Contact herbicides

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Kills on contact
Volutility

- The evaporation of herbicide molecules directly from water, soil or plant surfaces.
**Codistillation (lift off)**

- The evaporation of herbicide molecules from water, soil or plant surfaces **together** with water vapor.
Protox inhibitor herbicides

- Carfentrazone – Shark from FMC
- Flumioxazin – Chateau or Valor from Valent
- Oxyflourfen – Goal, GoalTender from Dow AgroSciences
Protox inhibitors

Goal (oxyfluorfen)

Chateau (flumioxazin)

Shark (carfentrazone)
Protox inhibitors + paraquat

Goal (oxyfluorfen)

Chateau (flumioxazin)

Shark (carfentrazone)

Gramoxone (paraquat)
Main point

- These herbicides have very different chemistries, but cause similar symptoms on plant foliage.
Protox inhibitor herbicides

- These herbicides act in the chlorophyll synthesis pathway.
- They all inhibit an enzyme called “protoporphyrinogen oxidase” or “protox”.
- Also called “PPO” herbicides
- These herbicides kill by lipid peroxidation. In other words they break down the cell membrane. The cell then breaks open and the leaf dies.
Paraquat

- Paraquat reacts with photosynthetic enzymes to form reactive radical molecules.
- These radicals break down the cell membrane. The cell then breaks open and the leaf dies.
Protox & paraquat herbicides compared

<table>
<thead>
<tr>
<th>Factor</th>
<th>Chateau</th>
<th>Goal</th>
<th>Shark</th>
<th>Paraquat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil residues</td>
<td>Long</td>
<td>Long</td>
<td>Short</td>
<td>None</td>
</tr>
<tr>
<td>Lift off</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Drift concerns</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
How protox inhibitors & paraquat kill weeds

- These herbicides cause a reaction that attacks lipid molecules in the plant cells.
Cell Membrane Disrupters – Bipyridylium Herbicides

- Paraquat (Gramoxone)
- Diquat

Paraquat on tomatoes
**How Applied:**
Foliar applied

**Mode of Action:**
These herbicides intercept the energy of the photosynthetic process and produce disruptive compounds which result in membrane disruption and plant desiccation.

**Common Symptoms:**
Water soaked appearance followed rapidly by necrosis and desiccation of leaves and stems, may cause chlorotic spots in dilute concentration.
Paraquat foliar symptoms

Paraquat on almond leaves

Paraquat on beans
Paraquat drift on wheat
Paraquat drift on apricots
Grape leaf with spots from paraquat
Defoliant on lettuce
Stemfillium leaf spot
Paraquat

- Interferes with photosynthesis (PS I). This is a different site of action from the protox inhibitor herbicides.
- Paraquat also kills by lipid degradation which results in rupturing of the cell membrane.
- Very rapid kill – on sunny days symptoms can be seen within 15 minutes.
Paraquat – characteristics

- Not volatile
- Contact activity only, not translocated
- Activity can be improved with mixtures of Karmex
- No soil activity – immediately binds to soil particles especially clay.
- Requires surfactant
Cell Membrane Disrupter – Herbicides

- Goal
- Buctril
- Shark
- Chateau
**How Applied:**
Soil and foliar applied with limited movement in the soil.

**Mode of Action:**
Oxyfluorfen, flumioxazin and carfentrazone cause membrane disruption through lipid peroxidation.

**Common Symptoms:**
These herbicides cause necrosis of leaves and stems.
Protox inhibitor foliar symptoms

- Water-soaked appearance then necrotic spots.
Goal injury in cauliflower
Drift Roundup and Goal severe swelling in March
Buctril on onion treated too late
Peppers with Goal (oxyfluorfen) injury
Cucumbers – Goal (oxyfluorfen) drift, new growth OK
Shark injury in wheat
Shark drift injury
Shark drift injury
1st year almond and Shark

Mature almond and Shark
Prune injured by Shark (carfentrazone)
Chateau drift
Chateau drift
Chateau from poor application in grapes
Chateau, poor sprayer clean out
More on protox herbicides

- These herbicides are fast acting
- Don’t translocate
- Crop selectivity is based on placement and timing
- Most crops are susceptible to foliar drift injury eg. Lettuce.
- Selectivity for Goal on onion is due to the waxy cuticle.
Goal soil characteristics

- Moderately volatile, and can co-distill from moist soil surfaces.
- Goal binds to the soil organic matter.
- Some Goal dissociates to enter the soil water and kill weed seedlings.
- Forms a soil barrier that can be broken by tillage.
Chateau – characteristics

- Can photo degrade
- Not volatile
- Has soil residual activity. Broken down by microbial activity and hydrolysis.
- Very effective on hairy fleabane
- Good clover control preemergence
Shark – characteristics

- Does not photo degrade
- Not volatile
- Short soil resides – rapidly degrades by hydrolysis and microbial degradation.
# Protox & paraquat weed spectrum

<table>
<thead>
<tr>
<th>Weed</th>
<th>Chateau</th>
<th>Goal</th>
<th>Shark</th>
<th>Paraquat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickweed</td>
<td>C</td>
<td>N</td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>Clover</td>
<td>C</td>
<td>P</td>
<td>--</td>
<td>P</td>
</tr>
<tr>
<td>Henbit</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Fleabane</td>
<td>C</td>
<td>P</td>
<td>N</td>
<td>P</td>
</tr>
<tr>
<td>Malva</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>P</td>
</tr>
<tr>
<td>Mustard</td>
<td>--</td>
<td>C</td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>B. nettle</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>P</td>
</tr>
<tr>
<td>Shepherd's</td>
<td>C</td>
<td>C</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Sowthistle</td>
<td>C</td>
<td>C</td>
<td>N</td>
<td>P</td>
</tr>
</tbody>
</table>
Summary

- All these herbicides can cause drift injury.
- It is likely that oxyfluorfen is the only product that causes lift off among these products.
- All of these products have soil activity except paraquat.