Observation of Injury Symptoms

• Where are we seeing the injury?
  – Entire Field
  – Whole Plants
  – Plant parts-leaf, root, stem, fruit

• Pattern or Random?
Documentation

• Record any information you think will help you or others determine how incident occurred
  – Date of suspected application and when injury first observed
  – Herbicides applied to and nearby incident site
  – Climate information during applications
  – Application equipment – boom height, speed, pressure, etc.
  – Previous crop/herbicides in field
Alternative causes

• Eliminate possibilities
  – Disease, fertility, insects, carryover, weather

• Applicator error by you, your employee, or your custom applicator?

• Neighbor?

• Farther away?
Fitting the puzzle together

• Simple hand-drawn maps or color coding satellite images can help illustrate the relationship of damaged areas to surrounding fields.

• Showing injury and severity patterns along with weather and application information can help identify the source.

• Knowing herbicide injury symptoms and how quickly they may develop can verify the source of the incident.
Herbicide Injury influenced by

- Field Operations
  - Overlap
  - Compaction
  - Contamination
  - Improper mixing (rate, order, agitation)
  - Drift (physical, vapor)
  - Operator/guidance error

- External Factors
  - Carryover
  - Drift
  - Topography
  - Weather
  - Stress
  - Soil Moisture/Texture/O.M.
What is affected on the plants?

- Leaves
  - Upper
  - Lower
- Roots
- Grain/Fruit/Pod
- Mix of some or all
- Can help determine when and what caused the damage
Leaf Injury

• Symptoms on leaves
  – Deformation
    • Strapping, cupping, failure to fully emerge
  – Stunting
    • Node stacking, “drought” stressed
  – Discoloration
    • Necrosis
    • Chlorosis
    • Bleaching
    • Red/Purple

Leaf veins OR between Veins
Root Injury

• Root injury symptoms
  – Deformation
    • Clubbed, bottle brush, thickened
  – Pruning
  – Proliferation

• Effects of root damage
  – “Drought Stress”
  – Lean/fall down
Key to Herbicide Injury

1. Photosynthesis Inhibitors (PSII- Triazines, Ureas)
2. Membrane Disruptors (PPO/PS I- Diphenyl ethers, Bipyridiliums)
3. Pigment Inhibitors (inhibitors of 4-HPPD, DOXP, PDS,)
4. ALS inhibitors (IMIs, SUs)
5. Inhibition of EPSP (Glyphosate)
6. Inhibition of Glutamine Synthase (Glufosinate)
7. Lipid Synthesis Inhibition (ACCase-Fops, Dims; Non-ACCase-thiocarbamates)
8. Seedling Growth Inhibitors (inhibitors of microtubule assembly-DNA’s)
9. Seedling Shoot Inhibitors (VLCFA inhibitors- Chloroacetamides, Oxyacetamides)
10. Growth Regulators (Synthetic Auxins-Benzoic and Phenoxy-carboxylic Acids)
Classification by Mode of Action

- Can give clues to
  - Symptoms
  - Behavior
  - Crop Tolerance
  - Weed Spectrum Controlled
  - Application Timing

- Not every chemical fits the way we think it should
Herbicide Injury Key

• Read the question and click on the **Underlined** text that best describes what you are observing.
• Link will take you to the next slide in the key
• When did the injury appear?

A. During or immediately after crop emergence (initial stand not uniform and/or plants lacked vigor)

B. After crop emergence (initial plant stand uniform and vigorous)
A. During or shortly after crop emergence

Where does the injury appear?

1. **Plants stunted, leaves damaged, roots generally unaffected**

2. **Plants stunted, leaves damaged and roots injured**
A.1. Plants stunted, leaves damage, roots generally unaffected

What type of injury?

a. *White or bleached leaves*

b. *Chlorotic leaf veins and margins*

c. *Deformed leaves*
• A.1.a White or bleached leaves
• Pigment inhibitor
• Ex: Callisto, Command, Brake, Balance
A.1.b. Margins chlorotic or necrotic
Photosynthesis inhibitors
Ex: Sencor, Atrazine, Linex
A.1.c. How are the leaves deformed?

I. Tightly rolled grass leaves, broadleaves more sensitive-epinasty/cupping

II. Improper leaf unfolding and buggy whipping on grasses, drawstring effect on broadleaves
• A.1.a.l. Tightly rolled grass leaves, broadleaves more sensitive – epinasty/cupping

• Growth regulators

• Ex: 2.4-D, Clarity, Grandstand, Facet L
• A.1.a.II. Improper leaf unfolding and buggy whipping on grasses, drawstring effect on broadleaves

• Seedling Shoot Inhibitors

• Ex: Dual II Magnum, Warrant, Outlook,
A.2. Plants stunted, leaves damaged and roots injured.

a. Root growth inhibited with root tips having a clubbed appearance

b. Plants have pruned roots; short, slender lateral roots and bottle brush appearance

c. Seedling roots short and thickened, proliferation of roots
• A.2.a. Root growth inhibited, root tips have clubbed appearance
• May appear drought stressed under normal moisture conditions
• Seedling Root Inhibitors
• Ex: Prowl, Treflan
• A.2.b. Plants have pruned roots, slender lateral roots and bottle brush appearance

• ALS inhibitors

• Ex: NewPath, Envoke, Canopy, Grasp
• A.2.c. Seedling roots short and thickened, proliferation of roots.

• Growth Regulators

• Ex: 2,4-D, Clarity, Grandstand, Facet
B. After Crop Emergence

What tissue is affected?

1. **Older (lower) leaves injured, new (upper) leaves healthy** - Contact Herbicide

2. **New leaves damaged, old leaves unaffected** – Translocated Herbicide
B.1. Older (lower) leaves injured, new (upper) leaves healthy – Contact herbicide

a. Broadleaf weeds more sensitive than grasses
b. Grasses and broadleaf weeds both affected
• B.1.a. Contact herbicide with more activity on Broadleaf weeds

I. Photosynthesis inhibitors – Atrazine, Buctril, Basagran, Direx

II. PPO inhibitors – Valor, Reflex, Aim, Cobra, Sharpen
• B.1.b. Grasses and broadleaf weeds both affected

I. Cell membrane disruptor – Gramoxone, diquat

II. Glufosinate
B.2. New leaves damaged, old leaves unaffected – Translocated herbicide

a. Broadleaves more affected than grasses, leaf cupping, strapping

b. New leaves chlorotic and plants stunted
• B.2.a. Broadleaves more affected than grasses, leaf cupping, strapping
• Growth Regulators
• 2,4-D, Clarity, Grandstand
• B.2.b. New Leaves chlorotic and plants stunted

I. Grass meristems (newly emerging leaf) pull out easily, brown to black meristem, only grasses affected

II. Broadleaves and grasses affected, chlorotic and crinkled leaves, shortened internodes and reddened veins

III. Variable injury; Chlorosis of terminals leading to necrosis and death, does not stunt like ALS
B.2.b.1. Grass meristems (newly emerging leaf) pull out easily, brown to black meristem, only grasses affected

Lipid Synthesis Inhibitors (ACCase)

Ex: Poast Plus, Select, Clincher, Ricestar HT, Assure II
• B.2.b.II. Broadleaves and grasses both affected; chlorotic and crinkled leaves, shortened internodes and reddened veins

• ALS inhibitors

• Ex: NewPath, Scepter, Classic, Harmony, Accent, Beyond, Envoke
• B.2.b.III. Variable injury; Chlorosis and purpling leading to necrosis and death

• Glyphosate