Herbicide Mode of Action

Some things to remember…..

- photosynthesis (food)
- respiration (energy)
- amino acids (proteins/growth)
- lipids (cell membranes)
- pigments (energy/light capture)
- mitosis (cell division)
Mode of Action

- the sequence of events that leads to plant death or growth interruption

- 2 phases
  - movement to target site
  - interaction at target site

Modes of Action (7)

1. Growth Regulators
2. Seedling Growth Inhibitors
3. Cell Membrane Disruptors
4. Photosynthesis Inhibitors
5. Amino Acid Synthesis Inhibitors
6. Pigment Inhibitors
7. Lipid Synthesis Inhibitors
1. Growth Regulator Herbicides

These herbicides affect several plant processes such as cell division, cell enlargement, protein synthesis and respiration. They act by upsetting the normal hormonal balance in plants.

Examples: 2,4-D, 2,4-DB, MCPA, MCPP, Banvel, Tordon 22K, Stinger, Reclaim, Remedy, Grandstand, Facet

Characteristics

- Generally applied foliarly, but have soil residual activity
- Length of soil activity is herbicide-dependent
- Highly translocated in susceptible plants (systemic)
- Activity (pound for pound) varies between herbicides
- Primarily broadleaf activity but can affect grasses
Symptomology

- Broadleaf plant stem twisting and curling
- Leaves on broadleaf plants exhibit cupping, crinkling, strapping, or drawstring affect
- Symptoms on grass plants include leaf rolling, crinkling, brace root fusion and malformation. Also, flower sterility and missing grain in crops (blasting)

Malformed brace roots

Blasted grain heads
2. Seedling Growth Inhibitors

These herbicides include both seedling root inhibitors and shoot inhibitors. The root inhibitors interrupt cell division (mitosis) stopping root growth in seedling plants. The shoot inhibitors disrupt protein synthesis, cell division, cell enlargement and weaken cell membranes.

Examples:

**Root Inhibitors:** Balan, Sonalan, Surflan, Prowl, Treflan, PendiMax

**Shoot Inhibitors:** Surpass, Harness, Lasso, MicroTech, Machete, Dual Magnum, Kerb, Ramrod, Frontier, Outlook, Devrinol
Seedling Growth Inhibitor

**Characteristics**
- Seedling plant death generally occurs prior to emergence
- Root inhibitors translocate very little
- Generally stable in upper soil profile after incorporation through mechanical means or by rainfall or irrigation
- Soil surface stability (potential for loss) is herbicide-dependent
- Most effective on small-seeded grass and broadleaf weeds

**Symptomology**
- **Root Inhibitors**
  - Roots on susceptible plants will be stubby and thick, especially lateral roots
  - Root limitation may cause stunting of plants and phosphorus deficiency symptoms
  - Broadleaf plants may have swollen hypocotyls
  - Concentration of herbicide at soil surface may cause callus tissue to form, leading to plant lodging
Prowl Injury on Corn

Grass crops may leaf out underground, leaves may exhibit improper leaf unfurling, buggy whipping, and crinkling.

Affected crops may show erratic stand and height.

Broadleaf plants may exhibit leaf puckering or a drawstring effect.

Symptomology

- Shoot Inhibitors
  - Grass crops may leaf out underground, leaves may exhibit improper leaf unfurling, buggy whipping, and crinkling.
  - Affected crops may show erratic stand and height.
  - Broadleaf plants may exhibit leaf puckering or a drawstring effect.
3. Cell Membrane Disruptors and Organic Arsenicals

The cell membrane disruptor herbicides destroy cell membranes, causing cell contents to leak out and dessication of plant tissue. The organic arsenicals have similar activity but their exact mode-of-action and site-of-activity is unknown.

**Cell Membrane Disruptors:** Gramoxone Max, Boa, Avenge, Ultra Blazer, Reflex, Cobra, Goal, Valor, Spartan

**Organic Arsenicals:** DSMA, MSMA
**Characteristics**

- Paraquat and diquat are non-selective
- MSMA, DSMA selective for controlling wide-leaved grasses and a few broadleaf weeds
- Goal, Reflex, Blazer, and Cobra generally selective for broadleaf weeds
- Some of these herbicides have little or no soil activity. Goal, Reflex, Valor, Spartan have significant soil residual properties.

**Symptomology**

- Rapid yellowing followed by dessication of affected plant tissue
- MSMA, DSMA symptoms generally appear first on leaf tips
- Drift or off-target application may show speckled leaf burn
4. Photosynthesis Inhibitors

These herbicides interrupt photosynthesis which is the process where green plants convert light energy from the sun into food.

Examples: Aatrex, Bladex, Caparol, Princep, Velpar, Sencor, Hyvar, Karmex, Cotoran, Basagran, Buctril, Stam
**Characteristics**

- Most PI’s are applied preemergence except Buctril, Basagran, and Tough
- All PI’s have at least some postemergence activity
- Soil-applied PI’s translocate systemically
- Soil residual activity is herbicide-dependent

**Symptomology**

- Interveinal or veinal yellowing followed by death of plant tissue from leaf margins inward
- Postemergence applications cause rapid burning of plant tissue
- Crops tolerant to POST applied PI’s may exhibit spotted leaf yellowing or bronzing
5. Amino Acid Synthesis Inhibitors

These herbicides inhibit amino acid synthesis which is necessary for the formation of plant proteins.

Examples: Cadre, Scepter, Pursuit, Arsenal, Glean, Permit, Accent, Beacon, Peak, FirstRate, Staple, Strongarm, glyphosate, Liberty, Python
Amino Acid Synthesis Inhibitors

**Characteristics**

- Most of these herbicides have soil and foliar activity except glyphosate, and glufosinate.
- Systemically translocated in plants.
- Soil residual activity herbicide-dependent.
- Generally, low use-rate herbicides.

**Symptomology**

- Injury symptoms on grass include stunting, purple coloration, and inhibited root systems with “bottle-brush” appearance.
- Broadleaf plant symptomology includes formation of red or purple leaf veins, yellowing of new leaf tissue and blackening of terminal growth.
- Roundup and Touchdown injury includes initial yellowing followed by death of affected tissue.
5. Pigment Inhibitors

These herbicides cause the green pigments (chlorophyll) in plants to be destroyed. Without chlorophyll, plants cannot photosynthesize and will die.

Examples: Command, Zorial, Evital, Solicam, Amitrol, Balance, Callisto
Pigment Inhibitors

Characteristics

- These herbicides are absorbed by roots and translocated to the shoot tissue by way of the xylem.
- Amitrol is mobile in the phloem and will move with plant sugars.
- The soil activity with these herbicides will vary from a few months to 12 months.

In order to use Command in cotton, an organophosphate insecticide (Thimet or Di-Syston) must be used in-furrow to “safen” the cotton.

Caution is advised when these herbicides are used in sandy soils.
Symptomology

- Pigment inhibitors cause white foliage (“albino growth”) in susceptible plants
- New growth will not contain the normal green pigmentation necessary for photosynthesis
- Symptoms may be found on the cotyledonary leaves and true leaves
- Albino growth may be observed within veins (primarily with Zorial) and between veins (primarily with Command)
6. Lipid Synthesis Inhibitors

These herbicides act by disrupting lipid biosynthesis in grass plants. Plant cells and cellular organelles all contain lipid membranes. Therefore, these herbicides affect cell membrane integrity in the meristematic areas.

Examples: Select, Poast Plus, Fusilade DX, Assure II, Hoelon, Achieve

Lipid Synthesis Inhibitors

Characteristics

- All LSI’s are foliarly applied, except for Hoelon
- Translocated in phloem to meristematic tissue
- Affect annual and perennial grasses only
Symptomology

- Initial injury in meristematic regions occurs where newest leaves are developing.
- These regions will turn chlorotic, which is followed by necrosis.
- The affected area will become “rotted” and will easily separate from rest of plant.
- Injury will develop slowly (7 to 14 days).

Source: W. K. Vencill, UGA