Relate these chapters to your everyday herbicide application
CHAPTER 1:
INTEGRATED PEST MANAGEMENT (IPM)
What is a Pest?

- any insect, mite, rodent, weed, disease, etc.
- injurious to the health of humans, animals, plants or the environment
Goal of Integrated Pest Management (IPM)

- not to eliminate the entire pest population
- keep pest below economic & aesthetic injury level
- to avoid adverse effects on humans, wildlife & the environment

http://www.ag.ndsu.edu/pubs/plantsci/pests/pp863-1.gif
Economic Injury Level

- breakeven point at which
  - cost of pest control equals
  - revenue loss caused by pest

Shedd - damage to planting

http://www.dreamstime.com/royalty-free-stock-photo-rabbit-eating-grass-image9357955
Economic/Action threshold

- the number of pests per plant or amount of damage to plant at which control measures should begin

If control applied, the pest population should not reach economic injury level (aphids)
Aesthetic injury level

- the number of pests that might cause enough damage to the appearance of a plant to warrant the cost of control

- based on Appearance

  What is acceptable at the FPCC might not be the same at the Chicago Botanic Garden

http://pep.wsu.edu/hortsense/scripts/query/displayProblem.asp?tableName=plant&problemID=777&categoryID=1
Pest Identification before treatment

- Key to successful IPM program is scouting
  - Regular monitoring of pest population & plant conditions
    - Properly identification of pest is essential prior to treatment
    - Properly diagnose disease symptoms in order to effectively treat
5 types of control methods (IPM)

1. Cultural
2. Mechanical
3. Biological
4. Chemical
5. Preventative

In most cases an IPM approach is the most efficient & environmentally safe approach.
Cultural control

- improves crop health so it may compete better against pests
  - Crop rotation
  - Mulching
  - Spacing
  - Plant selection
Mechanical control

- physical elimination of pest (pulling, cutting, etc.)
  - Pruning
  - Weeding
  - Hoeing
  - Hand picking Insects
  - Mowing
  - Bury or burning
Biological control

- using living organisms to reduce pests to economically acceptable levels
- Beneficial organisms that are natural enemies of the pest
- Or diseases
- Weed eating fish
- Purple Loosestrife beetles
Chemical control

- using chemical agents to reduce pests
- at proper time using scouting techniques

Before using pesticide consider:

- Other effective nonchemical controls
- Has scouting indicated the pest population large enough to warrant control?
- Is this the correct time to apply for optimal control?
Preventative control

- To prevent entry & spread of pests
  - Prevents spread by seed or plant parts
    - Clean equipment for weed seeds before leaving infested site
  - Stopping spread of insects, larvae & eggs
    - Quarantines

http://faculty.cu-portland.edu/cterill/images/BootbrushinstalledatChannelIslands.jpg

http://forestry.publishpath.com/Websites/forestry/Images/Don%27t%20Move%20Firewood.bmp
Pesticide failure

- Can be caused from:
  - Applying wrong type of pesticide or wrong application rate
  - Applying when pest is not in susceptible stage
  - Not applying the pesticide to the part of the plant or animal where the pest is located
  - Applying a pesticide to a resistant pest population

(page 4)
Important to identify pests & their life cycles

- Many people think that all insects are pests
- Most insects are a beneficial part of ecology
  - Predators or parasites of other insects
  - Very important for pollination
- Proper identification
  - understand if injurious or not to the plant
  - if the pest is susceptible or not susceptible to control
- Proper plant & insect ID is important
  - identify insect & lifecycle
  - identify plant found on
  
http://www.kidfish.bc.ca/images/insect_life_cycle.jpg
Insects

- Have an outside exoskeleton
- Shape & number of body parts are used to properly identify
- As they grow they shed their exoskeleton & grow larger
Adult insects

- 3 pairs of jointed legs
- 3 distinct body regions
  - Head
  - Thorax
  - Abdomen

Figure 1.2 Adult insect.
Incomplete development

- Some insects have simple metamorphosis
- 3 life stages: eggs, nymph, adult
Complete development

- 4 life stages - eggs, larvae, pupae, adults
- Pupae - resting stage when it does not eat & not very active
Insect Relatives

- Mites - are spiderlike and as adults have 4 pairs of jointed legs
- Spiders - have 4 pairs of legs and 2 distinct body regions
- Crustaceans - sowbugs & pillbugs with 7 pairs of legs (feed on decaying organic matter)
Mammals & Bird Pests-

- All birds are protected under the law except non-native birds - starlings, feral pigeons, and house sparrows.

- All mammals are protected by law except for rats, mice and ground squirrels.
Plant Pathology -

- Is the study of plant diseases
- Plant considered diseased when:
  - differs from a normal plant in appearance, structure or function
- 2 types of plant diseases:
  - Non-infectious
  - Infectious
Noninfectious diseases

- Cannot be transferred from pest to pest or plant to plant
- Often a result of unfavorable growing conditions
  - Temperature
  - Moisture
  - Compaction
  - Pesticide misapplication
  - Air pollution
Infectious diseases

- Multiply within the host
- Can be transferred from plant to plant
- Caused by pathogens or living organisms
  - Fungi
  - Bacteria
  - Nematodes
  - Viruses
  - Phytoplasmas

http://www.gardenaction.co.uk/fruit_veg_diary/fruit_veg_mini_project_november_1ba_potato.asp
Fungi

- Small multi-celled organisms that feed on waste materials
- Most are beneficial or harmless but some are pathogenic & leading culprits of plant diseases

Bacteria

- Microscopic single-celled organisms
- Enter plants through wounds or natural openings

http://kiranniranjan.blogspot.com/2011/02/bacteria.html
Nematodes

- microscopic roundworms that live in or on soil
- feed in the roots of plants
- few are injurious

http://kentsimmons.uwinnipeg.ca/16cm05/16labman05/lb5pg8_files/bene_nematode_l.jpg
Viruses

- submicroscopic pieces of DNA or RNA transmitted by sap-sucking insects
- CANNOT be controlled by pesticides
Phytoplasma

- Bacteria-like organisms that lack cell walls
- transmitted by sap sucking insects or plant propagation
- CANNOT be controlled by pesticide
Plant disease (common)

- Condition when plant differs from normal healthy plant in appearance, structure or function

- Common signs of plant pathogens
  - wilting
  - yellowing
  - leaf spots
  - dropping leaves
  - necrosis
3 Common Plant Disease Examples

- Chlorosis
- Mosaic
- Gall

(see page 10 for additional examples)
Chlorosis

- is a yellowish-green coloration in normally green tissues such as leaves

http://www.dias.kvl.dk/Plantvirology/esymptoms/IMG-color4.gif
Mosaic

- an intermingling patch of green and yellow color on a leaf

http://www.ctahr.hawaii.edu/nelsons/kava/mosaic1.jpg
Gall

- An abnormal swelling in portion of a branch, leaf, root or bud - wasp

http://www.hiltonpond.org/images/GallGoldenrodBall01.jpg
Development of Infectious Disease

4 elements necessary for the development of an infectious plant disease

- Susceptible host
- Plant Pathogen
- Favorable Environment
- Time

http://en.wikipedia.org/wiki/Plant_disease_forecasting
Susceptible host

- for a disease to occur a plant must be able to become infected by that type of pathogen
- Example Oak wilt, gall
Plant Pathogen

- Microorganism capable of causing an infectious disease
- Often host-specific & can only infect a few species of plants

http://nfrec.ifas.ufl.edu/paret/u-scout/Brassica/Pages/White_mold.html
Favorable Environment

- Plant pathogens have certain temperature & moisture requirements
- In order to grow or enter plants
- Such as extra moisture susceptibility or drought
Time

- Symptoms change over course of weeks or months
- Time for the disease to progress throughout the plant
Weeds

- any plant growing where it is not wanted
- some are legally declared noxious
- first step in planning weed control is correct identification of the plant

http://www.fcps.edu/islandcreekes/ecology/common_dandelion.htm
Weed classification

- **Noxious**
  - Declared so by Illinois law, must be controlled
    - Common/ giant ragweed, marijuana, musk/ Canada thistle, johnsongrass, perennial sowthistle, sorghum-alumum, & kudzu

- **Exotic**
  - Unlawful to buy, sell, offers for sale, distribute or plant
    - Japanese honeysuckle, multiflora rose, purple loosestrife, common/ glossy buckthorn, japanese /dahurain buckthorn & kudzu
3 types of weeds

- Grasses
- Grass-like
- Broadleaf weeds
Grasses and Grass-like weeds

- Parallel veins
Broadleaf weeds

- Broadleaf plants- have net-veined leaves and are usually less elongated than grasses
- Broadleaf Weeds
- Trees and shrubs –
  Drop leaves in fall w/ persistent stems that overwinter
Life cycles of weeds

Plants are easiest to control when they are seedlings

- Annual weeds- complete life cycle in 1 year
- Biennial- complete life cycle in 2 years-
- Perennial- live longer than 2+ years
  - Most shed leaves in fall or above ground die back
Life Cycles of Weeds

Figure 1.6. Weed life cycle.

Cycle repeats until plant dies.
Sample Question

- What type of weed germinates in the spring, develops a root system and low growing cluster of leaves called a rosette?

What type of weed germinates in the spring, develops a root system and low growing cluster of leaves called a rosette?

A Biennial weed

CHAPTER 2:
UNDERSTANDING PESTICIDES
What is a Pesticide?

- Any chemical used to destroy, prevent or control any form of life declared as a pest

http://www.pestcontrol.ws/
Pesticide formulation

- Made up of Active and Inert ingredients

- Picloram (2 lbs)
- Adjuvants (.05 gal)
- Water (.95 gal)
- Tordon® 22K (1 gal)
Active ingredient (AI)

- The chemical effective against the pest
- the part of the pesticide that kills
Inert ingredients

- Don’t directly harm pest but will make the Active ingredient more effective
Herbicide Formulations

- may be ready to use as is or may require dilution with water or another carrier (oil or liquid)

Dry formulations:
- 60WDG means 60% active ingredient water-dispersible granule (.6 pounds AI)

Wet formulations:
- 4EC means 4 lbs of active ingredient per gallon of emulsifiable concentrate
Dry Formulations

- Soluble powder (SP)
- Wettable powder (WP, P)
- Dry flowables or water-dispersible granules (DF, WDG)
- Granules (G)
- Pellets (P, PS)
- Dusts (D)
Soluble powders (SP)- are mixed with water and dissolve readily and form a true solution.

Figure 2.1 Differences among solutions, suspensions, and emulsions.
Wettable powders (WP)

- Finely ground powder mixed with water to form a **suspension** and not a true solution

- **ABRASIVE** to pumps and nozzles
  **Also an inhalation hazard**

- Require agitation when mixed with water
Dry Flowables (DF) and Water-dispersible granules (WDG)

- Similar to wettable powders except the Active ingredient (AI) is formulated in a microgranule or granule instead of a powder.
- Forms a suspension in liquid carrier – forms less dust than WPs.
Granules (G)

- Active ingredient is coated to make coarse particles such as clay, newspaper pellets.
- Granules are applied directly—no mixing with water
- Presents less hazard to handlers with little dust/no spray
- Sometimes called “Pellets (P)” but Ps are larger than Granules

http://product-image.tradeindia.com/00190004/b/0/PP-Granules.jpg
Dusts (D)

- Contain low percentage of Al on a very fine, dry inert carrier
  - Talc, chalk or clay
- Most ready to use as purchased
- Can present an inhalation hazard to handlers
- Likely to drift to non-target areas
  - Therefore use of these has decreased over the years
Wet formulations

- Emulsifiable concentrates
- Emulsions
- Microencapsulated
- Liquids or Flowables
- Solutions
- Ultra-low-volume concentrates (ULV)
Emulsifiable concentrate (EC)

- Active ingredient is mixed with 1 or more solvents & emulsifier that allows mixing with water
  - They are easily absorbed into the skin and create a dermal hazard
Microencapsulated (ME)

- Active ingredient is surrounded by a plastic capsule or coating that is suspended in a liquid—resulting in a time-released product.

- Use caution near bee hives.
- Bees carry it back to the hive & can poison the entire colony.
Solutions (S)

- Form true solutions when mixed according to label
  - will not settle out or separate

Ultra-low volume concentration (ULV)

- have high % of active ingredient in solution with a solvent- usually oil
Fumigants

- substances or mixtures that produce
  - gas, vapor, fumes or smoke intended to control a pest
- Special Licensing is required to handle most fumigants
- highly toxic to humans & animals
Restricted Use Pesticides

- Can only be purchased by:
  - Certified Applicators or persons under their direct supervision

- Records of restricted pesticide applications must be maintained for 2 years
Adjuvant

- Chemical that modifies pesticide physical properties or enhances its performance or both
- Includes spray modifiers
Drift reduction additives

- Thickening agents that increase droplet size & reduce the amount of spray drift
- To reduce drift droplets must be over 200 microns
Sticker

- used to increase the adherence of the chemical to the surface
Surfactant or Spreaders - p. 19

- added to spread the spray mixture more thoroughly over the target plant or insect
- decreases the surface tension of water
- allowing the water carrier to spread over the leaf surface
Penetrants

- help pesticide pass through the outer surface of the plant—through the waxy coating on leaves.
Defoaming agents

- eliminate foam in the spray tanks, especially when agitation is necessary

http://www.silicone.jp/e/products/type/defoaming/images/image1.jpg
Mixing of pesticides

- By Law it is your responsibility
  - Ensure that pesticides retain their properties if you mix them together
  - They do not change toxicity or other physical properties when combined.

- It is *illegal* to mix pesticides with other products that are prohibited on the label
Chemical Incompatibility

- **Antagonism:** Decreased activity or effectiveness
- **Synergism:** Increased pesticide activity (can be good, can be bad)

**Cannot tell if pesticides are chemically incompatible by mixing alone**
Physical Incompatibility

- Some pesticides cannot be physically mixed together
- Can result from improper mixing or inadequate agitation
- Signs of incompatibility
  - Upon mixing 2 or more pesticides they may curdle, gel or become sludge-like
- Must perform a jar compatibility test to check prior to placing in tanks
Proper mixing order: p. 20 2nd paragraph on right
(from hardest to dissolve to easiest)

1) fill tank ¼ - ½ with carrier and agitate
2) add compatibility agent (if needed)
3) add suspension products
   First dry: (WP, DF, WDG)
   Second liquids: (F, L, ME)
4) add emulsion products (EC)
5) add solution products (S, SP)
6) add surfactants and penetrants (if needed)
7) Finish filling tank with carrier
Which of the following would you add to the tank first?

- Wettable Powder (WP)
- Emulsifiable Concentrates (EC)
- Solutions (S)
Which of the following would you add to the tank first?

Wettable Powder (WP)
Other info on pesticide labels
Residual or persistent pesticides

- remain active in soil or area to kill pests for several days, weeks or years
  - Pre-emergence or Early Pre-plant
- Residue may also affect non-target species
Preharvest interval (PHI)

- The latest time a pesticide may be applied prior to harvest
- PHI is listed on the label to help stay under the tolerance

What is “tolerance”?
The amount of chemical residue that may legally remain in or on food or feed crop when it is harvested.
Selective pesticides

- control pest with little or no injury to related organisms

Garlon = broadleaf specific, selective herbicide
Nonselective (broad-spectrum) pesticide

- control nearly all related organisms

Overuse of broad-spectrum insecticides may also kill natural predators and parasites of that pest, resulting in pest resurgence
Nonselective pesticide resistance

- Overuse of broad-spectrum pesticides
  - In insecticides may also kill natural predators and parasites of that pest
    - resulting in pest resurgence
  - In plants over time only plants that are resistant to the herbicide survive and live to produce seed
    - making future generations more resistant
Systemic (or translocated) pesticide

- Move within the plant/animal from site of uptake to other parts
- Effective for plants with underground/connecting reproductive structures
Contact pesticide

- control by **direct contact** with the pest only
- kill annuals if all the growing parts are above ground

*Figure 2.2. Contact pesticides kill pests only at the site of pesticide contact.*
Pest Resurgence

- Occurs from overuse of broad spectrum insecticides since they may also kill natural predators for the pest.
- Predator and parasite populations rebound more slowly than the target pest, making it harder to control pest.
Information on a Product Label:

Pesticide’s impact on wildlife

Personal protective equipment required using pesticide

How long to wait before entering a treated area/ re-entry interval
Read the Label

- Labels change very little typically but new formulations occur
- Recognize hazards to yourself and the world around you
- How much to use
- How often to spray
- Legal limit per acreage per year

When purchasing and applying a pesticide remember:

a) The label is a legal document
b) Before you buy and apply a pesticide read the label
c) A General Use pesticide is not given a classification on the label
Specimen Label

For control of annual and perennial weeds and woody plants in forests, non-crop sites, and in and around aquatic sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression and grazed areas on these sites.

Avoid contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees, because severe injury or destruction may result.

Active Ingredient(s):
- glyphosate
- N-(phosphonomethyl)glycine
- isopropylamine salt

Total Ingredients: 100.0%

Environmental Hazards
Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

Environmental Hazards
- Contains 5.4 pounds per gallon glyphosate, isopropylamine salt (4 pounds per gallon glyphosate acid).
- EPA Reg. No. 62719-324

Personal Protective Equipment (PPE)
Applicators and other handlers must wear:
- Long-sleeved shirt and long pants
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations
Users should:
- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid
If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

Keep the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Physical or Chemical Hazards
Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

Do not mix, store or apply this product or spray solutions of this product in galvanized steel or unlined steel (except stainless steel) containers or spray tanks. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas, which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder’s torch, lighted cigarette or other ignition source.

Notice: Read entire label. Use only according to label directions. Before using this product, read Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label. If terms are unacceptable, return at once unopened.

Precautionary Statements
- Hazards to Humans and Domestic Animals
  - Harmful If Inhaled
  - Avoid breathing spray mist. Remove contaminated clothing and wash before reuse. Wash thoroughly with soap and water after handling.

Keep Out of Reach of Children

CAUTION
PRECAUCION
Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Trade Name (Refers to this specific formulation of herbicide)

Chemical Name (Shows what active ingredients are in the formulation)

Active Ingredient Concentration (Important to know this to determine rates and solutions for application)

EPA Registration Number (kind of like a social security number for herbicides. Each specific formulation must be registered with the EPA)
PPE Requirements
(You must follow these requirements when applying this particular herbicide)

Description of Herbicide Use
(Tells you what type of species and what locations it is legal to apply this herbicide)

Hazard Statement
(Volunteers can only apply herbicides labeled as ‘Caution’)

RODEO – Page 1
Contact information for Manufacturer
(In case of health of environment emergency)

General information
(Basic information on how the herbicide works, how long it takes to see visible signs of effects, and conditions to treat)

General Information

This product is a water-soluble liquid, which mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants. This product is intended for control of annual and perennial weeds and woody plants in forests, pine straw plantations, non-crop sites such as utility rights-of-way and in and around aquatic sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression and grazed areas on these sites.

The active ingredient in this product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days, 7 days or more on most perennial weeds, and 30 days or more on most woody plants. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects include gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason, best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product and surfactant within the recommended range when vegetation is heavy or dense, when treating dense multi-canopied sites or woody vegetation or difficult-to-control herbaceous or woody plants.

Do not treat weeds, brush or trees under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced control of target vegetation may also occur if foliage is heavily covered with dust at the time of treatment.

Reduced control may result when applications are made to woody plants or woods following site disturbance or plant top growth removal from grazing, mowing, logging or mechanical brush control. For best results, delay treatment of such areas until resprouting and foliar growth has reached the target vegetation to the recommended stage of growth for optimum herbicide exposure and control.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may destroy the effective concentration of this product in the leaf or foliage tissue.
Cautionary statements
(To avoid unintended injury to desirable plants)

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions. The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications, public health uses or to applications using dry formulations.

1. The distance of the outer most nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

The applicant should be familiar with and take into account the information covered in the following Aerial Drift Reduction Advisory Information:

Importance of Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversion section of this label).

Controlling Droplet Size: Volume-Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows product larger droplets.

Pressure-Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.

Number of nozzles-Use the minimum number of nozzles that provide uniform coverage.

Nozzle Orientation-Orienting nozzles so that the spray is released backwards, parallel to the airstream will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.

Nozzle Type-Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.

Boom Length-For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

Application-Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

ATTENTION: Avoid drift. Extreme care must be used when applying this product to prevent injury to desirable plants and crops.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to crops, plants or other materials not recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of materials of this product or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

Avoid applying at excessive speed or pressure.
Spray solution chart
(Used by mixer to determine amount needed for different solution strengths)

Control recommendations
(Specific recommendations for control of different categories of weeds)

Spray Solution Chart

<table>
<thead>
<tr>
<th>Desired Volume</th>
<th>3/4%</th>
<th>1%</th>
<th>1 1/4%</th>
<th>1 1/2%</th>
<th>2%</th>
<th>5%</th>
<th>8%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 gal</td>
<td>1 fl oz</td>
<td>1 1/3 fl oz</td>
<td>1 2/3 fl oz</td>
<td>2 fl oz</td>
<td>2 2/3 fl oz</td>
<td>6 1/2 fl oz</td>
<td>10 1/4 fl oz</td>
<td>12 3/4 fl oz</td>
</tr>
<tr>
<td>25 gal</td>
<td>3 1/2 qt</td>
<td>3 qt</td>
<td>1 1/4 qt</td>
<td>1 qt</td>
<td>3 qt</td>
<td>5 1/2 qt</td>
<td>8 1/2 qt</td>
<td>10 qt</td>
</tr>
<tr>
<td>100 gal</td>
<td>3 qt</td>
<td>1 gal</td>
<td>1 1/2 gal</td>
<td>1 gal</td>
<td>2 gal</td>
<td>5 gal</td>
<td>8 gal</td>
<td>10 gal</td>
</tr>
</tbody>
</table>

For use in knapsack sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill the knapsack sprayer with the mixed solution and add the correct amount of surfactant.

Selective Equipment
This product may be applied through shielded sprayers or wiper application equipment. This equipment may be used to selectively control undesirable vegetation without harming desirable vegetation.

Shielded sprayers direct the herbicide solution onto weeds while shielding desirable vegetation from the spray solution. Any recommended rate or tank mixture of this product may be used employing this equipment.

Wiper applicators physically wipe product directly onto undesirable vegetation. Care should be taken to avoid wiping desirable vegetation. Use a 33 to 100 percent solution of this product, diluted in water for wiper applications. Use a 33 percent solution for wick or gravity feed systems. Higher concentrations may be used in pressurized systems that are capable of handling this dilution. Addition of a nonionic surfactant at a rate of 10 percent by volume of the herbicide solution is recommended.

Weeds Controlled

Annual Weeds
Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See “Instructions for Use,” “General Information” and “Mixing and Application Instructions” for labeled uses and specific application instructions.

Broadcast Application Rates: For weeds less than 6 inches tall, use 1 1/2 pints of this product per acre plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus a non-ionic surfactant containing 80% or greater active ingredient.

Hand-Held, High-Volume Application Rates: Use a 3/4 percent solution of this product in water plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. Apply to foliage of vegetation to be controlled.
Species specific control recommendations chart
(Label gives specific control recommendations for certain species)

Common Name | Scientific Name
--- | ---
Sowthistle, annual | Sonchus oleraceus
Spanishneedles | Bidens bipinnata
Stinigrass | Eragrostis cilianensis
Sunflower | Helianthus annuus
Thistle, Russian | Salsola kail
Spyrula, umbrela | Holostea umbellatum
Velvetleaf | Abutilone theophrasti
Wheat | Triticum aestivum
Witchgrass | Panicum capillare

Apply with hand-held equipment only.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

**Perennial Weeds**

Apply this product to all vigorously growing perennial weeds. Unless otherwise directed, apply when target plants are actively growing and most have reached early head or early bud stage of growth. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

**NOTE:** If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before frost begins.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

**Specific Weed Control Recommendations:** For perennial weeds, apply the recommended rate plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient. Use of this product without surfactant will result in reduced herbicide performance. Refer to the “Mixing and Application Instructions” section of this label and the surfactant manufacturer label for more information.

When applied as directed, this product plus a surfactant such as a non-ionic surfactant containing 80% or greater active ingredient will control the following perennial weeds: (Numbers in parentheses “(“) following common name of a listed weed species refer to “Specific Perennial Weed Control Recommendations” for that weed which follow the species listing.)

| Common Name | Scientific Name |
--- | ---
Alliflora | Medicago sativa
Alligatorweed | Alternanthera philoxerca
Anise-Fennel | Eupatorium cannabinum
Artichoke, Jerusalem | Helianthus tuberosus
Bahiagrass | Paspalum notatum
Bermudagrass | Cynodon dactylon
Bendweed, field | Convolvulus arvensis
Bluegrass, Kentucky | Poa pratensis
Bluegrass, Texas | Holcus lanatus
Brackenfern | Pteris sp.
Bracken, smooth | Dicranopteris linearis
Canarygrass, reed | Phalaris arundinacea
Cattail (6) | Typha sp.
Catcher, white (31) | Trifolium pratense
Clover, red (31) | Trifolium repens
Clover, white (31) | Trifolium repens
Cocoggrass (6) | Imperata cylindrica
Cordgrass (7) | Spartina spp
Cutgrass, giant (8) | Zizania morrhua
Dallisgrass (31) | Paspalum dilatatum
Dandellion (31) | Taraxacum officinale
Dock, curly (31) | Rumex crispus
Dogbane, hemp (9) | Apocynum cannabinum
Fescue (31) | Festuca spp.
Fescue, tall (10) | Festuca arundinacea
Guinnaqgrass (11) | Panicum maximum
Hemlock, poison (31) | Conium maculatum
Horseweed (31) | Solanum carolinense
Horsehair (9) | Armoracia rusticana
Iceplant (22) | Mesembryanthemum crystallinum
Johnsongrass (12) | Sorghum halepense
Kikuyugrass (21) | Pennisetum clandestinum
Knapweed (13) | Centaurea repens
Lantana (13) | Lantana camara
Lepeodes, common (31) | Lepeodes striata
Lepedeea, sorossa (31) | Lepeodes aegyptiaca
Loosstrife, purple (14) | Lythrum salicaria
Lotus, American (15) | Nelumbo lutea
Maidencane (16) | Panicum horizontalis
Milkweed (17) | Asclepias spp.
Muhly, wisentwre (21) | Muhlenbergia frondosa
Mullein, common (31) | Verbascum thapsus
Napiergrass (31) | Pennisetum purpureum
Narahshe, silverleaf (3) | Solanum elaeagni/obovatum
Nutseed, purple (18) | Cupana rotundus
Nutseed, yellow (18) | Cupana esculenta
Orchardgrass (12) | Dactylis glomerata
Pampasgrass (19) | Cortaderia selloana
Paraggrass (16) | Brachiaria mutica
Paragrapnites (20) | Paspalum notatum
Pasturegrass (21) | Agropyron repens
Red, giant (26) | Arundo donax
Ryegrass, perennial (12) | Lolium perenne
Rye, smooth (31) | Polygala palmata
Spargue (23) | Nuphar lutea
Startball, yellow (31) | Centaurea solstitialis
Swede potato, wild (23) | Ipomoea purpurea
Tall, artichoke (25) | Cynara cardunculus
Tall, Canada (25) | Cirsium arvense
Timothy (12) | Phleum pratense
Torpedoggrass (26) | Panicum repens
Tules, common (27) | Scirpus acutus
Vaseygrass (31) | Paspalum notatum
Velvetgrass (31) | Holcus spp.
Wheatgrass, field (3) | Echinochloa crus-patru
Waterhemp (28) | Echinochloa crus-patru
Waterlilly (29) | Nuphar lutea
Watermarinorose (30) | Ludwigia spp.
Weedgrass, western (12) | Agropyron smithii

1 Partial control
2 Partial control in southeastern states. See “Specific Weed Control Recommendations” below.

**Specific Perennial Weed Control Recommendations:**

1. **Alligatorweed:** Apply 8 pints of this product per acre as a broadcast spray or as a 1:4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.
Wetland/aquatic information
(If you herbicides in or near water, it is crucial that you use a product labeled for use in aquatic areas. This section gives specific information about this type of application)

Sites specific control recommendations chart
(Label gives specific control recommendations for certain sites)
Use higher rates of this product within the recommended rate ranges for control or partial control of woody brush, trees, and hard-to-control perennial herbaceous weeds. For best results, apply to actively growing woody brush and trees after full leaf expansion and before fall color and leaf drop. Use increased rates within the recommended rate range to control perennial herbaceous weeds from emergence up to the appearance of seedheads, flowers, or berries appear. Use lower rates within the recommended rate range to control annual herbaceous weeds and actively growing perennial herbaceous weeds after seedheads, flowers, or berries appear. Apply to foliage of actively growing annual herbaceous weeds anytime after emergence.

Tank Mixtures

This product may be used in tank mix combination with other herbicide products to broaden the spectrum of vegetation controlled. When tank mixing, read and observe applicable use directions, precautions, and limitations on the respective product labels. Use according to the most restrictive precautionary statements for each product on the mix. Any recommended rate of this product may be used in a tank mix.

Note: For forestry site preparation, make sure the tank mix product is approved for use prior to planting the desired species. Observe planting interval restrictions. For side trimming treatments, it is advisory that this product be used alone as recommended, or as a tank mix with Garlon.

<table>
<thead>
<tr>
<th>Product</th>
<th>Broadcast Rate</th>
<th>Use Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenal Applicators Concentrate</td>
<td>2 to 16 fl oz/acre</td>
<td>Forestry site preparation</td>
</tr>
<tr>
<td>Oust</td>
<td>1 to 4 oz/acre</td>
<td>Forestry site preparation, utility sites</td>
</tr>
<tr>
<td>Garlon 3A</td>
<td>1 to 4 qt/acre</td>
<td>Forestry site preparation, utility sites</td>
</tr>
<tr>
<td>Garlon 4</td>
<td>1 to 4 qt/acre</td>
<td>Forestry site preparation, utility sites</td>
</tr>
<tr>
<td>Arsenal 2WSL</td>
<td>2 to 32 fl oz/acre</td>
<td>Utility sites</td>
</tr>
</tbody>
</table>

Spray-to-Wet Rates

<table>
<thead>
<tr>
<th>Product</th>
<th>Rates</th>
<th>Use Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenal Applicators Concentrate</td>
<td>1/32 to 1/2% by volume</td>
<td>Forestry site preparation</td>
</tr>
<tr>
<td>Arsenal 2WSL</td>
<td>1/32 to 1/2% by volume</td>
<td>Utility sites</td>
</tr>
</tbody>
</table>

Low Volume Directed Spray Rates

<table>
<thead>
<tr>
<th>Product</th>
<th>Rates</th>
<th>Use Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenal Applicators Concentrate</td>
<td>1/8% to 1/2% by volume</td>
<td>Forestry site preparation</td>
</tr>
<tr>
<td>Arsenal 2WSL</td>
<td>1/8% to 1/2% by volume</td>
<td>Utility sites</td>
</tr>
</tbody>
</table>

1 Ensure that Garlon 3A is thoroughly mixed with water before adding this product. Agitation is required when mixing this product with Garlon 3A to avoid compatibility problems.

Mixing Information

Important information on which other herbicides are compatible with this specific herbicide and what rates to use and how to mix them correctly.

Forestry Conifer and Hardwood Release

Directed Sprays and Selective Equipment

This product may be applied as a directed spray or by using selective equipment in forestry conifer and hardwood sites, including Christmas tree plantations and silvicultural nurseries. This product requires use with a surfactant. Use only surfactants that are approved for conifer release and specified on the surfactant label as safe for use in conifer release (pine release). Use of this product without surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.

Tank Mixing: In hardwood plantations, tank mixes with Oust may be used. In pine plantations, tank mixes with Garlon 4 or Arsenal AC may be used. Comply with all site restrictions, forestry species limitations, and precautions on the tank mix product labels.

Avoid contact of spray drift, mist or drips with foliage, green bark or non-woody surface roots of desirable plant species. See "Application Equipment and Techniques" section of this label for specific recommendations and precautions.

Spray-to-Wet Applications: Use a 2 percent spray solution to control undesirably wooded brush and trees. To control herbaceous weeds, use a 1 to 2 percent spray solution.

Low Volume Directed Spray Applications: Use a 5 to 10 percent spray solution. Coverage should be uniform with at least 50 percent of the foliage contacted. Coverage of the top one-third of the unwanted vegetation is important.

Broadcast Applications: For equipment calibrated for broadcast applications, use 1 1/2 to 7 1/2 quarts of this product per acre. Apply in 10 to 60 gallons of clean water per acre. Shielded application equipment may be used to avoid contact of the spray solution with desirable plants.

Wiper Application Equipment: See the "Selective Equipment" section of this label for equipment and application rate recommendations.

Broadcast Application

Note: Except where specifically recommended below, make broadcast applications of this product only where conifers have been established for more than one year.

Broadcast application must be made after formation of final conifer resting buds in the fall or prior to initial bud swelling in the spring.

Injury may occur to conifers treated for release, especially where spray patterns overlap or the higher rates are applied. Damage can be accentuated if applications are made when conifers are actively growing, or are under stress from drought, flood water, improper planting, insects, animal damage or diseases.

Accord Concentrate requires use with a surfactant. Use a surfactant that is labeled/recommended for use in over-the-top release applications. Use of this product without a surfactant will result in reduced herbicide performance. Refer to the "Mixing and Application Instructions" section of this label and the surfactant manufacturer label for more information.
Tank Mixture with Atrazine: To release Douglas fir, apply 3/4 quart of this product with 4 pounds a.i. of atrazine per acre. Apply only over Douglas fir that has been established for at least one full growing season. Apply in the early spring, usually mid-March through early April. Injury will occur if applications are made after bud swell in the spring. For this use, do not add surfactant to the tank mixture.

Abnormal seedlings: Check the manufacturer’s label for all herbicides and surfactants used.

Wetland/aquatic information
(If you herbicides in or near water, it is crucial that you use a product labeled for use in aquatic areas. This section gives specific information about this type of application)

Wetland Sites

This product may be used in and around water (aquatic areas) and wetlands found in forestry and in power, telephone and pipeline rights-of-way sites, including where these sites are adjacent to or surrounding domestic water supply reservoirs, supply streams, lakes and ponds. Read and observe the following before making applications in and around water.

Consult local public water control authorities before applying this product in and around public water. Permits may be required to treat in such areas.

There is no restriction on the use of treated water for irrigation, recreational or domestic purposes.

Note: Do not apply this product directly to water within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.), or within 1/2 mile of an active potable water intake in a standing body of water such as a lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after application. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the application. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.

Do not spray open bodies of water where woody brush, trees and herbaceous weeds do not exist. The maximum application rate of 3 3/4 quarts per acre must not be exceeded in a single over-water broadcast application except as follows, where any recommended rate may be applied:
- Stream crossings in utility right-of-way.
- Where applications will result in less than 20 percent of the total water area being treated.

Habitat Restoration and Maintenance: When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract wildlife, and for similar broad-spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants.

Wildlife Food Plots: This product may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reseed the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tillaging to allow for maximum effectiveness.

Wiper Applications

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 50 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "Weed Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results.

Cut Stump Application

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting. Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will control, partially control or suppress most woody brush and tree species, some of which are listed below:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder</td>
<td>Alnus spp.</td>
</tr>
<tr>
<td>Coyote brush</td>
<td>Baccharis consanguinea</td>
</tr>
<tr>
<td>Dogwood</td>
<td>Cornus spp.</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>Eucalyptus sp.</td>
</tr>
<tr>
<td>Hickory</td>
<td>Carya spp.</td>
</tr>
<tr>
<td>Madrone</td>
<td>Abietus menziesii</td>
</tr>
<tr>
<td>Maple</td>
<td>Acer spp.</td>
</tr>
<tr>
<td>Oak</td>
<td>Quercus spp.</td>
</tr>
<tr>
<td>Poplar</td>
<td>Populus spp.</td>
</tr>
<tr>
<td>Reed, giant</td>
<td>Andro donax</td>
</tr>
</tbody>
</table>

Information on cut stump treatments
(Specific information on the rates and methods used for this application type)
1) Why is Marksman a Restricted use pesticide?  
Due to ground and surface water concerns

2) What crops can Marksman be used on?  
Corn, Fallow systems, and sorghum

3) Are there any animals to which Marksman is particularly toxic to?  
Yes it is toxic to aquatic invertebrates.

4) What is the REI of Marksman?  
Restricted-entry interval (REI) of 24 hours

5) What is first aid for getting Marksman in your eye?  
Hold eye open & rinse for 15-20 minutes. Remove contact lenses after 5 minutes. Call poison control or doctor.

6) What is the phone number to call for emergency treatment info?  
Call at BASF Corporation 800-832-4357 (HELP)
7) Can you perform aerial applications with Marksmen?  
Yes at 2 to 10 gallons of water per acre.

8) How high or low can you spray an aerial application from?  
Application should not be made at a height greater than 10 feet above the top of the largest plant unless greater height required for aircraft safety.

9) When is the lowest drift potential for Marksman?  
Between wind speeds of 2 to 10 mph. But droplet size and other factors may affect.

10) What is the A.I. of Marksmen Herbicide?  
Dicamba and Atrazine

11) What is the percent of A.I.?  
35.65 %

12) When should Marksman herbicide be added to tank mix?  
Step #5 after products in 4) PVA bags and before 6) water-soluble products
13) If you applied 3.5 pints per acre of Marksman on corn what is the maximum pints you can apply for a late season treatment before maximum rate is achieved? p8

5.25 - 3.5 = 1.75 pints

14) What crops are particularly sensitive to Marksman? p5

Beans, cotton, flowers, grapes, etc.

15) Is Marksman registered for use on Sweet Corn? p8

No

16) What tank partner would you use for improved control of velvetleaf per acre and how much? p10

Exceed 0.25 - 0.5 oz.

Spirit 0.5 oz.

Permit 0.17 -.33 oz.

17) Can you graze cattle in Sorghum postemergent treated with Marksman? p11

Yes, but you must wait 21 days or more following application
18) Can you use Marksman in a tank mix or after applying Banvel? p11
   Yes for both

19) Can Marksman be mixed or loaded within 50 feet of an abandoned well? p3
   No, precaution needs to be used around any water. Atrazine can seep/leach through soil

20) Can you use Marksman to control Wild Buckwheat? p5
   Yes

21) What is the last date Marksman can be used in rotation with crops other than corn or sorghum without injury? p8
   June 10
Sample Question

- What warning is on every herbicide label?
Answer

- What warning is on every herbicide label?

Keep out of the reach of children
Sample Question

If you have herbicide that you bought in 2015 and a new formulation comes out in 2016. The new label says that the herbicide can be used on corn. Can you use the old herbicide on corn?
Sample Question

- If you have herbicide that you bought in 2015 and a new formulation comes out in 2016. The new label says that the herbicide can be used on corn. Can you use the old herbicide on corn?

No, you cannot apply the old product to sites that are not on the old label but appear on the new one.
Toxicity

- The pesticide’s ability to cause damage/ death
- Pesticide label gives a quick indication of how poisonous it is by the signal word.

[Image of skull and crossbones]

[Link to image: http://media.supereco.com/media/2009/01/20/320w/warning-skull-crossbones.png]
$\text{LD}_{50}$

- Dose that kills half of the test animals, stands for lethal dose (LD) for 50%-

Figure 4.2 $\text{LD}_{50}$: The amount that kills half of the tested animals.
Exposure

- how pesticides enter the body
- reason to wear proper protective equipment
Routes of Exposure

- Oral - by mouth
- Dermal - by skin
- Eye - by eye
- Inhalation - by lungs
Acute exposure

- One-time hazardous contact with pesticide
  - Spilling chemical on clothes & skin
  - Ingesting a pesticide accidentally
- Working with highly toxic chemicals you should never work alone in case you are exposed

Detecting poisoning

Many insecticides used today are organophosphates or carbamate

Organophosphates are involved in more cases of poisoning & deaths than other insecticides

Levels can be measured doing a blood cholinesterase test

- Reduction in cholinesterase indicates possible poisoning
- Stop exposure immediately
Chronic Effects

- Risks associated with long term use of a pesticide
- example chronic effects-not a pesticide
Routes of Exposure

Why protective equipment is needed
Dermal absorption rates

- Parts of the body absorb pesticides at different rates
- Forehead is 4 times more absorbent than the hand
- Genital area is 11 times more absorbent
Treatment for Exposure

- **Oral**
  - Check label or contact poison control

  *Do not use food containers to hold herbicide*

- **Skin**
  - Rinse with water
  - Remove contaminated clothing
  - Wash with plenty of soap and water

Most serious dermal exposures is when a pesticide mixed with oil crosses the skin barrier and into the bloodstream, the results can be fatal.
Treatment for Exposure

- **Eye**
  - Rinse eye with water or eyewash bottle at least 15 min
  - get medical attention if there is pain or reddening of the eye (best to be safe than sorry)

- **Inhalation**
  - Move to better ventilated area
  - keep air passages clear
  - perform artificial respiration if necessary
Personal Protective Equipment (PPE)

- **When using any pesticide at minimum wear:** p. 38
  - Hat, long sleeves, trousers/coverall, socks and shoes

- **During mixing:** boots, glove, apron, and goggles
  - Unlined: chemical resistant gloves
  - Rubber, Nitrile or Neoprene

- Label states minimum PPE in the precautionary statement

http://www.pesticides.montana.edu/PAT/images/MTPPE.gif
PPE Care

- Wash PPE separately from other clothing at home [p.41]
  - As soon as possible, do not have contaminated clothing sit around
  - Wash daily
- If you spill highly concentrated toxic chemicals on your clothes **do not** wash -- dispose of them properly
Respirators

- Protect from inhaling toxic chemicals
- Label indicate if respirator is need for application
- whether a prefilter is needed
- Designated with the following letters
  - N- not to be used with oil
  - R- oil resistant
  - P- oil proof
  - HE- high-efficiency

Figure 4.10 Respirators used for pesticide protection.
Safe Handling & Storage

To protect others
Transporting Pesticides

- Check to make sure all containers are not leaking
- Do not transport with:
  - Food
  - Animal feed
  - Animal supplies
- Tie down & secure containers
Pesticide Storage

- Store downwind & downhill from houses, play areas and ponds
- Away from human & livestock areas to avoid contamination in case of fire
- If possible in a separate building – first floor, in cool dry area away from direct sunlight
- Signs posted with a locked door
Large Quantity Containment Area

- Soap
- Pesticide absorptive material
- Fire extinguisher
- Broom & dustpan
- Trash can
- Keep Labels on containers
When filling, rinsing and draining equipment you should have a wash pad, wash rack or concrete apron with well designed sump to catch contaminated water.
What if you do not have this?

- Small amounts of surplus mixtures or rinsates can be diluted and reapplied to the treated area
- Do not exceed label rates for area listed on the label

<table>
<thead>
<tr>
<th>Crop</th>
<th>Maximum Rate Per Acre Per Application</th>
<th>Maximum Rate Per Acre Per Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>3.5 pints</td>
<td>5.25 pints</td>
</tr>
<tr>
<td>Fallow Ground</td>
<td>8.6 pints</td>
<td>8.6 pints</td>
</tr>
<tr>
<td>Sorghum</td>
<td>2 pints</td>
<td>3.5 pints</td>
</tr>
</tbody>
</table>

Figure 4.14 Pesticide mixing and loading area.
Pesticide Container Rinsing

- At end of day
- From backpack
- Spray remaining herbicide on target plants to empty

- Triple Rinsing
- Still have residue

http://elkhorn.unl.edu/epublic/live/g1736/build/graphics/g1736-2.jpg
Tank/Backpack Rinsing

- Some oil formulations such as 2,4D may leave residues that can stay in tank & cause harm to plants if not thoroughly cleaned out
- To remove oily residue household ammonia is used
CHAPTER 5:
PESTICIDES IN THE ENVIRONMENT
Particle Drift

Movement of spray particles, usually by the wind resulting in misapplication

Prevent drift by NOT spraying when:
- Winds are over 10mph
- Winds are shifty
- Winds are blowing towards sensitive areas
- During periods of calm/inversions
Vapor Drift

- Vapors formed after application
- Carried out of target area, volatilization
- Can occur up to several days after application - can result in damage
- If some products used in hot weather (Garlon 4)
  *Labels list if herbicide is prone to volatilization, so switch to another formula (Garlon 3a) on those days

Both vapor & particle drift can result in off-target damage to vegetation and people
Factors likely to increase drift

- small droplet size (under 200 microns)
- wind or air currents
- sprayer a large distance from the target plant
- high temperatures with increased evaporation rates
Movement of Pesticides by Water

- Movement of pesticides out of the target area and into groundwater or surface water

Leaching, Seepage

Application prior to rainfall

Runoff into surface water

Reduce this by

- Nozzle pressure
- Droplet size
- Spray height
Run-In and Leaching

Run-In
- when pesticide moves directly from soil surface to groundwater below

Leaching
- movement of pesticides downward in the soil profile with percolating water
- can contaminate groundwater

Pesticides degradation (breakdown)
- is much slower in ground water because of the low oxygen and light conditions
Leaching more likely if

- Pesticide over-applied
- Applied to sandy soil
- Pesticide properties
- Applied before heavy rain or irrigation
- Spills not cleaned up
4 factors determine if Pesticides Reach the Groundwater

- Pesticide properties
  - persistence, adsorption and solubility
- Soil properties
  - soil texture and organic matter
- Site conditions
  - depth of groundwater, slope & climate
- Management practices
  - mishandling, not following directions or label

Example - Leaching occurs more on sandy soil or runoff on sloped areas
Protect Water Resources

- Check weather forecasts & delay application if rain is predicted
  - Always have back up plans
Backsiphonining

- To prevent back-siphonining of pesticide back into the water supply by keeping an air gap or using anti-siphonining devices on garden hoses (page 45)
Water advisory statements on labels

- These are related to leaching & runoff issues
  - May not be mixed or loaded within 50 feet of intermittent streams...
  - May not be applied aerially or by ground within 66 feet of the points...
  - May not be mixed, loaded or used within 50 feet of all wells and sinkholes...
Spills

- Do everything to stop the spill
- Attend to injured people, wear your protective equipment
- Confine spilled pesticides
- Contact the proper authorities for large spills
- For large spills contact Illinois Emergency Management Agency (IEMA)
- Remove the spilled materials
Protecting Nontarget Species

1. Use pesticides with low bee toxicity
2. Spray when bees are not active (before dawn/after dusk)
3. Notify the beekeeper to remove bees
   - 48hr prior to spraying if within 3 miles

- Remember:
  - microencapsulated formulas are harmful to honeybees
  - endangered plant & animal species are protected by the U.S. Fish & Wildlife Service
Applications

- **Spot**
  - Treat only a portion of the total area
  - Used to control pests that are clustered

- **Band**
  - Treat only a narrow strip
  - Over/alongside a row of desirable plants & areas between untreated
  - Uniformly within the band

- **Broadcast**
  - Treat the entire area or field
  - Most uniformity throughout field
Pumps move liquids & create pressure for spraying solutions

- Centrifugal- low pressure up to 140psi & high volume
- Roller- medium pressure up to 300 psi & higher volume
  - not as many gallons per minute as above
- Diaphragm- medium-high pressure up to 725psi & medium flow
- Piston- high pressure up to 1,000 psi and low flow
  - cannot be used with abrasive formulas
Most pesticide solutions need to be mixed to keep pesticide from settling out

- **Hydraulic agitation**
  - Solution circulates through the pump & back into tank to mix solution

- **Mechanical agitation**
  - Uses paddles instead

- If sprayer not equipped with agitation do not use it to apply pesticides that may settle out of the solution
Hoses used must be the right size, strength & material for flow, pressure and type of chemical

- If hose damaged replace it with same material & size
- Hose of wrong material is dangerous may become weak & break

- Oversized hoses
  - may allow pesticides to settle out before sprayed

- Undersized hoses
  - Restrict flow & pressure
Strainer & Pressure Gauge

- **Strainers**
  - Filters made of slotted metal, wire or plastic mesh that prevent foreign objects in solutions from damaging equipment.

- **Pressure Gauge**
  - Allows applicator to see pump is working properly.
  - Monitor application problems:
    - Rise or drop in pressure.
Nozzles for boom spraying

- **Flat fan** - thin sheet of spray more in the center of fan
- **Even flat fan** - thin sheet spray with uniform deposit
- **Hollow cone** - sprays in a circle, no droplets in center
- **Solid cone** - sprays in a circle droplets throughout

To clean nozzles
- Turn off flow
- Clean with brush non damaging brush
Boom Sprayer Height

- Raising the boom sprayer does what?

It increases overlap, but it also increases the amount of drift.
Boom Sprayer Height

- Lowering the boom sprayer does what?

Reduces drift & overlap

http://www.arnoldsinc.com/cih-sprayers.htm
Make sure to have simple calculator ready
Cell phones are not allowed for calculator
Formulas given on test - back of book

Abbreviations
Weights
Linear Measurements
Area Measurements
Fluid Measures
Aquatic Liquid Measures
Formulas
- Given but often do not spell out abbreviations
~5 questions- lets look at formulas

Gallons per Minute:

GPM = GPA x MPH x W (effective width sprayed per nozzle in inches)

GPM = GPA x MPH x SW (swath width, in feet)

Gallons per Acre

GPA = \frac{GPM \times 5,940}{MPH \times W} (effective width sprayed per nozzle in inches)

GPA = \frac{GPM \times 495}{MPH \times SW} (swath width, in feet)
18. What Gallons per Minute (GPM) should your nozzles provide if you want to apply 30 GPA traveling 8 MPH with nozzles 20-inches apart?

Which formula do we use we want GPM as answer?
18. What GPM should your nozzles provide if you want to apply 30 GPA traveling 8 MPH with nozzles 20-inches apart?

Answer is in GPM and question is in inches

Formula to use: \( \text{GPM} = \text{GPA} \times \text{MPH} \times W \text{ inches} \)

5,940
18. What GPM should your nozzles provide if you want to apply 30 GPA traveling 8 MPH with nozzles 20-inches apart?

Answer is in GPM and question is in inches

Formula to use: \[ \text{GPM} = \frac{\text{GPA} \times \text{MPH} \times W \text{ inches}}{5,940} \]

\[
\begin{align*}
= & \quad \frac{30 \text{ GPA} \times 8 \text{ MPH} \times 20”}{5,940} \\
= & \quad 0.81
\end{align*}
\]
3. How many square feet are in a circle 80 feet in diameter (across)?

Area of a circle = 3.14 x radius squared

Diameter is twice the radius so 80/2 = 40

= 3.14 x 40 x 40

= 5,024 sq. ft.
To convert a dry a.i. rate to a product rate, use this equation:

\[
\text{lb of prod per A} = \text{lb of a.i. per A} \times \frac{100\%}{\text{% a.i. for prod}}
\]

To convert a liquid a.i. rate to a product rate, use this equation:

\[
\text{gal of prod per A} = \frac{\text{lb of a.i. per A}}{\text{lb of a.i. per gal of prod}}
\]

To convert a dry product rate to an a.i. rate, use this equation:

\[
\text{lb of a.i. per A} = \text{lb of prod per A} \times \frac{\text{% a.i. in prod}}{100\%}
\]

To convert a liquid product rate to an a.i. rate, use this equation:

\[
\text{lb of a.i. per A} = \text{gal of prod per A} \times \text{lb of a.i. per gal of prod}
\]
7. How much of a 20G pesticide is needed to provide 1 pound of A.I.? 

Wet or dry?

Since dry it says:

20G means 20 % per as a decimal .20 – G stands for Granular (dry form)
7. How much of a 20G pesticide is needed to provide 1 pound of A.I.?

Dry 20%
7. How much of a 20G pesticide is needed to provide 1 pound of A.I.?

20G means 20% per (or as a decimal .20)

\[
\text{1 pound of a.i. } \times \frac{100\%}{20\% \text{ a.i. per product}} = 5 \text{ pounds}
\]
8. How many pints of a 8 EC pesticide is needed to provide 1 pound of A.I.?

Wet or dry?

Since liquid it says:

8EC means 8 lbs of active ingredient per gallon of product—since EC stands for Emulsifiable Concentrate (liquid form)
8. How many pints of a 8 EC pesticide is needed to provide 1 pound of A.I.?

Liquid →

8EC means 8lbs per gal.
8. How many pints of a 8 EC pesticide is needed to provide 1 pound of A.I.?

8EC means 8 lbs of active ingredient per gallon of product

\[
\frac{1 \text{ pound of a.i.}}{\_\_\_\_\_\_\_\_\_} = 0.125 \text{ gallons} \quad \text{(we need pints)}
\]

8 lb of a.i. per gallon of prod
1 pound of a.i. per = .125 gallons
8 lb of a.i. per gallon of prod

.125 gallons x 128 fluid ounces = 16 fluid ounces

1 gallon

16 fluid ounces x 1 pint = 1 pints

16 fluid ounces
Insecticide Act of 1910

- Truth in Labeling Act
- Required chemical producers to label packages with the word “poison”
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)- 1947

- Regulates the use of pesticides to protect humans, wildlife and the environment
- Administered by the U.S. EPA
- Pesticide user assurance
- Pesticide registration
  - general use
  - restricted use- too hazardous for general public
Federal Environmental Pesticide Control Act (FEPCA)- 1972 Amendment

- Extended federal authority to cover pesticide manufacturing, shipment and use
- Made the product label a legal document
- Products used in US to register with U.S. EPA
- Requires states to laws paralleling FIFRA
- Classified products general use & restricted use pesticides
1975 Revisions

- Added provisions for state enforcement
- Misuse penalties
- Cooperative Extension Services to inform & educate pesticide uses
- Strengthened certification & restricted uses
Food Quality and Protection Act (FQPA)- 1996

- Tolerance reevaluation
- Special provision for infants and children
- Endocrine disruptor testing
- Minor use registrations
- Right to know
- Regulations for employers with 10 or more employees
- “Worker Right-to-Know” intended to protect our nations workers
- Dissemination of chemical safety information on labels, SDS’s & training programs
- SDS sheets are to be available to employees
Clean Water Act (CWA)

- Regulates water pollution in navigable waters
- Including pesticide spills or point sources that enter these water from urban & agricultural sources

http://mjcdn.motherjones.com/preset_16/frontline.jpg
Illinois Department of Public Health (IDPH)

- Administers Illinois Structural Pest Control Act
  - Protect public health by setting standards
  - To control pests inside or under structures
  - Licensing restricted pesticide use
    - commercial businesses
    - Individuals- technician certs.

Indoor pests, rodents, wood treatment, fumigation, bird, termites, food storage

http://www.padminipestcontrol.com/images/pests.gif
Illinois Pesticide Act regulates:
- Pesticides
- Agricultural Pesticides
- Certification & Licensing
- Misuse Investigation

http://www.environmentalhealthnews.org/ehs/images/2008/pesticide-spray%20besemer.jpg
- Hazardous waste laws
- Spills and illegal disposal
- Laws regulating air, land and water quality
Lawn Care Products Application & Notice Act

- Any applicator that applies lawn care products
- Requires the placement of markers immediately after application is made
  - Must be placed at the points of entry into the area
- Requires containment area must be used for the loading of products for distribution to a customer
  - Intercept, retain, recover & reuse pesticide spills
  - Portable & non-portable containment areas
    - Permitted & installed provided they are constructed of impervious materials compatible with pesticide
Worker Protection Standards (WPS)

- Protects agricultural workers & pesticide handlers in farms, forests, nurseries & greenhouses
  - Facts about each pesticide application
  - Provide safety training
  - Decontamination areas with clean up supplies—water/soap/towels
  - Emergency assistance from poisoning/injury
Record-keeping requirements

- Restricted Use - All certified applicators are required to keep records
  - Private Applicators - recorded within 14 days & kept 2 years
    - Pesticide product name & USEPA reg. #
    - Amount applied
    - Size of area treated
    - Site treated
    - Location
    - Date
    - Applicators name & certification #
Commercial Applicators

- Addition to above private requirements
- Federal regulations state they must also furnish a copy of State or Federal records to customer within 30 days of application
Chapter 1: Integrated Pest Management
Chapter 2: Understanding Pesticides
Chapter 3: Labels & Labeling
Chapter 4: Human Pesticide Protection
Chapter 5: Pesticides in the Environment
Chapter 6: Application Equipment & Calibration
Chapter 7: Pesticide Laws & Regulations