between the soil particles for their movement. A few nematicides are applied as liquid or granular formulations. They may act by direct contact with nematodes or systemically so that nematodes feeding on or in the plant acquire a lethal dose.	**Know what pesticides are used for nematode control and how they work.**	**Identify what type of pesticides are used for nematode control.** **Describe how nematicides work.**

Category: FORESTRY

Concept: PEST MANAGEMENT - VERTEBRATES

General Objective: To understand pest management principles to carry out safe and effective vertebrate control in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Vertebrate Management in Forestry		
A number of wildlife vertebrate species damage conifer and deciduous crop trees. Most crop trees can be severely damaged as a result of grazing at their seedling stage. The most significant damage is caused by deer, elk and hare grazing on seedlings and porcupine feeding on pole-sized trees. Other animals which cause damage include moose, beavers, bears, gophers, voles and squirrels. Control measures include trapping, placement of browse guards and use of chemical repellents. Any control measures which remove wildlife or potentially damage a significant food supply should be reviewed with provincial wildlife authorities.	**Know common types of vertebrate pests that can damage forestry crop trees.**	**List common types of vertebrate pests that can damage forestry crop trees.**
	Know types of control measures for vertebrate pests.	**List types of control measures for vertebrate pests.**
	Know that controls which remove or damage wildlife should be reviewed with provincial wildlife authorities.	**Identify who to contact if controls will remove or damage wildlife.**
Vertebrate repellents are applied onto or adjacent to crop plants and produce an undesirable taste or odour or affect the behaviour pattern of the pest species. Different products or formulations are generally required for different species (e.g., deer, elk, mice, rabbits). Most are applied as a directed spray to foliage. Repellents vary in their toxicity to mammals. Repellents generally require an assessment on an experimental basis to determine efficacy in a specific geographic area. Some must be applied before animal feeding habits are established (e.g., to seedlings).	**Know how to apply vertebrate repellents.**	**Describe how to apply animal repellents.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques used in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Application techniques in forestry include: **- foliar spraying;** **- basal bark spraying;** **- trunk wound application (hack & squirt/injection);** **- stump treatment;** **- soil application.**	**Know the main application techniques used in forestry.**	**List the different application techniques that are used in forestry.**
Foliar Spraying		
Foliar spraying is the application of pesticide spray to plant leaves and stems. The required leaf coverage may be described on the label in different ways, such as "spray-to-wet" or "spray-to-runoff" or an application rate per unit area may be given. Foliar spray equipment includes back pack sprayers, power-hose sprayers, low pressure boom sprayers, air blast sprayers and helicopter or fixed wing aircraft (aerial application is dealt within a separate module).	**Know what equipment is used for foliar spraying.**	**List the types of foliar spray equipment.**
Backpack sprayers are used for spraying herbicides to small areas or spot treatments of scattered individual stems, especially in areas inaccessible to vehicle mounted equipment in forest management. The use of backpack sprayers in forestry field applications is constrained by cost, height of target vegetation, topography and accessibility. Backpack sprayers are also used in forest seedling and seed cone nurseries for insect and disease control.	**Know what backpack sprayers are used for.**	**Describe what backpack sprayers are used for.**
Backpack sprayer components include a spray tank, nozzle system, pumping device, and control valve.	**Know the main components of a backpack sprayer.**	**Describe how a backpack sprayer works and list the main components.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques used in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The pump moves the solution from the tank to the nozzle and supplies the pressure needed for producing spray droplets (atomization). Uniform pressure is essential to obtain uniform nozzle performance. Some sprayers have a built-in pressure regulator; on those that do not, one can be added in-line. The pressure is created in the pump and stored in the pump reservoir. Most backpack sprayers should be operated at 100 to 170 kpa for herbicides and 275 to 310 kpa for insecticides.		
The control valve regulates the flow of pressurized solution from the pump reservoir to the nozzle. A screen strainer in the wand prevents particles from plugging the nozzle.		
Convert a backpack sprayer from herbicide to insecticide by: **1. Thoroughly rinsing any residue from the system. Note: It is essential to neutralize any herbicide residue in the sprayer components using a neutralizing solution. Failure to do so may result in plant injury. (Contact local government agencies for disposal procedures).** **2. Changing the nozzle (for finer droplets required in applying insecticides).** **3. Increasing the pressure from 100 to 170 kpa to 275 to 310 kpa.** **4. Changing the hose (have a separate hose for herbicides and insecticides).** **5. Recalibrate the sprayer (changing the nozzle and pressure will affect the delivery).**	**Know the steps to follow when converting from herbicide to insecticide use.**	**List steps to follow when converting from herbicide to insecticide use.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques used in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Power hose (hydraulic sprayers) have components similar to agricultural row crop boom sprayers, but the power hose sprayer, has no boom, only a hose and single nozzle. The power hose sprayer usually is constructed more durably for forestry conditions. It can be used for spraying selected spots of brush or shrubs where the hose and nozzle can be pulled from the roadside as far as the length of hose will allow. It can also be used for continuous spraying of a strip of vegetation along roadways where the nozzle is mounted or held on the back of a truck. During operation, staff are needed to operate the pump, to operate the spray nozzle, and to lift and move the hose. The hose is usually stored on a reel mounted on the sprayer. Applicators should plan the system for treating an area so that walking through treated areas is avoided. When applicators have to enter and leave a spray block from one point, they should start spraying at the back of the spray block and work their way to the exit/entry point (walk-in, spray-out method).	**Know about power hose sprayers.**	**Describe power hose sprayers and describe their operation and use.**
Low pressure boom sprayers are hydraulic sprayers designed to distribute pesticide solutions over large areas. In forestry, they are most often used in bareroot forest tree nurseries. They are used to deliver low-to-moderate application rates usually 50 to 500 L/ha at working pressures ranging from 150 to 500 kpa. The most common booms are between 6 and 10 m long and contain nozzles spaced at 50 to 100 cm intervals. These sprayers are usually pulled behind an agricultural tractor.	**Know about low pressure boom sprayers.**	**Describe the operation and use of low pressure boom sprayers.**
Air-blast sprayers, are used for applying insecticides and fungicides in some seed cone nurseries. They can also be used to apply herbicides for stand tending in woodlots. Pesticide mixture is pumped through nozzles into a blast of air from a high speed fan. The air blast breaks the liquid into fine droplets and transports them to the target trees. Air-blast sprayers provide better penetration and coverage of trees than could be obtained with other sprayers. However, the small droplet size can result in considerable off-target drift.	**Know about air-blast sprayers.**	**Describe air blast sprayers and describe their operation and use.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques used in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Basal Bark Spraying		
Basal bark spraying is the spraying of a herbicide solution on the base of a stem from knee height to ground level and also spraying of root collars. A non-water carrier is used to penetrate the bark and root collar.	**Know about basal bark spraying.**	**Describe the basal bark method for application of herbicides.**
Several variations on the basal bark spraying, which involve using a more concentrated herbicide solution and spraying a smaller area are sometimes used. The variations include: **- one sided low volume;** **- thinline;** **- stream line.**		
The characteristics of basal bark spraying are: **- a high degree of selectivity is achieved, as only target plants are treated;** **- there may be additional environmental considerations due to use of non-water carrier;** **- it is more effective in late summer but can be done year-round except during heavy snow accumulations and after heavy rain;** **- it is usually done using hand-held application equipment.**	**Know the characteristics of basal bark spraying.**	**List and describe the characteristics of basal bark spraying.**
Trunk Wound Application		

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques used in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Trunk wound application includes "hack and squirt" and injection type applications of pesticide. Hack and squirt is a common method used to apply herbicide in forestry for brush control and conifer release. It is a two stage pesticide application technique. The tree or brush is first notched with a tool (e.g., hatchet) by making a downward cut at a 45E and through the bark at waist height. The label will specify the number of notches (often called frills) per size of tree. Then herbicide is injected into the cuts. Injection is where a tool is used to both puncture the bark of stems or trunks and inject pesticide into the wound. This include insertion of capsules or small calibre shells containing herbicide into a tree's inner bark. **Hack and squirt and injection treatments can be used throughout the period of growth of the target tree species. Sufficient efficacy may be achieved during the dormant season for some species.**	**Know about hack and squirt and injection techniques.**	**Describe hack and squirt and injection techniques.**
Plastic pump squirt bottles and oil cans may be used to apply concentrated herbicide or insecticide to cut frills on a tree. However, more durable equipment is available which can also be calibrated to apply a specific amount of pesticide per squirt. Given the danger of exposure to concentrated pesticide solution, crew members must be trained to handle the pesticide carefully, minimize exposure and follow label instructions.	**Know the equipment used for trunk wound application.**	**Describe the equipment used for hack and squirt treatments.** **Identify why herbicide or insecticide in the applicator should be handled carefully.**
The characteristics of trunk wound application are: **- it is highly selective and causes minimal environmental impact;** **- increased physical hazard to the applicator (using hatchet);** **- it is labour intensive.**	**Know the characteristics of trunk wound application.**	**List and describe the characteristics of trunk wound application.**

Stump Treatment

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques used in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Stump treatment involves applying a liquid herbicide (usually a water-soluble solution) to a freshly cut stump. The objective is to prevent resprouting.	**Know what stump treatments are used for.**	**Identify the objective of the stump treatment process.**
The procedure involves cutting off the stem close to the base with a powersaw, brushsaw, sandvick or axe. The herbicide is applied to the cut surface using a spray bottle or sponge applicator. The solution should be applied in a thin line around the perimeter of the stump just inside the cambium within five minutes of felling. Treatment during the period of heavy sap flow in the spring or to stumps left for a few days before treatment may produce inferior results. **An attachment is also available for the brushsaw, which allows the applicator to cut and apply the pesticide in one operation.**	**Know the procedures for stump treatment.**	**Describe the procedures for stump treatment.**
The characteristics of stump treatment are: **- it is highly selective;** **- it uses small amounts of herbicide and causes little environmental impact;** **- it is labour intensive and the cutting tools can be hazardous to the operator.**	**Know the characteristics of stump treatment.**	**List and describe the characteristics of stump treatment.**
Soil Application		
Soil application includes granular applications and spot or broadcast applications of liquids. **Granular soil application may be used for site preparation and conifer release and is also used in nurseries. The granules are applied before a rainfall or irrigation. The water helps dissolve the granule, allowing the herbicide to pass into the soil and be taken up through the roots. A variety of equipment is available for applying the granules.**	**Know the application techniques for soil application.**	**Describe soil application techniques.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - TECHNIQUES

General Objective: To understand application techniques used in forestry.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Liquid spot applications are made using a spotgun tool that delivers soil-active herbicide. It can be applied to the soil to treat individual stems or over a large area in a grid pattern. They may be used for site preparation or conifer release in forestry. Spotguns deliver a thin stream of predetermined volume (usually 4 to 8 mL). The stream can be directed to the soil at a spot near the base of a stem (root collar area).		
The Velpar^{R} Lance is used instead of a spot gun on soils with deep organic layers to place the herbicide below the soil surface and minimize off-site movement.		
Liquid broadcast applications to soil can be delivered with a low pressure boom sprayer. This type of application would only be used in nurseries.		
The characteristics of soil application are: **- it requires moisture to move herbicide into the root zone so soil applications may not be effective in dry areas;** **- consideration must be made of the potential for herbicide to be lost due to runoff or leaching.**	**Know the characteristics of soil application.**	**List and describe the characteristics of soil application.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - COMPONENTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Components of Hydraulic (motorized) Sprayers		
Hydraulic sprayer components are similar for power hose or boom sprayers. Components include: **- spray tanks;** **- pumps;** **- agitators;** **- filters;** **- controls;** **- pressure gauge;** **- plumbing;** **- structural framework (including boom design);** **- nozzles;** **- clean water tank.**	**Know the various components of hydraulic sprayers.**	**List the main components of hydraulic 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;** **- easy to clean;** **- labelled with graduated markings;** **- filled with baffles to prevent sloshing.** **The most common shape of tanks are oval and cylindrical. Rectangular tanks and flat-bottomed tanks are more difficult to agitate and clean.** **Tank size should be proportional to the sprayer boom width and sprayer output.**	**Know the purpose and desirable features of a spray tank.**	**List the desirable features of a spray tank.**
Pumps		

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - COMPONENTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Pumps provide the flow of spray solution from the tank to the nozzle. Choose a pump suitable for the: **- required output and operating pressure;** **- pesticide properties;** **- carrier properties;** **- power supply.**	**Know the factors to be considered for selecting the correct type and size of pump.**	**List factors to be considered when selecting a pump.**
Choose a pump with sufficient capacity, considering the: **- number of nozzles;** **- nozzle;** **- agitation requirements;** **- bypass filtration requirements.**		
It should be oversize by 20 percent.		
The type of pump affects the installation of controls. Refer to pump manufacturer's instructions. Piston and diaphragm pumps require a pulsation damper to minimize pressure fluctuations.		
Agitators		
Agitation mixes the formulated pesticide and carrier together and prevents suspended pesticides from settling out. The amount of agitation depends on the formulation used. It is important that adequate agitation occurs. Both under and over agitation can reduce pesticide performance.	**Know why agitation is required.**	**Identify why agitation is required.**
Two types of agitators are commonly used: **- mechanical;** **- hydraulic.**	**Know the main types of agitation systems.**	**List and describe the main types of agitation systems.**
Mechanical systems use a paddle to stir the contents of the tank, while hydraulic systems use special nozzles to create spray solution movement in the tank. Hydraulic systems must be of sufficient capacity and properly adjusted to provide adequate mixing.		

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - COMPONENTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Filters		
Filters prevent foreign particles and undissolved pesticides in the spray solution from damaging the pump or plugging the nozzles.	**Know why filtration is required.**	**Identify why filtration is required.**
Filters can be installed: **- in the tank opening to prevent debris from entering the tank during filling;** **- between the tank and pump to protect the pump from damage;** **- after the pump to remove finer particles to prevent them from entering the spray lines;** **- in the nozzle bodies to protect the nozzles from clogging.**	**Know where filters can be installed.**	**Describe where filters can be installed.**
Filtration should be scaled from the coarsest at the tank opening to the finest at the nozzle. Follow the nozzle manufacturer's recommendations. Be sure filters are coarse enough when using wettable powder or flowable formulations.	**Know how to select the correct filter.**	**Identify where information on filters can be found.**
Controls		
Two common control systems are: **- pressure control systems;** **- volume control systems.**	**Know how control systems work.**	**List and describe how control systems work.**
Pressure control systems use a pressure regulating valve (PRV) to maintain a constant operating pressure. Volume control systems (volumetric) allow the operating pressure or nozzle output to vary according to the forward speed or engine RPM.		
Control systems can be manually or electronically operated. Items such as spray monitors and controllers may improve the application of pesticides by supplying the applicator with more information.		
Plumbing		

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - COMPONENTS

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

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

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - COMPONENTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
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 specific patterns.	Know what a nozzle does.	Describe the functions of a nozzle.
Nozzles are available in many types, sizes and materials. They may be selected for such uses as drift reduction, banding, soil incorporation, or boomless operation. Nozzles are classified by the type of spray pattern produced. Three common nozzle types are: - the flat fan nozzle; - the off-centre nozzle; - the hollow cone nozzle.	Know the most common nozzle types.	List common nozzle types.
Pesticide labels may recommend specific types and sizes of nozzles. Follow label directions.		
Nozzles can be selected for their spray angle. Spray angle is the measurement (in degrees) of the spray angle formed by a single nozzle at a specific pressure. The spray angle varies slightly with pressure.	Know what the nozzle spray angle refers to.	Define nozzle spray angle.
Depending on the spray angle and nozzle spacing, adjust boom height to obtain the recommended overlap for a uniform application. Refer to nozzle manufacturer's or provincial recommendations for the required amount of overlap to achieve a uniform application.	Understand the factors that determine the correct boom height.	Identify the factors that determine the correct boom height. List the sources of information for the amount of spray overlap.
Flat fan nozzles: Flat fan nozzles are generally used for herbicide applications. Properly operated flat fan nozzles can provide a high degree of application uniformity.	Know that flat fan nozzles provide a high degree of uniformity.	Identify why tapered flat fan nozzles are used for herbicide work.
Flat fan nozzles are designed to be used at low pressures (between 100 and 400 kPa).	Understand that flat fan nozzles are to be used at low pressures.	Identify that flat fan nozzles are to be used at low pressures.

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - COMPONENTS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Tapered flat fan nozzles are intended to be used in an overlapping spray pattern. That is one nozzle spray angle overlaps the next nozzle spray angle. Offset the nozzles slightly from the adjacent nozzle to prevent spray interference.	**Know how to position tapered flat fan nozzles on a boom.**	**Describe how to position tapered flat fan nozzles on a boom.**
Even flat fan nozzles are available for banding applications.	**Know when even flat fan nozzles are used.**	**Identify when to use even flat fan nozzles.**
Off-centre nozzles produce a wide flat spray that is off to one 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.	**Know what an off-centre nozzle is.**	**Describe an off-centre nozzle.**
Hollow cone nozzles are generally used to apply fungicides and insecticides because they produce fine spray droplets. These nozzles are best suited for use as a directed spray where a uniform application is not a priority. They can be operated at a wide range of pressures (200 to 2000 kPa).	**Know why hollow cone nozzles are often used for insecticide and fungicide work.**	**Identify why follow cone nozzles are often used for insecticide and fungicide work.**
Clean Water Tanks		
All hydraulic 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 that all sprayers should be equipped with a clean water tank.**	**Identify the importance of a clean water tank.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Calibration Objectives		
1. Hack and Squirt Applicators - need to check that the squirt device applies the correct amount per notch. Also calculate the total pesticide required per stem diameter and density of stems per hectare.	**Know the objectives of calibration for hack and squirt applications, for pesticides applied at a specified dilution and for pesticides applied as a specified amount per unit area.**	**Identify the objective of sprayer calibration for hack and squirt applications, for pesticides applied at a specified dilution and for pesticides applied as a specified amount per unit area.**
2. Where the pesticide rate is given as a dilution rate (e.g., for backpack sprayers where you must spray to wet leaves): **- test sprayer nozzle, pressure and speed and adjust to obtain required spray droplet size and density on sprayed surfaces;** **- spray a test area and determine sprayer output per unit area to check that the maximum label rate per hectare is not exceeded, and to allow you to calculate total spray and pesticide required for a treatment block;** **- calculate the amount of pesticide to put in the spray tank based on the label dilution rate (see Pesticide Use Calculation Section below).**	**Know the procedures for calibration.**	**Describe the procedures for calibration.**
3. Where the pesticide rate is given as an amount per hectare (e.g., for boom sprayers used in seed orchards or seedling nurseries and some roadside power hose sprayers): **- check for nozzle pattern deformity;** **- check for uniformity of output across the boom;** **- determine sprayer output per hectares and hectares covered by a spray tank to calculate pesticide to add to a spray tank.**		
Select a calibration method that meets these objectives.		
Note: The following provides details on boom sprayer calibration although many principles apply to hand held sprayers as well.		

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Boom 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 sprayer output changes;** **- when the sprayer is modified.**	**Know when sprayer should be calibrated.**	**Describe when sprayers should be calibrated.**
Application Uniformity		
Application uniformity affects pesticide performance. Nonuniform application results in localized areas of over and under application, reducing the effectiveness of the pesticide.	**Understand the importance of uniformity in application.**	**Identify the effects of non-uniform application.**
Application nonuniformity occurs from: **- variations occurring across the width of the boom;** **- variations within the total application area.**	**Understand how nonuniformity can occur.**	**List possible causes of nonuniformity.**
Nozzles must be checked regularly to make sure that every nozzle has a similar output. Variations across the width of the boom are caused by: **- variation in nozzle output;** **- variations in pressure;** **- variations in nozzle spacing;** **- incorrect boom height.**		
Variations over the total application area can be caused by: **- variations in travel speed;** **- variations in pressure;** **- excessive boom movement.**		
Nozzle Output		
Nozzle output is the volume of spray solution a nozzle delivers in a specific period of time. Manufacturer's catalogues provide outputs of new nozzles either in litre per minute or U.S. gallons per minute over the range of acceptable operating pressures.	**Know what the nozzle output refers to.** **Know where to obtain information on nozzle output.**	**Define nozzle output.** **Identify where to obtain information on nozzle output.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nozzle output depends on the nozzle size and operating pressure. Increasing nozzle size and/or operating pressure increases the nozzle output.	**Understand the factors that affect nozzle output.**	**List the factors affecting nozzle output.**
Nozzle Wear		
The rate of nozzle wear depends on: **- nozzle material;** **- pesticide formulation;** **- operating pressure;** **- nozzle size;** **- the amount of use (time).** **In general, the harder the nozzle material, the longer the nozzle will last, yet the higher the cost. Brass is one of the softest nozzle materials and ceramic is one of the hardest. Other materials such as stainless steel and plastics fall between these two.** **Nozzle wear increases with more abrasive formulations (wettable powders) higher operating pressures, smaller nozzle size and longer use.**	**Know the factors that affect nozzle wear rates.**	**List and describe factors that affect nozzle wear rates.**
Checking Nozzles For Wear		
Nozzles should be checked to look for defective spray patterns, to assess the difference in output between used and new nozzles and to verify uniformity across the boom.	**Understand why nozzles must be checked.**	**Identify why nozzles must be checked.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Check nozzle wear by: **1. Measuring the output for each nozzle at a constant operating pressure.** **2. Calculating the average output for the set of nozzles. Replace nozzles whose output varies by more than five percent from the average. Properly maintained, they should wear evenly, allowing for the replacement of the entire set.**	**Know how to assess the maximum variation allowed in outputs for a set of nozzles.**	**Describe how to assess the variation in outputs for a set of nozzles.**
3. Replacing nozzles whose output is more than 15 percent higher than that specified by the manufacturer, or those that produce defective patterns.	**Know the maximum variation output allowed for used nozzles compared to manufacturer's specifications.**	**Describe the maximum variation in output allowed for used nozzles compared to manufacturer's specifications.**
Sprayer Output		
The sprayer output refers to the amount of spray mix (pesticide and carrier) that is applied per unit area.	**Know what sprayer output refers to.**	**Define sprayer output.**
Calibration involves measuring and adjusting sprayer output. Sprayer output is measured to ensure it meets label requirements and most importantly to be able to calculate how much pesticide to add to the spray tank to achieve a specified amount of pesticide per unit area.	**Understand why sprayer output is measured.**	**Identify why sprayer output is measured.**
A specific sprayer output may be recommended on the label. Sprayer output for broadcast treatments may be expressed as: **- a specific amount of spray per hectare, or;** **- a range (e.g., 100 to 300 L/ha);** **- band treatment in mL/m of row;** **- individual trees as L/plant, or;** **- broadcast treatments as spray to wet or to runoff.**	**Know how sprayer output is expressed on the label.**	**Identify how sprayer output is expressed.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Sprayer output can be determined by measuring the following: **- the nozzle output;** **- the travel speed;** **- the nozzle spacing.**	**Know the factors that determine the sprayer output.**	**Identify the factors that determine the sprayer output.**
Sprayer output = Nozzle output x constant ÷ travel speed ÷ width sprayed. **Metric Units: = L/ha = L/min x 60000 ÷ km/h ÷ cm.** **Imperial Units: gpa = gpm x 5940 ÷ mph ÷ in.**	**Know the mathematical equation for determining sprayer output.**	**Describe how to calculate sprayer output.**
Conversion factors can be used to convert any metric unit or measurement into either Imperial or American units.		
Use "width sprayed" in the above formulae for a single nozzle such as a backpack sprayer or roadside sprayer. Use nozzle spacing for a boom sprayer. Use centimeters or inches in these formulae or the constants must be changed.		
The constant in the formula is a conversion factor to account for the different units of measurement.	**Understand what the constant in the formula refers to.**	**Describe the purpose of the constant in the formula.**
Sprayer output can also be determined by measuring the volume of spray solution that was applied to a known area. If this approach is used, then it is important to also assess the uniformity of the nozzles when using a boom with multiple nozzles.	**Know an alternative method of determining sprayer output.**	**Describe an alternative method of determining sprayer output.**
Travel Speed		
The travel speed of the sprayer affects the sprayer output. For a given nozzle output, increasing forward speed decreases sprayer output.	**Understand how travel speed affects sprayer output.**	**Identify how travel speed affects sprayer output.**
Excessive travel speeds cause boom movement, resulting in a nonuniform application. Select a travel speed that minimizes boom movement.	**Know the importance and procedure for determining the forward speed of a field sprayer.**	**Identify how travel speed affects uniformity of application.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Measure travel speed: **- in the field;** **- with the sprayer approximately half full of water;** **- repeated in both directions and averaged.** **Calculate travel speed by using the following equation:** **Travel Speed = test distance ÷ time x constant.** **Metric Units: km/h = metres ÷ seconds x 3.6.** **Imperial Units: mph = feet ÷ seconds x 5.68.**		**Describe the procedure for measuring travel speed.**
Nozzle Spacing		
The nozzle spacing is the distance between nozzles on a boom for broadcast booms. For single nozzle units or band spraying it is the actual width sprayed.	**Know what nozzle spacing refers to for different types of sprayers.**	**Describe what nozzle spacing refers to for different types of sprayers.**
The closer the nozzles are together, the greater the sprayer output.	**Understand how nozzle spacing affects sprayer output.**	**Identify how nozzle spacing affects sprayer output.**
The spacing chosen depends on: **- the type of nozzle;** **- type of planting;** **- boom height.**	**Know the factors to consider when choosing spacing.**	**List the factors to consider when choosing spacing.**
Nozzle spacing on a boom is generally not adjusted to change output. Nozzle spacing on a boom must be equal to ensure application uniformity.	**Know the importance of a consistent spacing across the boom.**	**Identify the importance of consistent spacing across the boom.**
Nozzle Selection		
The required output of new nozzles can be determined if the sprayer output, forward speed and nozzle spacing are known. Select a new nozzle from the manufacturer's catalogues on the basis of the required nozzle output and acceptable operating pressure.	**Know the factors to consider to calculate nozzle output.**	**List the factors to consider to calculate nozzle output.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Nozzle output = Sprayer output x travel speed x width sprayed ÷ constant. **Metric: L/min = L/ha x km/h x cm ÷ 60000.** **Imperial: gpm = gpa x mph x inches ÷ 5940.**		**Describe how to calculate nozzle output.**
Pesticide Use Calculations		
Pesticide use calculations determine the correct amount of pesticide to add to a spray tank and how much pesticide is required for a given treatment area. They are based on the pesticide rate specified on the label.	**Know the importance of pesticide use calculations.**	**Identify the importance of pesticide use calculations.**
Pesticide rate is the amount of formulated pesticide concentrate to be applied. For boom sprayers it is most commonly expressed as litres of pesticide per hectare.	**Know what pesticide rate is.**	**Define pesticide rate.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Before application, perform the following calculations: **Know the size of the treatment area. It can be obtained by measuring or from other sources such as maps or aerial photographs.** **Area of a rectangular or square plot = length x width.** **Metric: Hectares = m x m ÷ 10000.** **Total pesticide required = treatment area x pesticide rate.** **Metric: L = ha x L/ha.** **Area covered per tank = tank size ÷ sprayer output.** **Metric: ha = L ÷ ha/L.** **Where pesticide rate is a dilution:** **Pesticide amount per tank = tank size x dilution rate.** **Metric: Litres/tank = litres x litre/litres.** **Where pesticide rate is amount per area:** **Pesticide per tank = pesticide rate x area covered per tank.** **Metric: Litres = litres/hectare x hectares/tank.** **Total number of tanks = treatment area ÷ area covered by tank.** **Metric: Tanks = hectares ÷ hectares/tank.** **Total number of tanks required may include a partial tank.** **Area left to be sprayed = total area - area already sprayed.** **Metric: Hectares = hectares - hectares** **Volume of spray for partial tank = treatment area left to be sprayed x sprayer output.** **Litres = hectares x litres/hectare.**	**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 solution required for a partial load, pesticide required for a partial load.**	**Perform calculations to determine: the size of a treatment area, total pesticide required, area covered per tank, amount of pesticide required per tank, total number of tanks, volume of solution required for a partial load, pesticide required for a partial load.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - CALIBRATION

General Objective: To understand calibration procedures to ensure the correct amount of pesticide will be applied.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Volume of spray for partial tank = treatment area left to be sprayed x sprayer output. **Metric: Litres = hectares x litres/hectare.**		

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - FIELD SPRAYERS - ENVIRONMENTAL CONSIDERATIONS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Spray Drift		
Before beginning any application, evaluate the weather conditions at the site to assess the potential for spray drift. Consider: **- air and ground temperature;** **- relative humidity;** **- wind speed and direction;** **- impending weather conditions;** **- water quality.**	**Know what weather conditions must be considered when applying pesticides.**	**List weather factors to consider when applying pesticides.**
Favourable weather conditions are those that will not reduce the efficacy of the pesticide or increase the potential of environmental damage.		
Minimize spray drift by: **- spraying under favourable weather conditions;** **- choosing suitable application equipment;** **- correctly operating the application equipment;** **- use of drift control agents;** **- choosing a formulation that is less subject to drift (e.g., amine vs ester).**	**Know how spray drift can be minimized**	**List methods of minimizing spray drift.**
Temperature		
High air temperatures may: **- reduce effectiveness of certain pesticides;** **- increase droplet evaporation;** **- create a temperature inversion.**	**Understand how temperature may adversely affect the application of pesticides.**	**Identify how temperature may adversely affect the application of pesticides.**
High temperatures combined with low relative humidity increases the rate at which airborne droplets evaporate. Evaporation decreases droplet size resulting in droplets that are more prone to drift.	**Understand how high temperatures combined with low relative humidity may increase drift.**	**Describe how high temperature with low density may increase drift.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - FIELD SPRAYERS - ENVIRONMENTAL CONSIDERATIONS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
A temperature inversion is a condition where air at ground level is cooler and more stable than air above the ground. The inversion prevents very fine spray droplets from settling, allowing them to remain suspended in the air for long periods of time and move off target.	**Understand how a temperature inversion may increase drift.**	**Describe how a temperature inversion may increase drift.**
Wind		
Increases in wind speed will increase the potential for spray drift. Maximum acceptable wind speeds and temperatures may be referenced on the label or by provincial recommendations/legislation. If spray drift occurs, stop the application, even though wind speeds may be acceptable.	**Understand how wind may adversely affect the application of pesticides.**	**Identify how wind may adversely affect the application of pesticides.**
	Know where to find references to acceptable wind speeds and temperatures.	**List sources of information for acceptable wind speeds and temperatures.**
No-wind conditions can cause herbicide sprays to remain suspended in air, which can be blown later onto sensitive plants. A 2 km/h wind is generally adequate.		
Equipment		
Control droplet spray drift by minimizing the number of small (fine) droplets that the nozzles produce. The droplet size decreases as nozzle size (output) decreases and pressure increases.	**Understand possible methods of operating application equipment to minimize spray drift.**	**Describe the adjustments to a sprayer that can reduce spray drift.**
A specific nozzle output can be obtained by using a variety of nozzle/pressure combinations. A small nozzle operated at high pressure can have the same nozzle output as a larger nozzle at a lower pressure. Reduce the drift potential by using larger nozzles and lower pressures.		
Selecting the maximum recommended sprayer output will require larger nozzles, which produce larger droplets and in turn will reduce drift.		

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - FIELD SPRAYERS - ENVIRONMENTAL CONSIDERATIONS

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Minimize drift by lowering the boom height. Use nozzles with wider spray angles or tilt the nozzles forward (to effectively lower boom height).		**Explain what boom height can reduce drift.**
Water quality		
Temperature, sediment, pH, and presence of salt in the water that is mixed with pesticide may affect pesticide performance.	**Understand how water quality may affect the performance of the pesticide.**	**List ways water quality could adversely affect the performance of the pesticide.**
The pH of a spray solution can have a significant effect on the performance of some pesticides. The active ingredient of some pesticides decreases in effectiveness when the spray solution is alkaline.		
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.**		
Silt and organic matter in the water can cause the following problems: **- premature pump wear;** **- plugging of screens;** **- reduced effectiveness due to organic matter aborbing pesticides.**		
Refer to the pesticide label or to provincial publications for specific recommendations.	**Know where to find specific recommendations for water quality.**	**Identify where to find specific recommendations for water quality.**

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - EQUIPMENT MAINTENANCE

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

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

Category: FORESTRY

Concept: APPLICATION TECHNOLOGY - MOUNTED SPRAYERS - EQUIPMENT MAINTENANCE

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

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
Store polyethylene tanks under cover to prevent deterioration by sunlight.		
Store galvanized steel tanks away from moisture to prevent rusting.		

Category: FORESTRY

Concept: EMERGENCY RESPONSE

General Objective: To know how to safely and effectively respond to pesticide emergencies.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
When applicators are working in areas which are remote from medical help or environmental emergency assistance, a wireless communication system should be available for contacting help in an emergency.	**Know when a wireless communication system is desirable for emergency response.**	**Identify the need for a wireless communication system for emergency response.**

Category: FORESTRY

Concept: PROFESSIONALISM

General Objective: To know and understand the principles that enable an applicator to deal effectively with the public.

COURSE OUTLINE	INSTRUCTIONAL OBJECTIVES	LEARNING OUTCOMES
The complex nature of the forest ecosystem makes it especially important for forest pesticide applicators to anticipate the public's concerns and be prepared to deal with them.	**Understand why good communications and public relations are essential to forestry pesticide use.**	**Identify why good communications and public relations are essential to forestry pesticide use.**
Distribute factual information. This information should include a description of the problem (e.g., the size and location of the threatened area, how the crop species is being affected, and current and potential losses), options that have been considered, why a pesticide option is being proposed and how it fits into an integrated pest management program.	**Know how to effectively provide public information.**	**Describe how to effectively provide public information.**
Answer concerns about potential for public exposure to pesticides such as in drinking water or berries picked for eating.		
Information regarding proposed pesticide projects should tie in with any public information guidelines dealing with forest management in general. It is easier to inform people about a proposed pesticide project if on-going information efforts have already provided background in forest management and pesticide use.		
The public should be approached in the early stages of a pesticide project proposal. It is best to offer information rather than wait for people to demand it.		