Weed Control in Rights of Ways:
Factors that Affect Herbicide Efficacy

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Outline

- Introduction

- Reasons why herbicide efficacy can be reduced
  - Weed biology and ecology
  - Environment
  - Herbicide and herbicide applicator

- Considerations and BMPs
Introduction

- **Rights-of-way (ROW)**
  - Federal, state, county, township, city roads
  - Public airports
  - Railroads
  - Electric utilities
  - Pumping stations and pipelines
  - Public irrigation waterways
  - Bicycle, bridle and other public paths/trails
  - More
Introduction

- Reasons for vegetation management
  - Reduce safety hazards
    - Line-of-site/visibility
    - Remove fire hazards
    - Remove habitat for undesirable wildlife
  - Prevent the disruption of services
    - Transportation of goods
    - Utilities
Introduction

- Reasons for vegetation management
  - Protecting structures
    - Road- and rail-beds
    - Utility poles or supports
    - Pumping stations
  - Provide ecological services/enhance aesthetics
    - Remove pests of crops/hosts to pests of crops
    - Remove plants inhibiting desired vegetation
    - Improve scenic resources
  - Maintain public relations
Strategies for managing vegetation

- Mechanical
  - i.e. mowing, pruning

- Biological
  - i.e. grazing

- Cultural
  - i.e. controlled burning, fertilizing/liming, mulching

- Chemical
  - i.e. tree growth regulators
  - i.e. herbicides
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- Considerations and BMPs
Weed Biology and Ecology

- Life form
  - i.e. Broadleaves vs. grasses

- Life cycle
  - i.e. Annuals vs. perennials

- Morphology
  - i.e. Leaf surface area, angle and texture

- Growth and development
  - i.e. Plant size, plant maturity, plant responses to stress

- Genetics
  - Development of herbicide resistance
Life Form

- Weed identification is necessary for designing an effective weed control program

- Weed species may respond differently to different weed control practices

- Monocots
  - Grasses

- Dicots
  - Broadleaves
Certain herbicides like Garlon (triclopyr), and Banvel (dicamba) are injurious to broadleaves weed species, but not grasses at labeled rates.
Life Cycle

- Weeds are also categorized by how long they live and how they reproduce.

- Life history traits can affect the timing/efficacy of weed control practices.

- Annuals (summer, winter)
  - Complete life cycle in one year
  - Easiest to control as seedlings, manage before seed set
  - Emergence within/ across years
  - Disturbed sites

- Perennials
  - Reproduce by seed or vegetatively
  - Rhizomes, stolons, rootstocks, tubers
  - Persistent and difficult to control
Morphology, Growth and Development

- Location of growing points
- Leaf shape
- Hairs
- Size
- Response to stress
The shape and orientation of grass leaves (narrow and more vertical than dicots) may affect herbicide deposition and, therefore, efficacy.

Growing points of grasses are below the ground, which will not be injured by contact herbicides.
Leaf hairs can either limit herbicide absorption by holding droplets away from the leaf surface (dense layer of hairs) or else allow for greater retention (thin layer of hairs).

Seedlings are often less hairy than mature plants.

Surfactants can be used to improve spreading and sticking.
Herbicides, especially the systemics, are most effective against actively growing plants.

Plants that are subjected to water stress will have thickened cuticles (waxy layer on the surface of the leaf), reduced transpiration, and limited physiological activity.
Under these conditions, herbicides are less likely to be absorbed and translocated.

Can’t interrupt biochemical processes that are barely occurring.
Environment

- Soil
  - Clay, OM can make herbicides unavailable
  - In less adsorptive soils, leaching can occur
  - Slope can lead to erosion or drainage
Environment

- Water
  - Soil moisture
    - *Needed for activation of residual herbicides*

- Precipitation
  - *Activation of herbicides*
  - *Erosion, leaching*
  - *Rain-fastness*

- Humidity
  - *Absorption*
  - *Translocation*
Environment

- Temperature
  - Plant affects
    - *Plant growth rate*
    - *Cuticle development/herbicide absorption*
    - *Water/herbicide translocation*
  - Herbicide affects
    - *Volatilization*
    - *Degradation*
  - Wind
    - Spray drift
    - Drought stress
Herbicide Selection

Classification

Method of application

- Soil-applied (pre-emergent)
  - Active of newly emerged seedlings or underground vegetative structures
  - Many products persist in the soil in an active form and provide ‘residual’ control over a period of time
  - i.e. sulfometuron, diuron, oryzalin

- Foliar-applied (post-emergent)
  - Control of vegetation through direct contact or by being translocated, to the site of action
  - i.e. glyphosate (systemic), triclopyr (systemic)
Herbicide Selection

- Classification
  - Selectivity
    - Non-selective
      - Kills all vegetation
      - i.e. glyphosate, MSMA, glufosinate
    - Selective
      - Controls specific types of vegetation
      - i.e. 2,4-D, triclopyr, sulfometuron
Herbicide Selection

- Classification
  - Mode/site of action
    - [http://wssa.net/weed/resistance/](http://wssa.net/weed/resistance/)
  - Formulation
Spray Solution

- Water quality (Spray solutions are >95% water)
- What goes in can affect what comes out: The case of glyphosate
  - pH – *high pH causes glyphosate to dissociate*
  - Cations – Mg, Ca, Na can bind to glyphosate
  - Turbidity – *glyphosate rapidly and tightly bound to soil and OM*
Spray Solution

- Spray Additives
  - Spray adjuvants (additives) are added to enhance the performance or handling of a pesticide
  - Adjuvants are usually classified according to their use rather than their chemistry
  - Activator adjuvants and modifier adjuvants
    - Activator additives increase the POST activity of herbicides, usually by increasing herbicide movement into the leaf tissue (e.g. oils, surfactants, and fertilizers)
    - Modifier additives alter the application characteristics of the spray solution (e.g. anti-foaming agents, compatibility agents, and drift control agents)
Spray Solution

- **Wetting agents** - allows wettable powders to mix with water.
- **Emulsifiers** - allows petroleum based pesticides to mix with water.
- **Invert emulsifiers** - allows water based pesticides to mix with a petroleum carrier.
- **Spreaders** - allows pesticides to form a uniform coating layer over the treated surface.
- **Stickers** - Allows the pesticide to stay on the treated surface and no roll off.
- **Penetrants** - Allows the pesticide to get through the outer surface to the inside of the treated areas. This is commonly used when penetrating the thick gel of some water plants.
- **Foaming agents** - Used to reduce drift so the pesticide stays in the target area.
- **Safeners** - To reduce the toxicity of a pesticide formulation to the handler or treated surface.
- **Anti-foaming agents** - Reduces the foaming of spray mixtures that require vigorous agitation.

Making sense of adjuvants

The 2012 Compendium of Herbicide Adjuvants is the 11th edition of the biennial publication and contains 607 entries from 39 companies. The 1st Edition of this Compendium was assembled in 1992 with 76 entries from 22 companies. The growth of the adjuvant products listed is a result of continued reliance on postemergence herbicide applications, scientific advancements and innovations pertaining to herbicide adjuvants, blending adjuvant chemistry into a single product for use with specific herbicides, and successful research and development by adjuvant manufacturers for commercialization of novel, multifunctional adjuvant products.

Each new edition of the booklet reflects the change in commercial adjuvant products in our website database over a two-year period since the previous publication. The products are organized by type of adjuvant such as nonionic surfactants, crop oil concentrates, etc. Product name, principal functioning agent, use rate, any special comments, and

<table>
<thead>
<tr>
<th>MANUFACTURER/DISTRIBUTOR</th>
<th>ADJUVANT CATEGORY</th>
<th>PRINCIPAL FUNCTIONING AGENTS</th>
<th>USE RANGE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemorse, Ltd.</td>
<td>Deposition (Drift Control) and/or Retention Agent plus Ammonium Sulfate and Defoamer and Water Conditioning Agent and Nitrogen Source</td>
<td>Ammonium sulfate, drift retardant, antifoam</td>
<td>2.5-5% v/v</td>
<td></td>
</tr>
<tr>
<td>ACCUQUEST WM Label/MSDS</td>
<td>Helena Chemical Co.</td>
<td>Deposition (Drift Control) and/or Retention Agent plus Ammonium Sulfate and Defoamer and Water Conditioning Agent and Nitrogen Source</td>
<td>Proprietary blend of polyhydroxycarboxylic acids, sulfates, and polymeric deposition agents</td>
<td>0.5-1% v/v</td>
</tr>
<tr>
<td>ACCUZONE DC Label/MSDS</td>
<td>Helena Chemical Co.</td>
<td>Deposition (Drift Control) and/or Retention Agent</td>
<td>Ammonium and potassium salts plus organic polymers</td>
<td>1-2.5 lb/A</td>
</tr>
</tbody>
</table>
Application equipment

- Equipment must be clean and in proper working order to ensure proper application and maximize herbicide efficacy

- Tank and agitator
- Pump and pressure gauge
  - Pressure control is important for proper application as it determines the amount of spray delivered by the nozzles
- Hoses
- Strainers
- Nozzles and nozzle assembly
  - Breaks the spray into droplets and forms the pattern of distribution
  - Nozzles are designed for specific spraying jobs at certain pressures
<table>
<thead>
<tr>
<th>Herbicides</th>
<th>Fungicides</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOIL APPLIED</strong></td>
<td><strong>POST-EMERGENCE</strong></td>
</tr>
<tr>
<td>Turbo Tejet</td>
<td>VERY GOOD</td>
</tr>
<tr>
<td>Turbo Tejet at pressures below 30 PSI (2.0 bar)</td>
<td>GOOD</td>
</tr>
<tr>
<td>Turbo Tejet Induction</td>
<td>GOOD</td>
</tr>
<tr>
<td>Turbo Tejet Induction at pressures below 30 PSI (2.0 bar)</td>
<td>VERY GOOD</td>
</tr>
<tr>
<td>XIX XRC Tejet</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>XIX XRC Tejet at pressures below 30 PSI (2.0 bar)</td>
<td>GOOD</td>
</tr>
<tr>
<td>AIXR Tejet</td>
<td>VERY GOOD</td>
</tr>
<tr>
<td>AIX, AIC Tejet</td>
<td>VERY GOOD</td>
</tr>
<tr>
<td>TwistJet</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>DG TwistJet</td>
<td>VERY GOOD</td>
</tr>
<tr>
<td>Turbo Tejet Duo</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>Turbo Tejet Duo at lower pressures</td>
<td>VERY GOOD</td>
</tr>
<tr>
<td>Turbo FloodJet</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>TurJet</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>QCTF Turbo FloodJet</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>AirMatic AirJet</td>
<td>EXCELLENT</td>
</tr>
</tbody>
</table>

*Note: Consult the chemical manufacturer's product label for specific rate and application recommendations.*
Herbicide Drift

- Once a herbicide is released into the air, it can be moved off-target

- Uncontrolled movement in air can be either from volatilization or particle drift
Herbicide Drift

- Volatilization - occurs when there is a physical change of the herbicide into gas, which can then be moved off-target via air currents

- Volatility potential increases:
  - As air temperature increases
  - As surface temperature increases
  - As relative humidity decreases
Herbicide Drift

- Drift - occurs when wind physically moves the herbicide and the carrier from the target site during the spraying operation.

- Drift potential increases:
  - As droplet or particle size decreases
  - As wind speed increases
<table>
<thead>
<tr>
<th>Factor</th>
<th>More Drift</th>
<th>Less Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray particle size</td>
<td>Smaller</td>
<td>Larger</td>
</tr>
<tr>
<td>Release height</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Wind speed</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Spray pressure</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Nozzle Size</td>
<td>Smaller</td>
<td>Larger</td>
</tr>
<tr>
<td>Nozzle Orientation (aircraft)</td>
<td>Forward</td>
<td>Backward</td>
</tr>
<tr>
<td>Nozzle Location (aircraft)</td>
<td>Beyond 2/3 wing span</td>
<td>2/3 or less wing span</td>
</tr>
<tr>
<td>Air Temperature</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>Lower</td>
<td>Higher</td>
</tr>
<tr>
<td>Nozzle Type</td>
<td>Produce Small Droplets</td>
<td>Produce Larger Droplets</td>
</tr>
</tbody>
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Considerations

- Groundwater advisories
- Injury to desirable plants
- Brownouts
- Hazards to pollinators
- Hazards to livestock, wildlife, endangered species
BMPs

- Know your weeds, know your site
  - Vegetation present (on- and off-site), vegetation desired
  - Site characteristics that influence vegetation management

- Read the herbicide label

- Take control of what you can
  - Weeds are complex
  - Weed-environment interactions are even more complex
  - Weed-environment-herbicide interactions are really complex

- NOTHING is a substitute for your own eyes and mind!
Thank you...