

# *Chapter 1*

## **Principles of Pest Management**

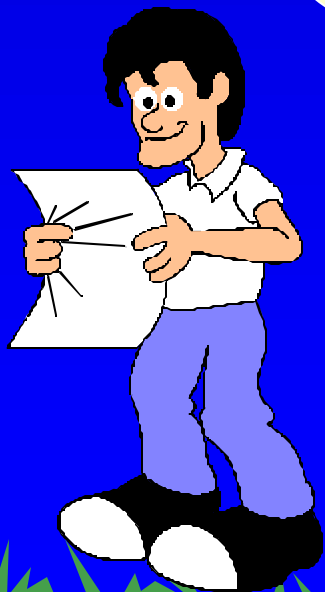


# *Right of Way Areas*

- Highways
- Utility areas
- Pumping stations
- Drainage ways
- Railroads, airports
- Paths and trails

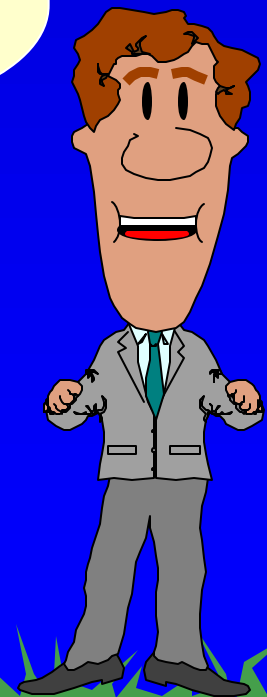


Integrated Pest Management  
(IPM) uses all available tactics  
and strategies to manage pests.  
Minimal impact to the  
environment.

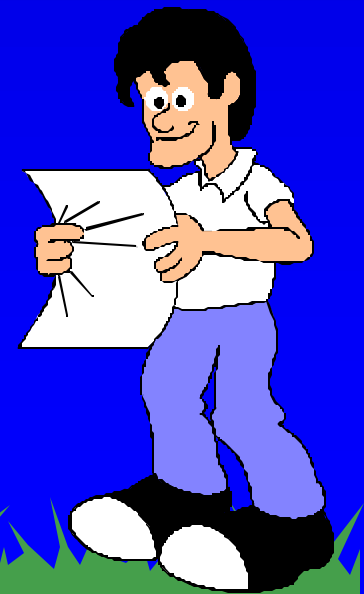


In right-of-way pest management,  
woody and herbaceous plant species  
are the major pests.

Not easy to define a crop-pest  
relationship.-



The “crop” of right-of-ways is the services the right-of-way provides.



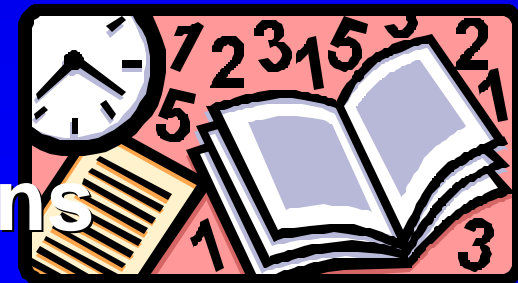
# *Right of Way IPM Components*

- Pest identification
- Monitoring
- Site specific requirements
- Development & implementation of control strategies
- Evaluation of effectiveness



# *Record Keeping*

- Control measures, dates
- Pesticides & related info
- ID of crew & equipment
- Environmental conditions



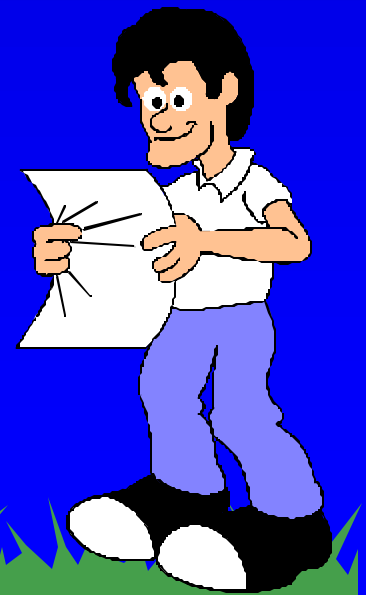
# *Pest Management Techniques*

- **Biological control**
- **Cultural control**
- **Mechanical control**
- **Chemical control**





Biological controls focus on enhancing the effects of natural enemies.



# Allelopathy

**Production by plants of chemicals that inhibit the growth of nearby plants.**

- black walnut
- quackgrass
- sunflower



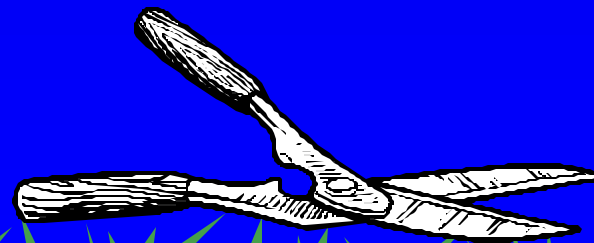
# *Cultural Controls*

- Time of planting
- Nurse crops
- Controlled burning
- Mulching
- Shading
- Sanitation



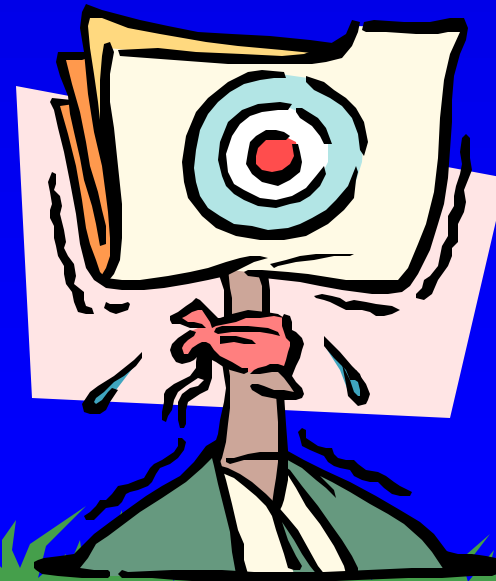
# *Mechanical Control*

- **Mechanical / manual**
- **Mowing, trimming, cutting**
  - mowing height must control weed plants and encourage desired vegetation



# *Chemical Control*

- Flexibility
- “Brown out”
- Timing.. Limited
- Public Perceptions



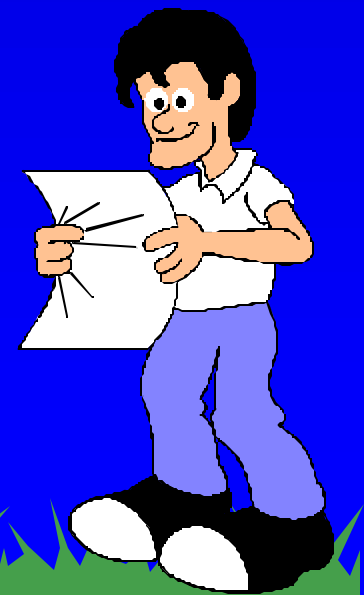
# *Site Requirements & Pest Species*

- **Will help to determine...**
  - pesticide to use
  - application technique
  - timing
  - equipment selection
  - mixing rate and additives



**Attitudes have changed.**

**Not all woody vegetation  
is considered undesirable.**



# *Environmental Concerns*

- Wetlands are critical sensitive to chemicals
- Use extreme care to avoid exposing wetlands and surface waters to pesticides
  - use a anti-back flow device



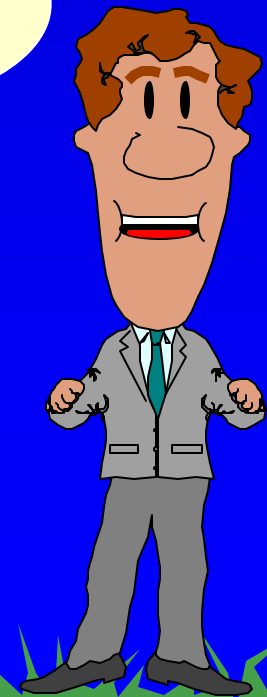
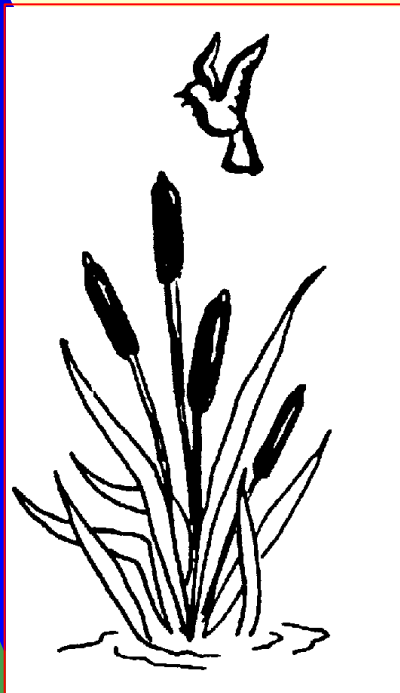


# *Chapter 2*

## **Weed Plants and Trees**



**Weed = any plant  
growing where it is not  
wanted.**



# *Developmental Stages*

- **Seedling**
- **Vegetative**
- **Seed Production**
- **Maturity**



# *Plant Types*

## ■ Annual

— summer

— winter

## ■ Biennial

## ■ Perennial



# *Plant Classification*

## ■ Grasses

- monocots, fibrous root system, growth point at soil surface, annual or perennial

## ■ Sedges

- similar to grasses, triangular stems, perennial



# *Plant Classification*

## ■ **Herbaceous broadleaves**

- annual, biennial, perennial
- net like venation
- dicots
- diverse growth points
- underground reproductive systems



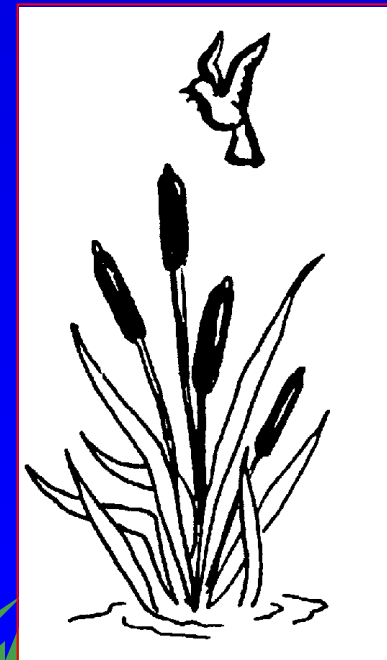
# *Plant Classification*

- Vines
- Brush & trees
- Ferns
  - spore reproduction, rhizomes
- Parasitic seed plants
  - dodder



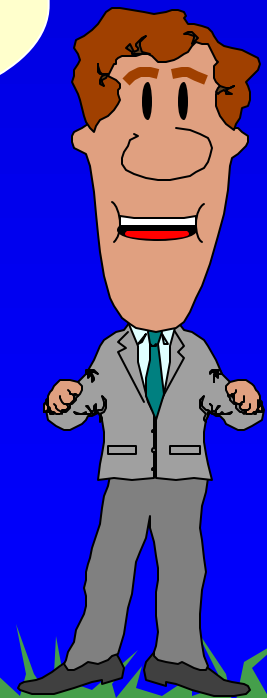
# *Aquatic Plant Classification*

- Emergent
- Floating
- Submergent
- Algae



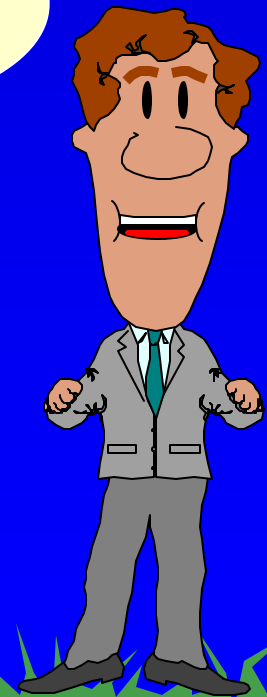


**Submergent plants have a thin outer layer on their leaves and are very susceptible to herbicide injury.**



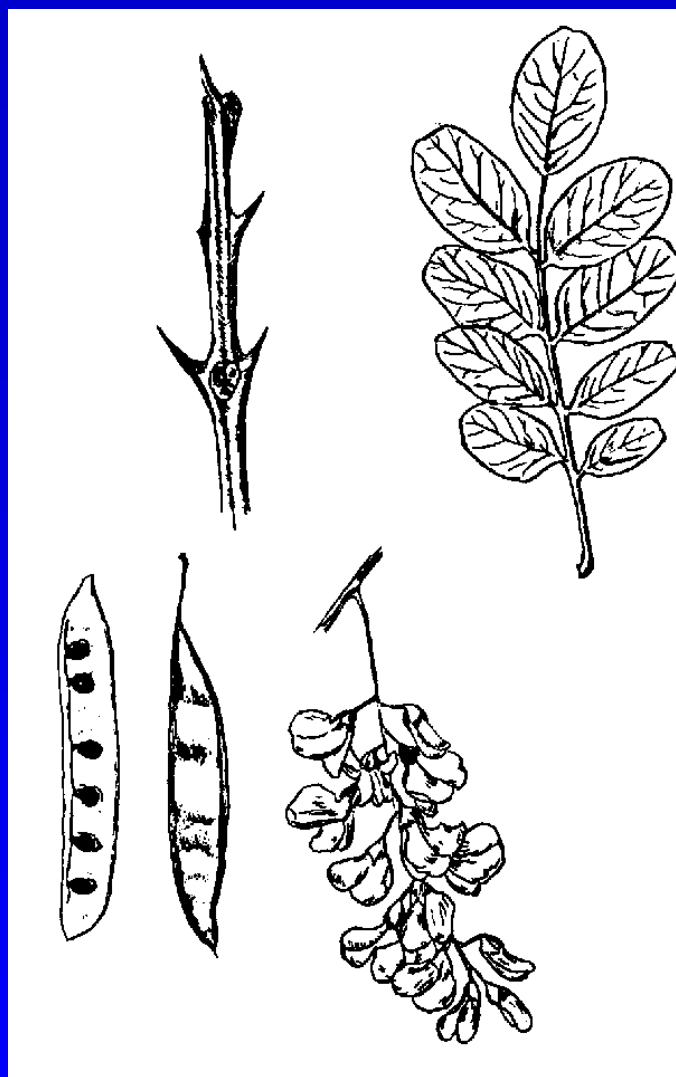
You must obtain a permit from DEQ (DNR) to control aquatic plants.

Excluding: < 2 acres, no outlet, not RUP

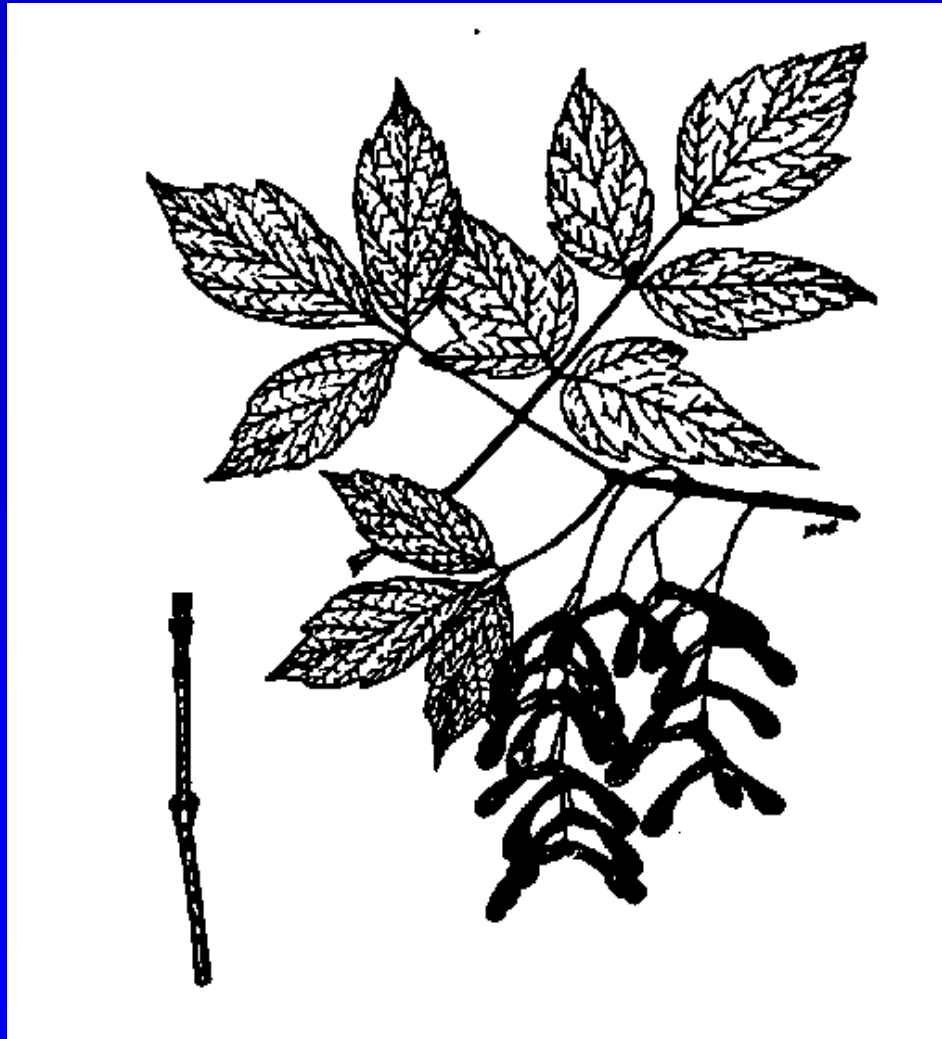




Ash: black, white, green

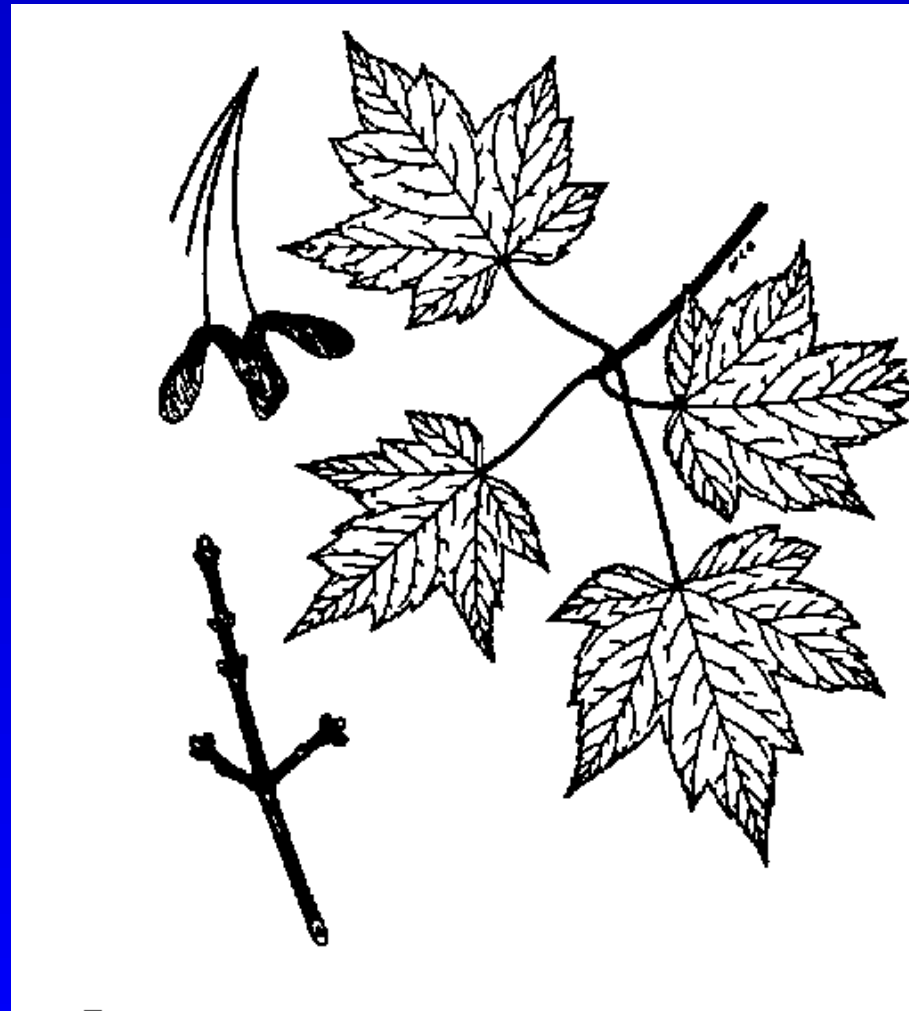


Black locust



Boxelder: ash- leaf maple



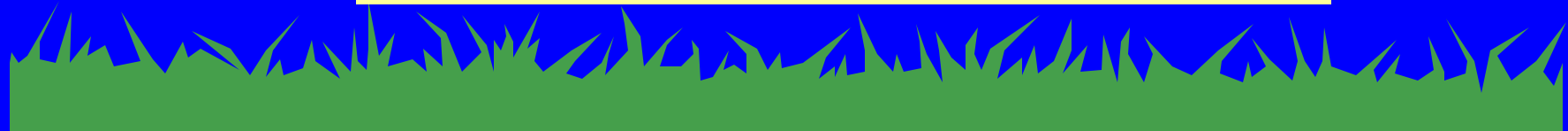


Red maple (soft maple)





Sassafras

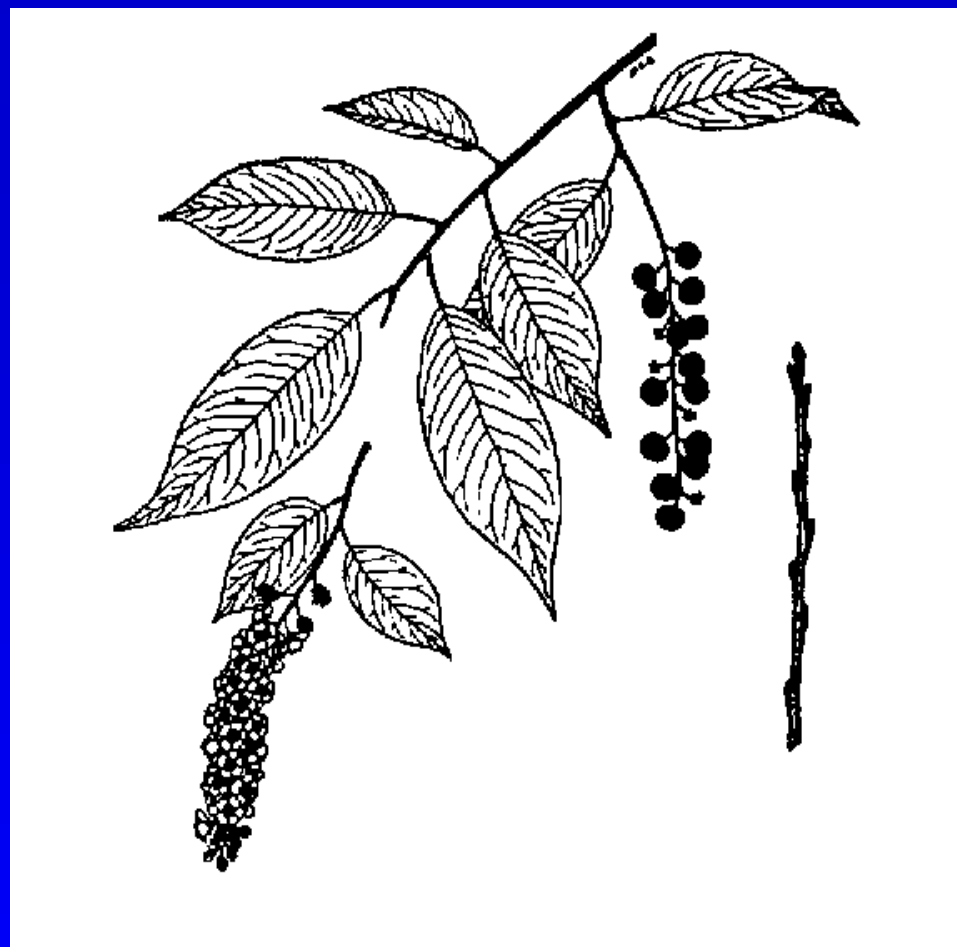




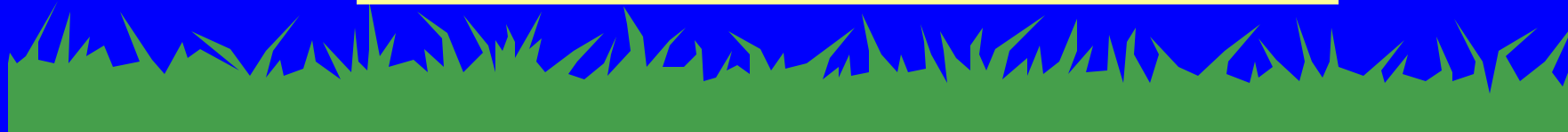
Black willow

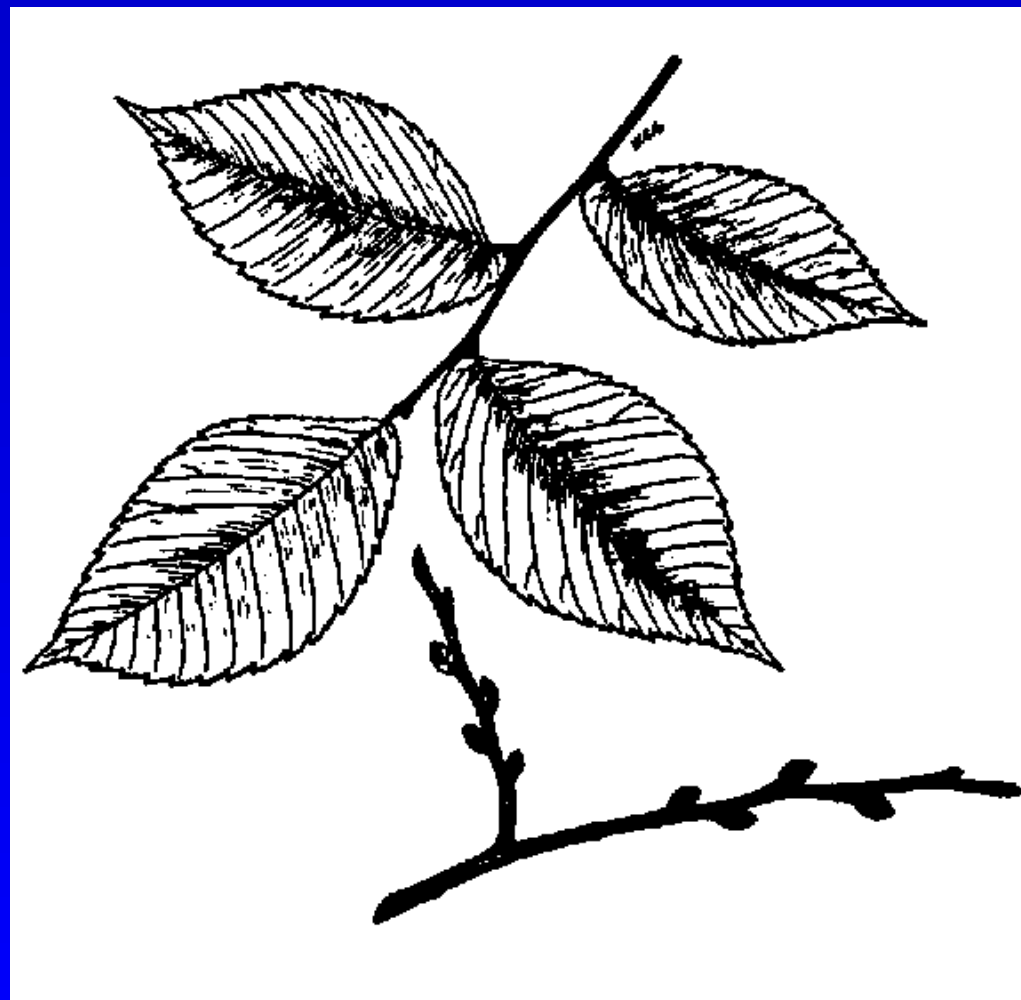




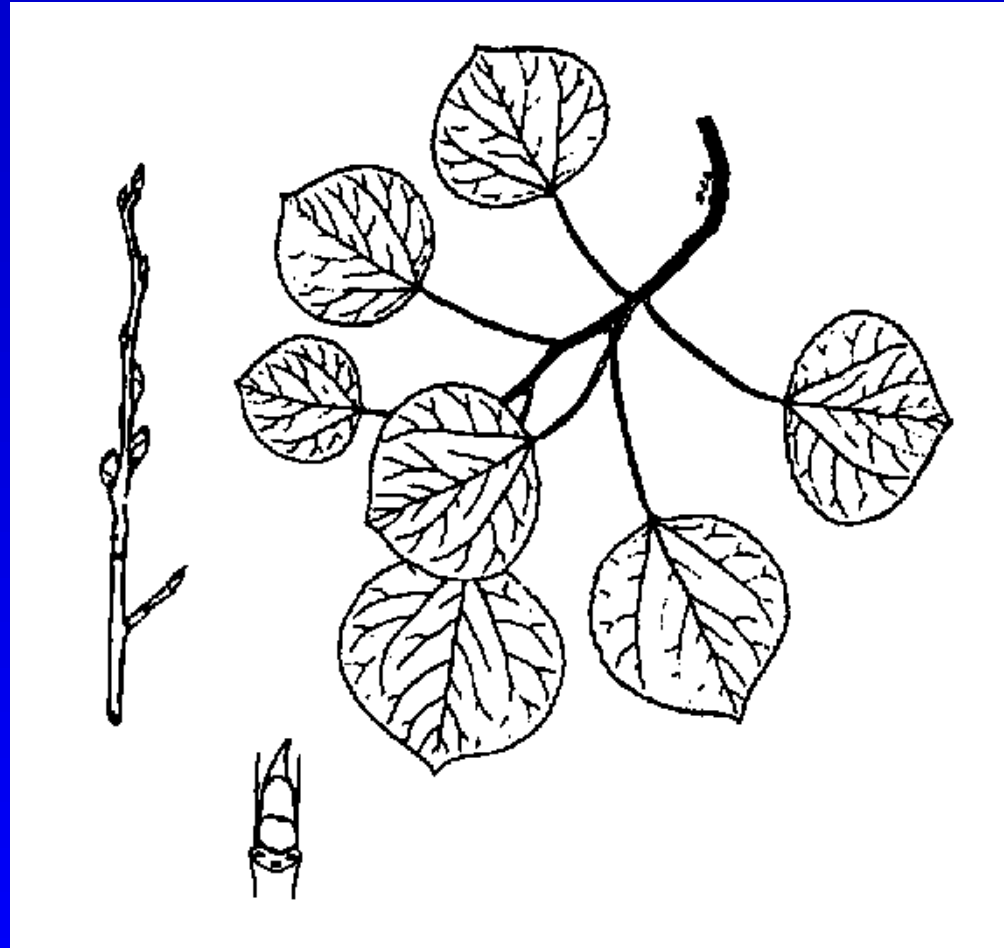


Black cherry



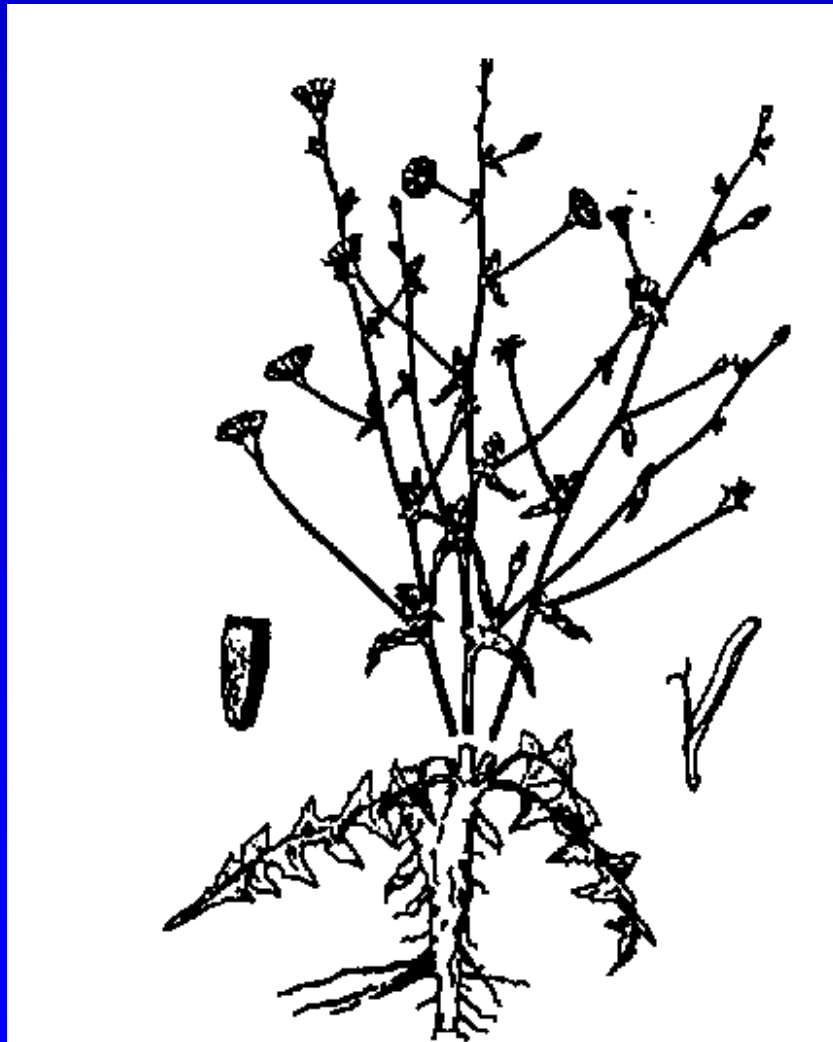


American elm

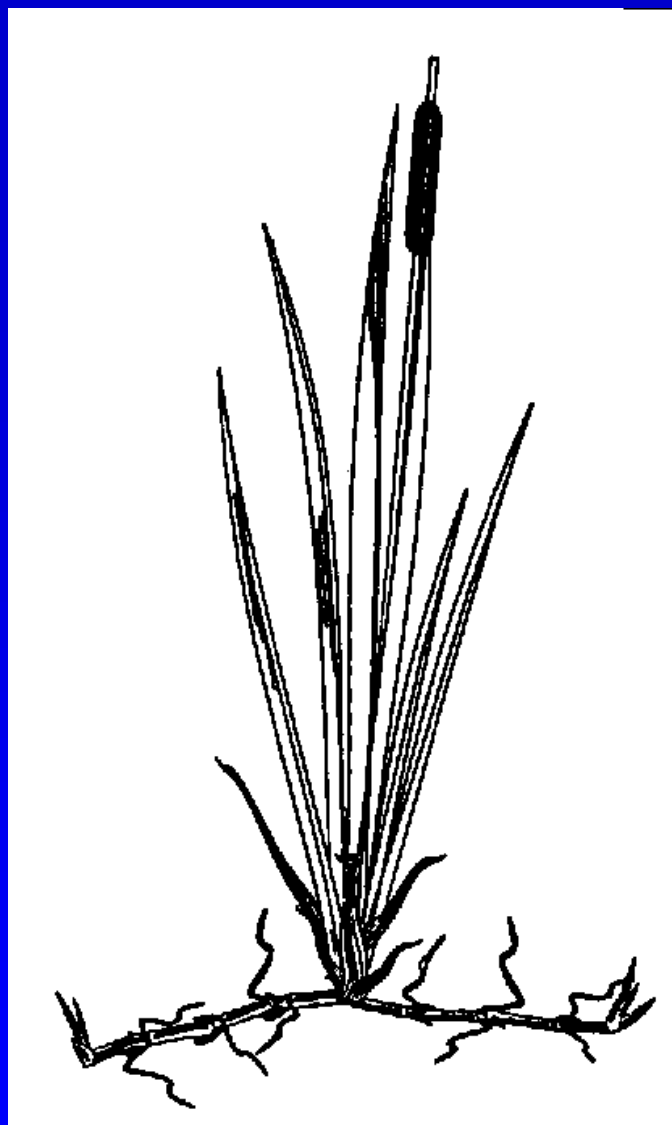


Trembling aspen, poplar





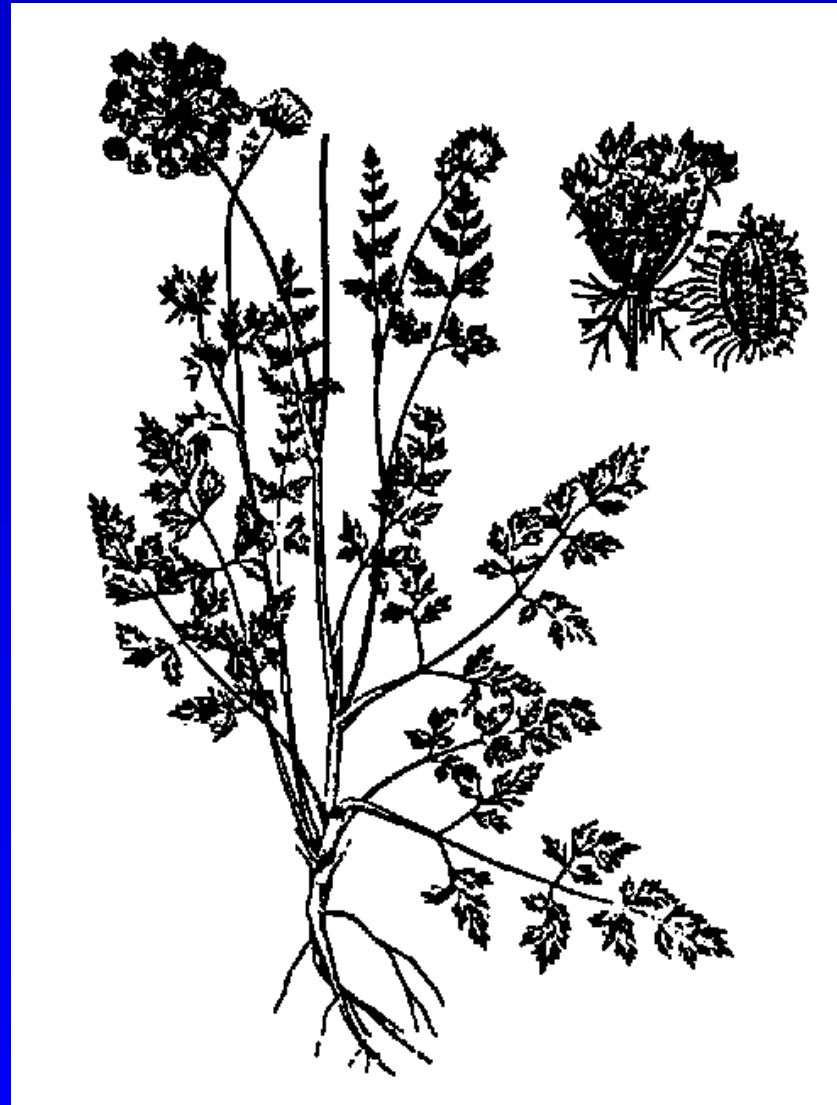
Chicory



Cattail



Goldenrod



Wild carrot (Queen Anne's lace)



Poison ivy





Canada thistle



Musk Thistle



Purple loosestrife



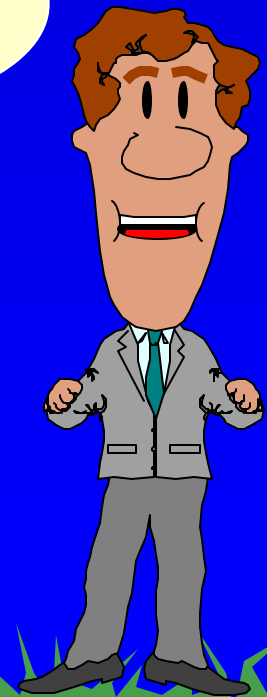
Phragmites

# *Chapter 3*

## **Herbicides & Weeds**

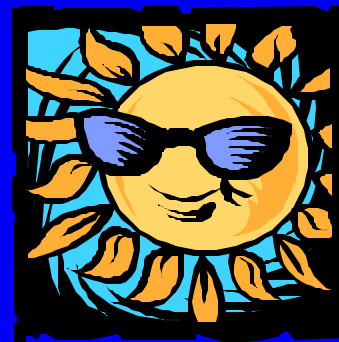


Herbicides are  
pesticides that control  
weeds.



# *Factors Affecting Herbicidal Action*

- Herbicidal action characteristics
- Plant characteristics
- Climatic factors



# *Herbicidal Action Characteristics*

- Foliage or root absorbed
- Contact or translocated
- Persistent or non- persistent
- Selective or Non- selective





# *Plant Characteristics*

- Growing points
- Leaf shape
- Wax & cuticle
- Leaf hairs



# *Plant Characteristics*

- **Deactivation**
- **Stage in life cycle**
- **Timing of stages in life cycle**



# *Climatic Factors*

- **Relative humidity**
- **Light**
- **Precipitation**
- **Wind**
- **Temperatures**
- **Length of growing season**



# *Temperature Inversions*

- Ground air cooler than air above
- Can suspend pesticide particles
- Particles can move to non-target areas

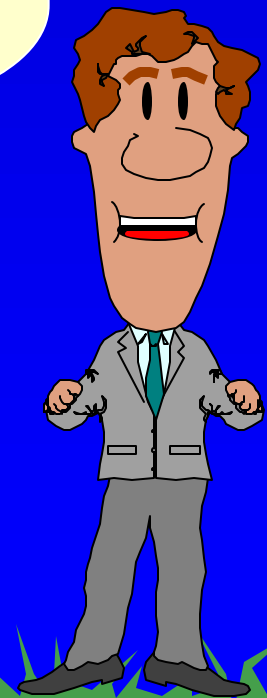


# *Selective Herbicides*

- Foliage spraying
- Basal spraying
- Granular or pellet
- Spotgun
- Cut surface



Foliage treatments can be done from full leaf to early fall color.



# *Low Volume Ground Foliage Treatment*

- 10 to 100 gal per acre
- Not treated to point of runoff
- Higher concentration of active ingredient
- Faster coverage
- Drift can be major concern



# *High Volume Ground Foliage Treatments*

- Herbicide concentration rather than rate per acre
- Spray to “drip”
- Larger volumes of mix
- Herbicide amount will vary considerably



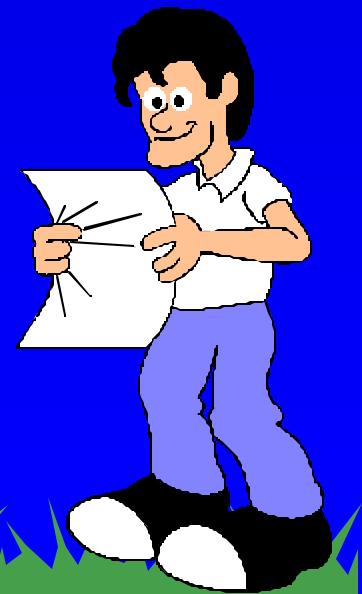


# *Aerial Application*

- Helicopters used most often
- Pilot must be certified in...
  - right-of-way
  - aerial application
- Commonly used in rough terrain



**Basal treatment can be applied any time of year, except with snow or ice.**



# *Basal Spray Methods*

## ■ Conventional basal spraying

- spray to wet or run down
- fuel oil carrier
- lower concentrations
- losing popularity
  - ◆ cost
  - ◆ odor



# *Basal Spray Methods*

## ■ Low Volume Basal Spraying

- more concentrated
- not sprayed to wet
- light & compact equipment
- more like spray painting



# *Granular Application*

- Broadcast
- Directed



# *Spotgun*

- Liquid herbicide applied to a “spot” in the root zone area.
- Similar to a granular stem treatment
- More effective in sparse vegetation
  - fewer risks to non- target plants

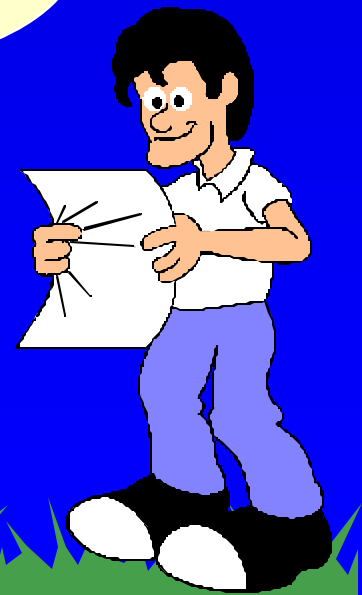


# *Cut Surface Treatments*

- **Cut stump, frilling, hack & squirt, girdling**
- **Errors**
  - too much chemical
  - improper girdling or frilling
  - applying too close to desirable vegetation



**Non-selective herbicides control most plant species. Many last 1+ years. Easily damage non-target plants.**





# *Factors Affecting Non- Selective Herbicides*

- **Soils**
- **Moisture**
- **Vegetation types**
- **Soil microorganisms**



# *Non- Selective Herbicides*

- Keep away from root zones of desirable plants
- Do not apply to frozen ground
- Be careful of residual herbicides on slopes
- Use low pressure
- Choose non- corrosive materials



# *Other Chemicals*

## ■ Defoliant

- removes foliage

## ■ Dessicant

- dries foliage

## ■ Plant growth regulator

- affects some aspect of plant development-

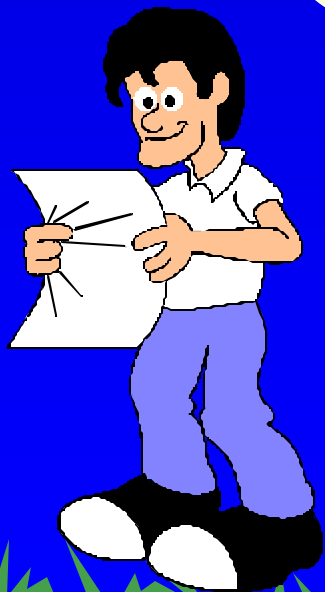


# *Chapter 4*

## **Plant Growth Regulators**



A plant growth regulator is a chemical that alters a plant's vegetative growth or reproductive characteristics.

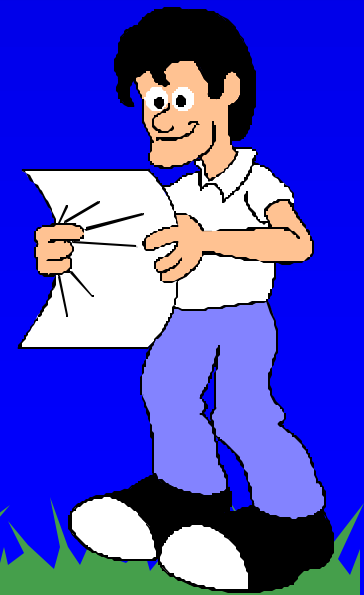


# *Growth Regulators*

- **Anti- gibberellins or inhibitors**
  - inhibits production of hormone that controls cell elongation
- **auxin type**
  - similar to natural plant chemicals
    - ♦ 2,4-D, dicamba
  - growth regulators at sub lethal dose



Growth regulators are regulated by FIFRA as pesticides. Handle accordingly.



# *Tree Growth Regulation*

- **Gibberellin inhibitors block cell elongation**
- **Soil or trunk injected**
  - move in xylem to growth points
- **Activity depends on....**
  - tree species
  - application rate
  - environmental conditions
  - trimming severity





# *Tree Growth Regulation*

## ■ Sprout inhibitors

- incorporated into wound dressing materials
- inhibit production of suckers or water sprouts

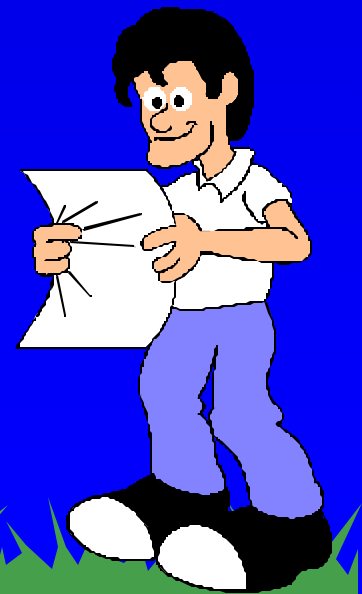


# *Roadside Turf Regulation*

- **Suppress seedhead development**
- **Reduce growth...**
  - for 2 to 6 weeks
  - applied in spring before seedhead formation
  - treated turf is often darker green
  - different grasses respond differently



Broadleaf herbicides can often be mixed with growth regulators. Check labels carefully.



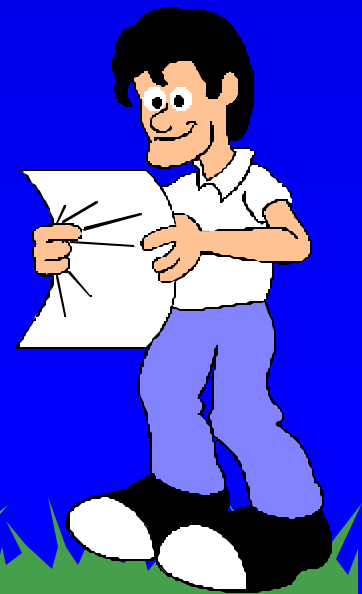
# *Roadside Turf Regulation*

## ■ **Selecting & using regulators...**

- results from the type of regulator
- rates vary by species
- timing affects results
- growth stage affects results
- environmental conditions impact results



Rates are crucial. Small changes can have major impacts. Read label carefully.



# *Chapter 5*

## **Other Right- of- Way Pests**



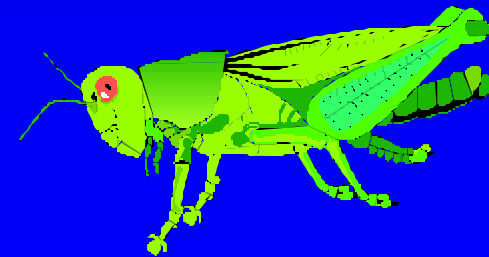
# *Pests*

- **Plants are the major right-of-way pests.**
  
- **Others could include...**
  - insects
  - diseases
  - vertebrates



# *Insect Pest Management*

- **Insects can damage or destroy desirable plants**
  - sucking sap, defoliation, boring
- **To control insects, you should understand....**
  - insect biology
  - insect life cycles

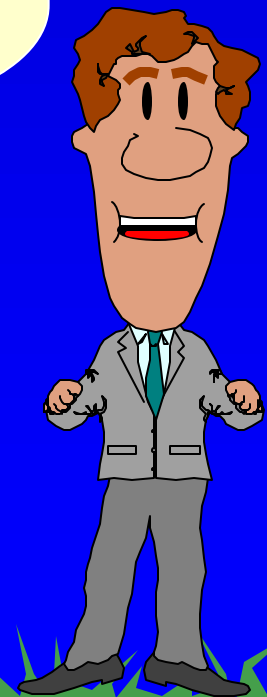




Periodically inspect for signs of insects and symptoms of their damage.

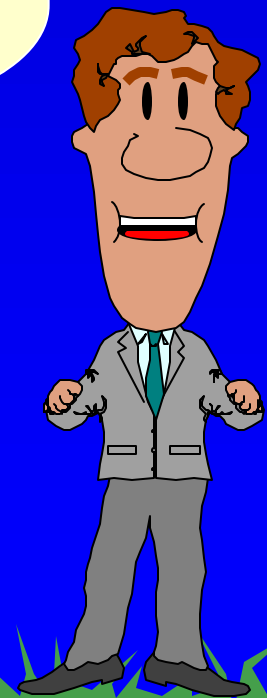
Damaging insects have...

- chewing mouthparts
- piercing-sucking mouthparts



Manage insects with the principles of IPM.

Life cycles are important in designing an IPM approach.



# *Metamorphosis*

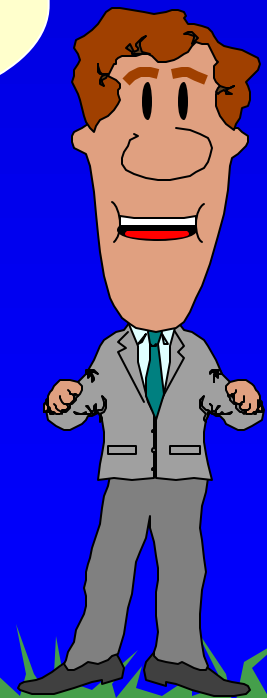
- **None, no change**
- **Gradual**
  - young nymphs resemble adults and feed in same habitat
- **Complete**
  - egg, larval, pupal, adult
  - not all life stages may feed the same



Early life stages...

- small larvae
- first nymphs

Are easier to control.



# *Chewing Mouthparts*

## ■ Types of insects

- grasshoppers, beetles, caterpillars, borers, grubs

## ■ Signs of activity (damage)

- missing foliage, skeletonized foliage, bore holes, frass, sawdust, dying grass, no roots



# *Piercing- sucking Mouthparts*

## ■ Types of insects

- aphids, scales, plant bugs, leaf hoppers, \* mites

## ■ Signs of activity (damage)

- honeydew, sooty mold, distorted foliage, foam, encrustations

♦ \* not a true insect



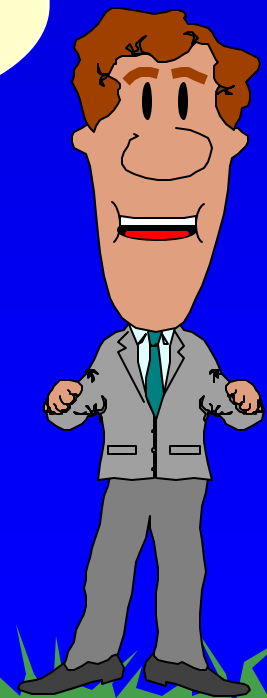
# *Insect Control Methods*

- **Host resistant**
- **Biological control**
- **Cultural control**
- **Mechanical control**
- **Sanitation**
- **Chemical**



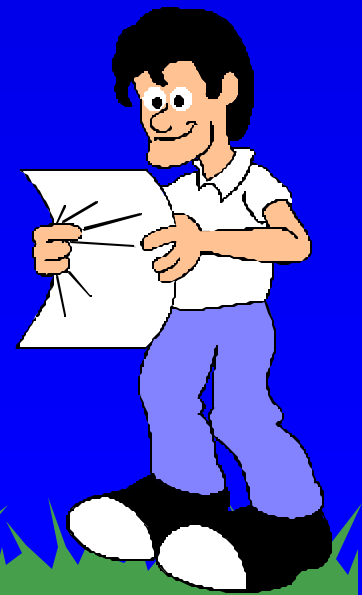
Many insects attack weakened or stressed plants.

Healthy plants withstand pest attacks.

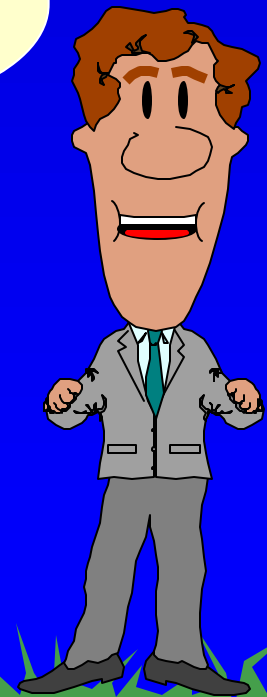




Plant selection is crucial for reducing plant and pest problems!



Disease is any  
departure from normal  
plant growth..



# *Causes of Disease*

- **Virus**
- **Bacteria**
- **Fungi**
- **Environmental factors**
- **Cultural practices**



# *Symptoms of Disease*

## ■ Over- development

- galls, swellings, leaf curls

## ■ Under- development

- stunting, lack of chlorophyll, incomplete development

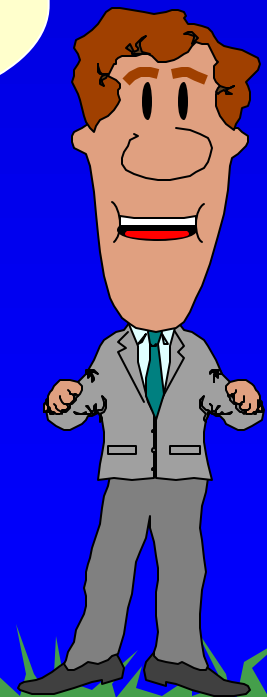
## ■ Death of tissue

- blights, leaf spots, wilting, cankers

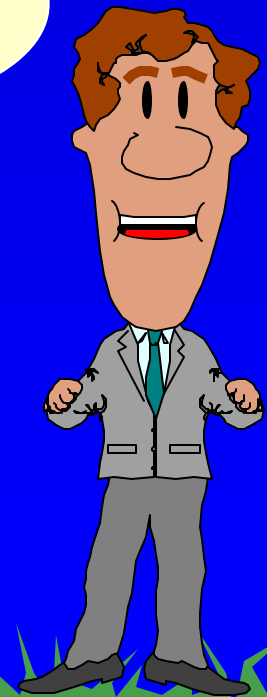


Remember, different  
causes can produce the  
same symptoms!

Healthy plants live longer!



Avoiding using the same  
spray equipment for  
herbicides and pest  
management.



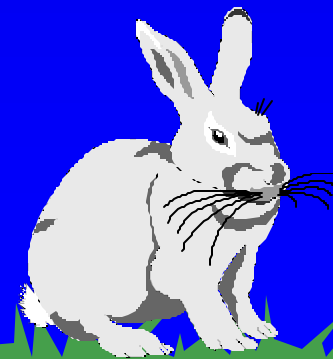
# *Pests in Wood*

- **Wood structures can be invaded and damaged by...**
  - insects
  - fungi
- **To treat wood, you must be certified in category 2A**



# *Vertebrate Pests*

- **Animals with a backbone**
  - mice, rats, beavers, rabbits, deer, woodchucks
- **For control, permits are required from MDNR**
  - check before acting
  - small rodents exempt





# *Vertebrate Control*

## ■ Mechanical

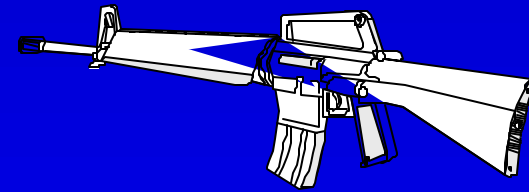
- traps

  - ◆ non- target hazard

## ■ Sanitation

## ■ Chemical

- non- target hazard



# *Chapter 6*

## **Equipment & Calibration**



# *Equipment Selection*

## ■ Depends on...

- target
- type of application
- pest to be controlled
- pesticide formulation

## ■ Equipment

- liquid sprayers, granular applicators, injectors, aircraft



Calibration of equipment is crucial to obtain the correct application rate according to the label.



# *Pesticide Deposit*

## ■ Deposit on target depends on...

- concentration in tank
- rate of discharge
- equipment speed
- swath width
- ◆ evaporation and drift excluded



# *Application Equipment Components*

- Tanks
- Agitators
- Strainers
- Pumps
- Pressure Regulators
- Pressure Gauge
- Hoses
- Nozzles



# *Tanks*

- Large enough for tasks
- Stainless steel and fiberglass are best
- Shut off valve required



# *Agitators*

## ■ Pesticide formulation determines agitation requirement

- liquid conc., soluble powders, emulsions....
  - ♦ Less.... By- pass
- wettable powders
  - ♦ more... mechanical



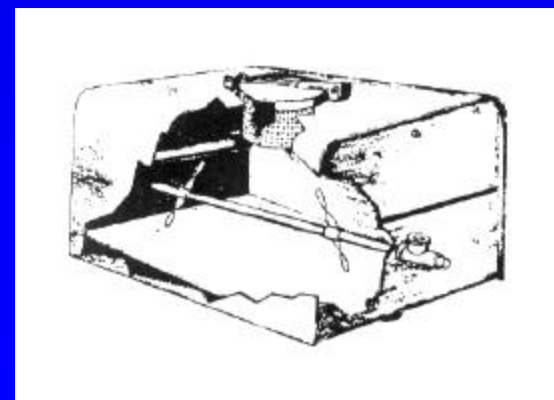


# *Agitators*

- **Mechanical**

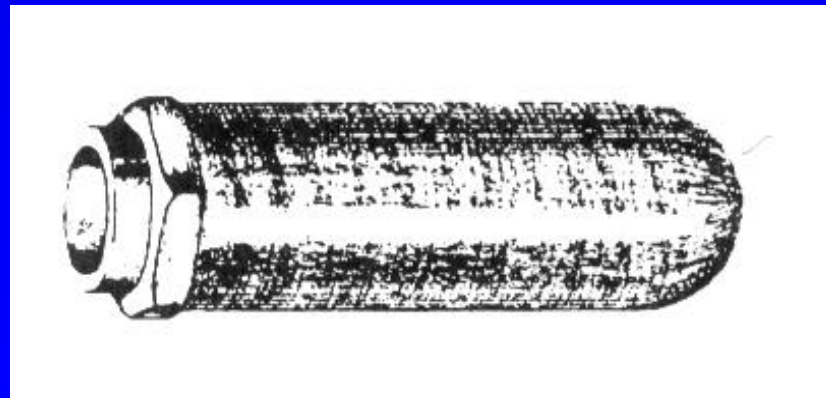
- **Hydraulic**

- by pass from pressure relief valve  
may not be sufficient



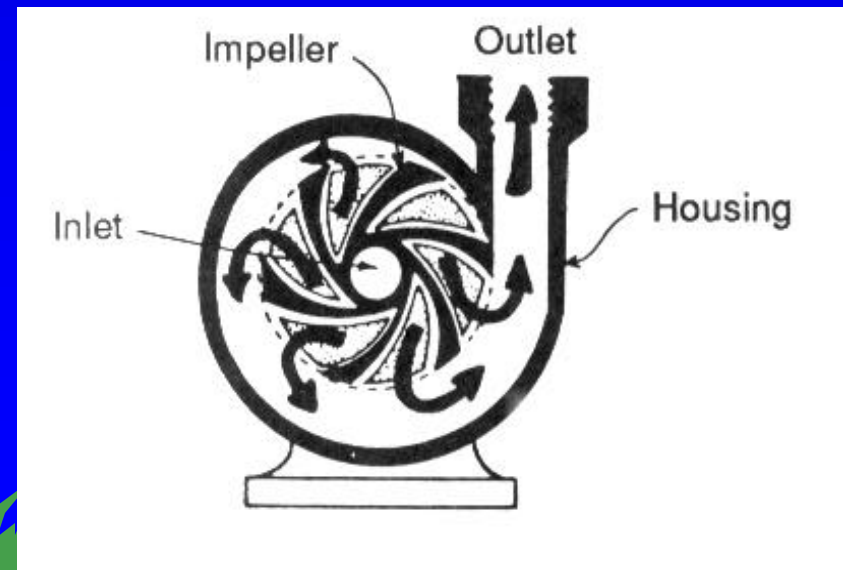
# *Strainers*

- Prevent foreign material from plugging working parts
- Nozzle strainers not a substitute for pressure line strainer



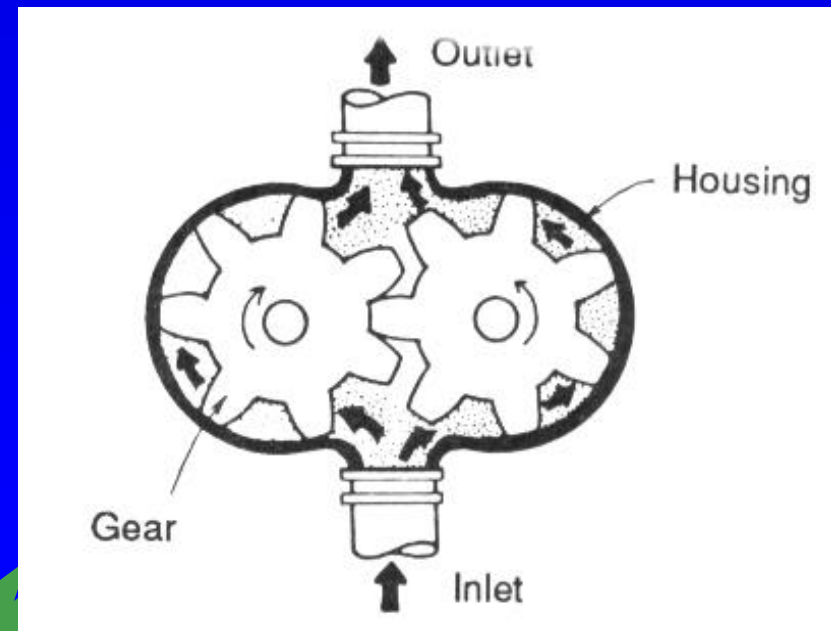
# *Centrifugal Pump*

- High volumes at low pressures
- Used with abrasive materials
- Not self-priming
- Pressure regulators not needed
- Inexpensive



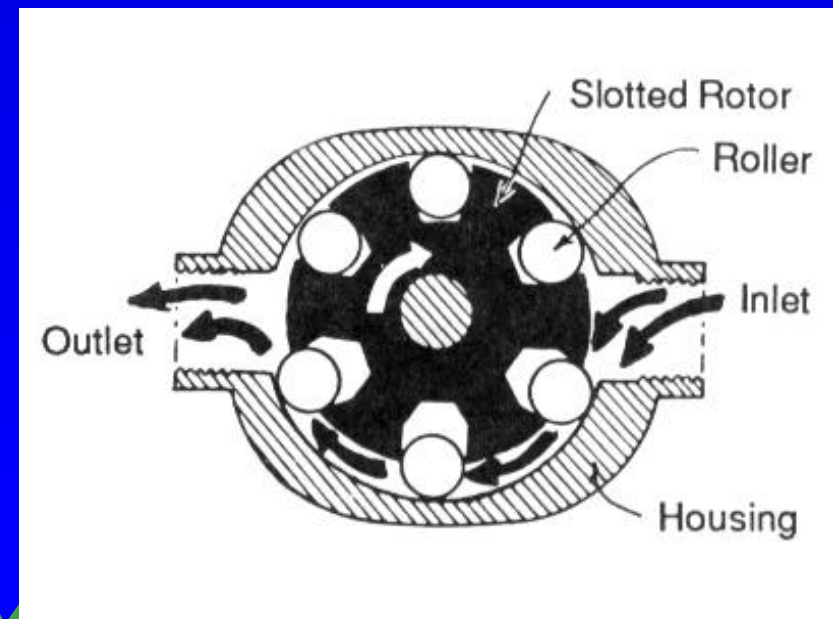
# ***Gear Pump***

- Simple & low cost
- Low pressure
- Not affected by solvents
- Disposable when worn



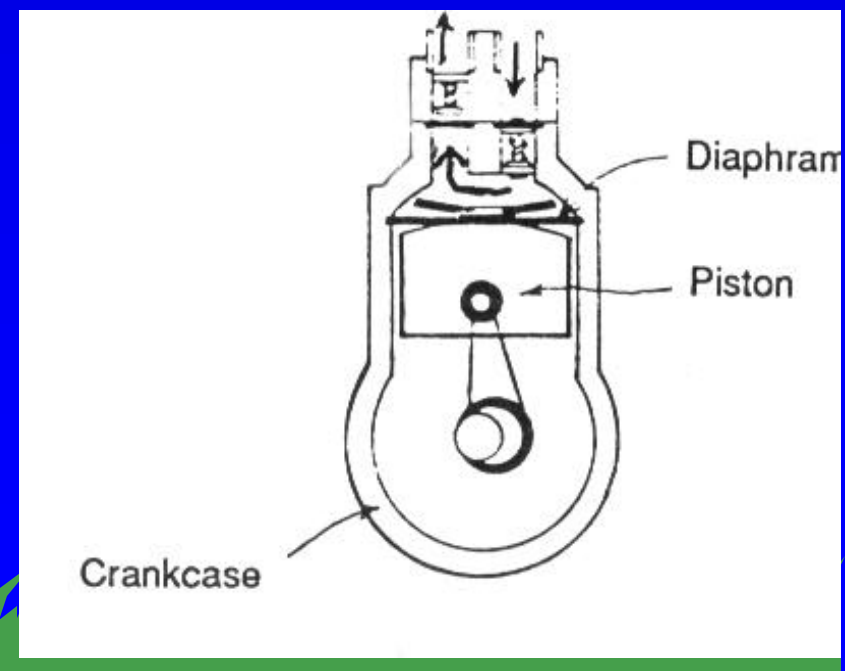
# *Roller Pumps*

- Low pressure, positive displacement, self-priming
- Similar to gear pumps, but abrasion resistant, repairable
- Somewhat more costly



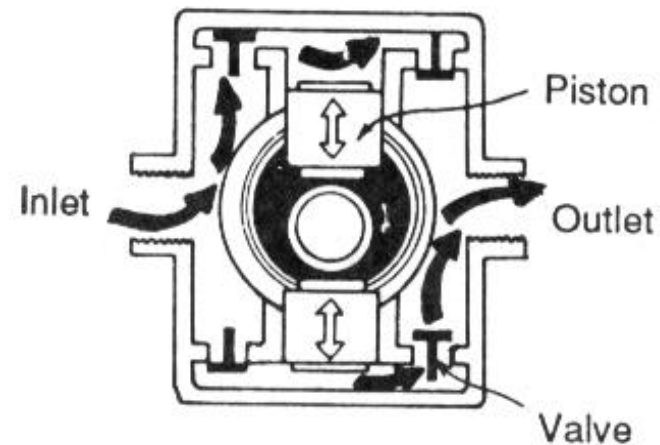
# *Diaphragm Pump*

- Similar in pressure & volume to gear pumps
- Very abrasion resistant



# *Piston Pumps*

- High volumes
- High pressures
- Rugged & versatile



# *Pressure Regulators*

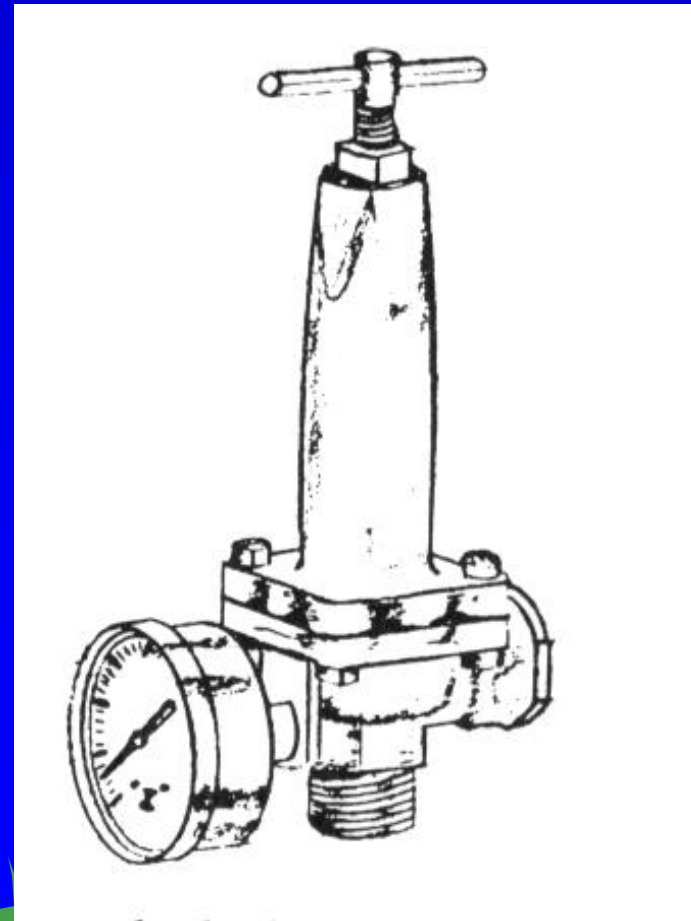
- **Controls pressure**
  - rate deliver to nozzles
- **By -passes excess material back to tank**





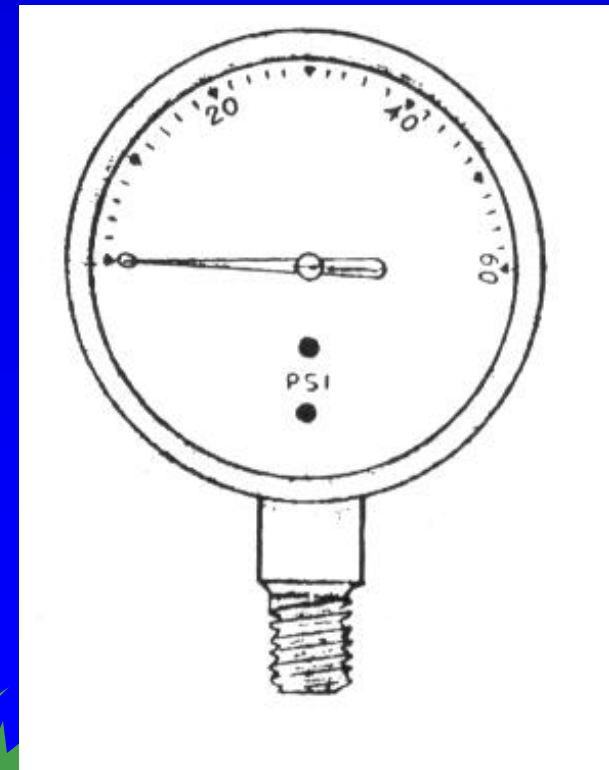
# *Pressure Regulators*

- **Two types**
  - simple relief valves
  - pressure unloaders



# *Pressure Gauge*

- **Essential**
  - pressure affects delivery
- **Gauges do wear out or become clogged**



# *Hoses*

- **Composition (chief liner material)**
- **Construction**
  - reinforcement, rigidity, flexibility
- **Working pressure**
- **Size**



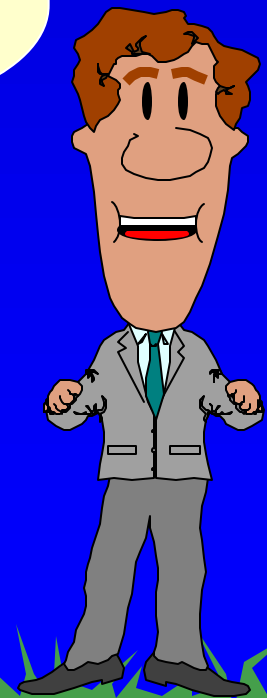
# *Nozzles*

- **Complete assembly consists of..**
  - Body
  - Screen
  - Cap
  - Tip or orifice plate
- **Many designs are available**
  - all spread a liquid into droplets



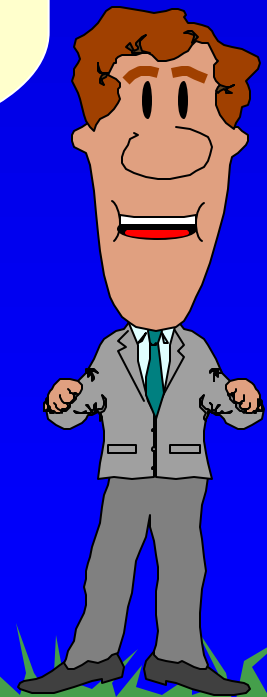
Manufacturer tech sheets are crucial.

Application rate depends on ground speed and pressure



Never operate at higher pressures to compensate for the wrong size.

This will cause nozzle wear and drift.



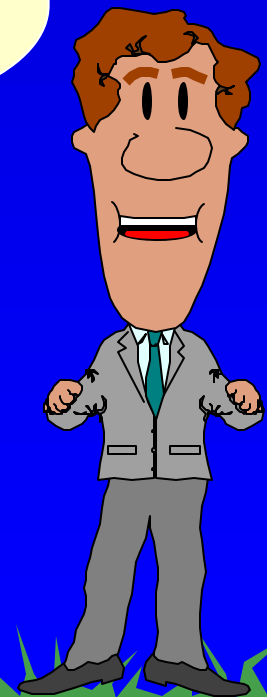
# *Nozzle Materials*

- Aluminum
- Brass
- Ceramic
- Plastic
- Nylon
- Stainless steel
- Tungsten carbide



Carbide & stainless steel are most abrasion resistant.. More expensive.

No single material is perfect for all applications methods.





# *Regular Flat Fan Nozzle*

- Used for broadcast spraying on boom
- 30-50% pattern overlap, 40 psi
- Calibrate frequently to check for nozzle wear



# *Off Center Nozzles*

- Roadside and railroad work
- Specialized booms for obstructions
- Possible wide application in a single pass



# *Other Nozzle Types*

## ■ Boomless

- wide swath without a boom
- affected by winds

## ■ Whirling disks

- reduce fine droplets



# *Sprayers for Right-of-Way Maintenance*

- **Backpacks to aircraft**
- **Often specialized for tasks**
  - don't try to clean herbicides from sprayers used for other pesticide applications
  - \*ammonia or detergent at 1 qt per 25 gallons of water
    - ◆ \* test before using



# *Portable Sprayers*

## ■ Compressed air

- convenient spot and small zone treatment

## ■ Mist blower

- greater coverage zone, faster
- greater drift potential



# *Sprayers Carried by Vehicles*

- Higher pressure sprayer
  - wide range of uses, with modifications
- Low pressure boom sprayers
- Aerial sprayers



# *Boom Sprayer Adjustment*

- Nozzle spacing
- Nozzle tip orifice
- Pressure
- Ground speed



# *Calibration*

- **Correct & effective amount of pesticide is delivered**
- **Saves money & legal problems**
  - exceeding legal rate
- **Reduces off target movement**





# *Calibrating Boom Sprayers*

- Check nozzles
- Clean nozzles and screens
- Check delivery for each nozzle
- Select ground speed
- Select pump pressure
- Measure swath width



# *Calibrating Boom Sprayers*

- Measure watered deliver in one minute by all nozzles
- Determine the amount of time to cover one acre

$$\text{Minutes per acre} = \frac{1}{\text{ground speed} \times \text{swath width} \times .002}$$



# *Calibrating Boom Sprayers*

- Convert to gallons per acre

Gal per acre = gal per minute x min per acre



# *Calibrating Boom Sprayers*

- **If amount delivered is too little...**
  - increase pump pressure
  - decrease ground speed
  - use larger nozzles



# *Calibrating Boom Sprayers*

- **If amount delivered is too much..**
  - decrease pump pressure
  - increase tractor speed
  - use smaller nozzles



# *Dosage Regulated Applications*

- **Based on target size and material concentration**
  - spray to drip
  - basal spraying
  - frill treatment
  - stump treatment



# *Error Factors*

- Improperly measuring and mixing
- Over application



# *Chapter 7*

## **Public Relations**





# *Public Relations*

- Differences in perception
- Carelessness
- Other areas of concern
  - water ways
  - toxic plants
  - farm operations
  - pets
  - brown out



# *Avoid Job Problems*

- **Choose contractors carefully**
- **Write contracts carefully**
  - follow up on performance
- **Consistent policies**
- **Educate the public**



# *Contractors*

- You're selling your reputation
- Choose employees carefully
- Train employees
- Keep records
- Inspect work
- Follow- up on complaints



# *Applicators Should...*

- **Have product information**
  - labels, MSDS
- **Respond to public inquiries**
- **Be professional**
  - be polite, overall appearance

