Resistance to Management

4. Passing on genes is all that matters in nature.

Biotech - e

Let's take a look at how a herbicide, glyphosate, interferes with EPSP synthase.

Biotech - f

Improving Efficacy

Versus Drift Management

Robert N. Klein
NU Extension Cropping Systems Specialist

Efficacy - a

These are the Velcro pieces that go with the poster.

Biotech - velcro
Pesticide Efficacy

- Type of Application
  - Pre or Post
  - Burndown with Pre’s
- Spray Volume
- Type of Pesticide
  - Translocated
  - Contact

Drift Management & Type of Drift

- Vapor Drift
  - Associated with volatilization (gas, fumes)
- Particle Drift
  - Movement of spray particles during or after the spray application

Spray Characteristics Affecting Drift

- Chemical
- Formulation
- Additives
- Drop Size
- Evaporation

Equipment & Application Factors Affecting Drift

- Nozzle type
- Nozzle size
- Nozzle Orientation
- Nozzle pressure
- Height of release
- Technology

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Weather and Other Factors Affecting Drift

- Temperature and humidity
- Air movement
  - Direction
  - Velocity
- Air stability/inversions
- Topography

Wind

- Direction is very important
- Know the location of sensitive areas
- Do not spray at any wind speed if it is blowing towards sensitive areas
- Spray when breeze is gentle, steady and blowing away from sensitive areas
- “Dead Calm” conditions are never recommended

Inversions

- Surface inversions are common
- Be especially careful near sunset and an hour or so after sunrise, unless
  - There is low heavy cloud cover
  - The wind speed is greater than 5-6 mph at ground level
  - 5 degree temp rise after sun-up
- Use of a smoke bomb or smoke generator to identify inversion conditions

Comparison of Micron Sizes

<table>
<thead>
<tr>
<th>Micron Size</th>
<th>Microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencil Lead</td>
<td>2000</td>
</tr>
<tr>
<td>Paper Clip</td>
<td>850</td>
</tr>
<tr>
<td>Staple</td>
<td>420</td>
</tr>
<tr>
<td>Toothbrush bristle</td>
<td>300</td>
</tr>
<tr>
<td>Sewing thread</td>
<td>150</td>
</tr>
<tr>
<td>Human Hair</td>
<td>100</td>
</tr>
</tbody>
</table>

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Control of Volunteer Wheat and Triazine-Resistant Kochia with Paraquat plus Atrazine plus Non-ionic Surfactant

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nozzle</th>
<th>Droplet Size**</th>
<th>TR-Kochia</th>
<th>Volunteer Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>XR1100</td>
<td>Medium</td>
<td>97 a</td>
<td>97 a</td>
</tr>
<tr>
<td>2</td>
<td>DG1100</td>
<td>Coarse</td>
<td>96 a</td>
<td>95 a</td>
</tr>
<tr>
<td>3</td>
<td>TF-VS2.5</td>
<td>Extremely Coarse</td>
<td>79 c</td>
<td>80 c</td>
</tr>
</tbody>
</table>

**Very fine <153, fine 154-241, medium 242-358, coarse 359-451, very coarse 454-740, and extremely coarse >741

Spray Drift

- Wind 2x wind
  - 700% more drift at 90 feet
- Boom height 2x height
  - 350% more drift at 90 feet
- Distance 2x distance = 80% less drift

Drift Reduction Additives

- Many Available
- Not EPA regulated
- Long chain polymers
- New-soluble powders
- 50-80% reduction in off-target movement?
- Some may affect spray pattern (AI nozzles)
- Pump shear problems

Why is the Nozzle Important?

- Amount of spray applied
- Uniformity of the spray
- Coverage on the target
- Amount of off-target drift
**Blended Pulse Spraying**

- Each nozzle in the SharpShooter System emits 10 spray pulses per second
- Adjacent nozzle having alternating timing

**Fall Fertilization**

- More time to apply fertilizers in the fall
- Prices for fertilizers are generally better.
- Application equipment is more available.

**Nozzle Types and Discharge Rates at Rated Pressure**

<table>
<thead>
<tr>
<th>Nozzle Type</th>
<th>Discharge (gpm)</th>
<th>Rated Pressure (psi)</th>
<th>Min (psi)</th>
<th>Max (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular flat fan 8006</td>
<td>0.6</td>
<td>40</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Regular flat fan 11008</td>
<td>0.8</td>
<td>40</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Low pressure flat fan 8006LP</td>
<td>0.6</td>
<td>15</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Extended range flat-fan 11008XR</td>
<td>0.8</td>
<td>40</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>Turbo TeeJet TT11005VP</td>
<td>0.5</td>
<td>40</td>
<td>15</td>
<td>90</td>
</tr>
<tr>
<td>DriftGuard DG11005VS</td>
<td>0.5</td>
<td>40</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Al TeeJet AI11005-VS</td>
<td>0.5</td>
<td>40</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Flood TKSS 8</td>
<td>0.8</td>
<td>10</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Turbo FloodJet TF-VS10</td>
<td>1.0</td>
<td>40</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Raindrop RA-6</td>
<td>0.6</td>
<td>40</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>Turbo Turf Jet ½ TTJ10</td>
<td>1.0</td>
<td>40</td>
<td>25</td>
<td>75</td>
</tr>
</tbody>
</table>

**Risk of Fall Fertilization**

- Apply full eight months prior to plants need for fertilizer
- Losses through soil erosion
- Leaching of nutrients out of the rooting zone
- Denitrification in Saturated Soils.

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Key to Fall Fertilization

- Prevent nitrogen from being leached out of rooting zone of plants.
- Prevent conversion of Ammonia to Nitrate.
  - NH₄⁺ is non-mobile in the soil – Positively charged. Attracted to negative soil particles
  - NO₃⁻ is mobile in the soil – Negatively charged Repelled by negative soil particles

The Nitrogen Cycle

Nitrification

\[
\begin{align*}
\text{NH}_4^+ & \xrightarrow{\text{Nitrification}} \text{NO}_2^- \\
& \xrightarrow{\text{Nitrate}} \text{NO}_3^-
\end{align*}
\]

(Ammonium) (Nitrite) (Nitrate)

Soil Temperature

- Microorganisms Convert Ammonia to Nitrate.
- As temperature Decreases, Microorganism Activity Decreases
- For Fall Fertilization, Soil Temperatures should be 50 degrees or less.

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Nitrogen Fertilizer

- Anhydrous Ammonia is the Recommended Form of Nitrogen for Fall Fertilization.
- Urea Should Not be Substituted for Anhydrous Ammonia in Fall Fertilization
  - Leaching Potential
  - Immobilization Potential
  - Volatilization Potential

Historic yield of corn and soybean
Yield increase more pronounced in dryland. Where does the yield increase come from?
Genetics + management

Conventional Plant Breeding

Trial & Error

Maximum Trial - Minimum Error = Yield Increase

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What is Plant Biotechnology?

Process of removing, modifying or adding genes to a living organism:
- also called gene splicing, recombinant DNA technology or genetic modification
- individual genes copied and transferred
- adds or removes specific characteristics

Biotechnology Offers Advantages Over Plant Breeding

Traditional Plant Breeding:
DNA is a strand of genes, much like a strand of beads. Traditional plant breeding combines many genes or strains.

Many genes are transferred across species.

Plant Biotechnology / Genetic Engineering:
Using plant biotechnology, you can add a single gene to the strand.

A single gene is inserted in the organism.

Genes Control Plant Traits

Bt gene control → Bt toxin expression → pest

Bacillus thuringensis → Transformed Plant → Lepidopteran Control

Genes code for production of proteins
Proteins influence specific plant characteristics

- Disease control
- Insect control
- Processing improvements
- Quality improvements
- Weed control
- Chlorotic tolerance
Plant-Made Pharmaceuticals

A business proposition at Monsanto

Plant-made pharmaceuticals are developed through the use of biotechnology. Plants are genetically enhanced to produce substances for pharmaceuticals that can treat diseases and save lives.

Considerations that will influence how and who grows ‘pharma’ crops

- Isolation
- Amount of corn needed

Pharma crops will be grown under very specialized situations:

- Isolation
  - 1 mile from seed production
  - 0.5 mile from other corn
  - 3 week temporal isolation of target corn and corn produced 0.5 to 1 mile

- Volume
  - Acreage is dependent on productivity of the system and demand for product
  - One thousand acres to make one metric ton of protein
Soybean Mosaic Virus
- Viral disease of soybeans which is seed (5% as high as 75%) and aphid transmitted

2% of fields sampled in 2000 survey were positive for SMV

Replant Decisions: Corn
- What’s Left
- What’s Coming

Need To Know:

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What’s Left?
1. Stand 
2. Growing Season

Potential = Yield

What’s Coming?
1. Yield of Replant
2. Weather
- Temperature
- Rainfall
- Frost Date

Costs
1. Leave Stand
2. Replant

Leave Stand Costs
1. Weed Control
- Herbicides Available
- How to Apply
- Rates to Apply

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Wheat Rust Diseases

- Leaf rust (*Puccinia triticina*)
- Stem rust (*Puccinia graminis*)
- Stripe rust (*Puccinia striiformis*)

Important Considerations

- Rust pathogens are highly specialized pathogens that exist in several race (virulence phenotypic) form.
- As new rust races evolve over time, wheat varieties become vulnerable to attack.
- This requires continued monitoring of rust populations and early screening of wheat lines to maintain or improve rust resistance in released varieties.

Stem Rust

Potentially, the most damaging of the rusts, but effectively controlled with resistant varieties.

Stem Rust Screening

- Annually screen 2000 early wheat lines in the greenhouse.
- Conduct an annual field screening.
- Recent varieties that have gone through the rust screening program include Wahoo, Wesley, Millennium, Pronghorn, Cougar, Culver, Niobrara, and Nekota.

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Leaf Rust

Leaf rust is the major rust disease in the Great Plains.

Leaf Rust Screening

- Annually screen 500 early wheat lines for reaction to leaf rust using a composite of the most common races identified in our leaf rust race surveys.
- Evaluate varieties for leaf rust severity and reaction in variety trials.

Rust Screening Procedure

Number of different leaf rust races in Nebraska from 1992-2000

<table>
<thead>
<tr>
<th>Year</th>
<th>Races</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>37</td>
</tr>
<tr>
<td>1993</td>
<td>46</td>
</tr>
<tr>
<td>1994</td>
<td>no data</td>
</tr>
<tr>
<td>1995</td>
<td>20</td>
</tr>
<tr>
<td>1996</td>
<td>18</td>
</tr>
<tr>
<td>1997</td>
<td>17</td>
</tr>
<tr>
<td>1998</td>
<td>42</td>
</tr>
<tr>
<td>1999</td>
<td>49</td>
</tr>
<tr>
<td>2000</td>
<td>43</td>
</tr>
<tr>
<td>2001</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>
Soybean defoliators

- Lepidoptera: moths and butterflies
- Coleoptera: beetles
- Orthoptera: grasshoppers
- Gastropoda: slugs

Defoliating “worms”

- Variegated cutworm
- Green cloverworm
- Loopers
- Armyworms

- Alfalfa caterpillar
- Thistle caterpillar
- Webworms
- Yellow woollybear

Count the prolegs

- 3 true legs + 3 prolegs
  Loopers (cabbage and soybean)
- 3 true legs + 4 prolegs
  Green cloverworm
- 3 true legs + 5 prolegs
  Armyworms, cutworms, webworms, corn earworm

Striped body

- Alfalfa caterpillar
  Green, dense hair with small black dots. White stripe.
- Corn earworm
  Alternating light and dark stripes. Head with net-like pattern
Assessing Soybean Defoliation

Dr. Thomas E. Hunt
Extension Entomologist
University of Nebraska

A. soydefol-i

B. soydefol-l

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Defoliation Estimation

- Usually overestimated and inaccurate
- Different insects feed at different locations of the canopy

Sampling for Defoliation Estimation:

1. Remove a trifoliolate from top, middle, and lower third of 10 plants.
2. Discard the most and least injured leaflet of each trifoliolate.

General Defoliation Thresholds

- Vegetative stages: nearing 40%
- Reproductive stages: nearing 20%
- Make sure insects are present and feeding
- Take relative canopy size into consideration
- If maturity close, don’t treat
yields-a

yields-b

yields-c

yields-d
yields-e

yields-f

yields-g

yields-h
Yield Potential Genes

Yield Protection Genes