Herbicide Modes of Action (effect on plant growth)

This chart groups herbicides by their modes of action to assist you in selecting herbicides 1) to maintain greater diversity in herbicide use and 2) to rotate among herbicides with different sites of action to delay the development of herbicide resistance.

<table>
<thead>
<tr>
<th>Site of Action Group*</th>
<th>Site of Action</th>
<th>No. of Resistant Weed Species in U.S.</th>
<th>Chemical Family</th>
<th>Active Ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lipid Synthesis Inhibitors</strong></td>
<td>ACCase Inhibitors (acetyle CoA carboxylase)</td>
<td>15</td>
<td>Arloxyphenoxy propionate</td>
<td>fenoxaprop, fluazifop, quizalofop, cyclohexanedione, clodhimgth, sethoxydim</td>
</tr>
<tr>
<td></td>
<td>ALS Inhibitors (acetolactate synthase)</td>
<td>38</td>
<td>Sulfonilurea</td>
<td>chlorimuron, foramsulfuron, halosulfuron, iodosulfuron, nicosulfuron, prosulfuron, rimsulfuron, thifensulfuron, tribenuron</td>
</tr>
<tr>
<td></td>
<td>EPSP Synthase Inhibitor (5-enolpyruvyl-shikimate-3-phosphate)</td>
<td>9</td>
<td>None accepted</td>
<td>glyphosate</td>
</tr>
<tr>
<td><strong>Amino Acid Synthesis Inhibitors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PPO Inhibitors</td>
<td>7</td>
<td>None accepted</td>
<td>glyphosate</td>
</tr>
<tr>
<td></td>
<td>Photosystem I Electron Diverter</td>
<td>2</td>
<td>Diphenylether</td>
<td>acifluorfen, fomesafen, lactofen</td>
</tr>
<tr>
<td></td>
<td>Photosystem II Inhibitors</td>
<td>6</td>
<td>Dinitroaniline</td>
<td>ethalfluralin, pendimethalin, trifluralin</td>
</tr>
<tr>
<td></td>
<td>Photosystem II Inhibitors (different binding than 5 &amp; 6)</td>
<td>7</td>
<td>Ureas</td>
<td>linuron</td>
</tr>
<tr>
<td></td>
<td>Photosystem II Inhibitors (different binding than 5 &amp; 6)</td>
<td>15</td>
<td>Chloroacetamide</td>
<td>acetochlor, alachlor, metachlor, dimethenamid, pyroxasulfone, oxyacetamide, flufenacet</td>
</tr>
</tbody>
</table>

*Site of Action Group is a classification system developed by the Weed Science Society of America.

This table is excerpted with permission from the Corn and Soybean Herbicide Chart (GWC-3), part of the Glyphosate, Weeds, and Crop Series published by Purdue University through a cooperative effort of weed scientists in the 16-state USDA North Central Region. Contained here are pages 8-10 of the 2016 Guide for Weed, Disease, and Insect Management in Nebraska. The 300+ page guide is available at Marketplace.unl.edu © The Board of Regents of the University of Nebraska–Lincoln. All rights reserved.
**Classification of Herbicides by Mode and Site of Action and Chemical Family**

Herbicides may be classified into families based on how they kill plants (mode of action and site of action) or by chemical similarity. An example of a common commercial herbicide containing the active ingredient is also listed. Please refer to the Herbicide Dictionary to identify other commercial herbicides that contain the same active ingredient. In some cases, herbicides from different chemical families have a similar site of action. A knowledge of herbicide families and herbicide mode and site of action will reduce the risk of choosing herbicides that will lead to the development of herbicide-resistant weeds or problems with chemical carryover.

Repeated use of a herbicide or herbicides with the same site of action may lead to the selection of herbicide-resistant weeds, or a shift in the weed species present in the field to weeds tolerant to a particular herbicide or herbicide family. For example, repeated use of ALS inhibitors can result in the selection for ALS-resistant weeds. Using both sulfonyleurea and imidazolinone herbicides (Classic, Pursuit, etc.) in the same growing season can result in increased carryover problems or possible crop injury.

These problems can be lessened by rotating or combining herbicides with different action sites. In the table the site of herbicide uptake is indicated by: \( R = \) root uptake; \( S = \) shoot uptake; and \( F = \) foliage uptake. Letter sequence indicates the primary order of herbicide uptake. Repeated use of herbicides with a common mode and site of action pose the highest risk of an additive effect which can lead to resistant weed development, additional carryover, or more crop injury. Refer to the journal, *Weed Technology*, 11: 384-393 (1997) for additional information on herbicide classification.

### Lipid Synthesis Inhibition

**Group 1. ACCCase inhibition**

1. Arylxypropoxypropionates (FOPs)
   - clodinafop propargyl — Discovery — F
   - diclofop — Hoelon — F
   - fenoxaprop — Acclaim Extra — F
   - fluazifop — Fusilade DX — F
   - pinoxaden — Axial — F
   - quizalofop-P — Assure II — F

2. Cyclohexanediones (DIMs)
   - clethodim — Select Max — F
   - sethoxydim — Poast — F
   - tralkoxydim — Achieve — F

### Amino Acid Synthesis Inhibition

**Group 2. ALS-AHAS inhibition**

1. Imidazolinones
   - imazamethabenz — Assert — F/R
   - imazamox — Raptor — F/R
   - imazapic — Plateau — F/R
   - imazapyr — Arsenal — R/F
   - imazaquin — Scepter — R/F
   - imazethapyr — Pursuit — R/F

2. Sulfonyleureas
   - bensulfuron — Londax — F/R
   - chlorimuron — Classic — F/R
   - chlorsulfuron — Clean/Telar — F/R
   - ethamsulfuron — Muster — F
   - foramsulfuron — Option — F
   - halosulfuron — Permit — F/R
   - iodosulfuron — Autumn — F
   - metsulfuron — Ally/escort — F/R
   - nicosulfuron — Accent — F
   - primisulfuron — Beacon — F/R
   - prosulfuron — Peak — F/R
   - rimsulfuron — Matrix — F/R
   - sulfoeturon — Oust — F/R
   - sulfosulfuron — Maverick
   - thifensulfuron — Harmony — F/R
   - triasulfuron — Amber — F/R
   - tribenuron — Express — F/R
   - triflusulfuron — Upbeet — F

### Seedling Growth Inhibition

**Group 3. Microtubule assembly inhibition**

1. Dinitroanilines
   - benfluaril — Balan — S/R
   - ethalfluralil — Curbit/Sonalan — S
   - oryzalin — Surflan — S
   - pendimethalin — Prowl — S
   - prodimi — Barricade — S
   - trifluralin — Treflan — S

2. Pyridines
   - dithiopyr — Dimension — R/F

3. Benzamides
   - bromamidine — Kerb — S/R

4. Benzolic acids
   - DCPA — Dacthal — R

**Group 15. Long-chain fatty acid inhibitor**

1. Chloroacetamides
   - acetochlor — Harness/Surpass NXT — S/R
   - alachlor — Intrro — S/R
   - dimethenamid — Outlook — S/R
   - metolachlor — Dual — S/R
   - propachlor — Ramrod — S/R

2. Oxyacetamides
   - flufenacet — Define — S/R

3. Acetamides
   - naproxam — Devrinol — R/S

4. Oxazoles
   - pyroxasulfone — Zidua — S/R

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Seedling Growth Inhibition (continued)

Group 16. Lipid synthesis inhibition (not ACCase)
1. Benzofuranes
   ethofumesate — Nortron SC — S/R

Group 8. Phosphorodithionates
1. Benzofuranes
   bensulide — Betasan — R
2. Thiocarbamates
   butylate — Sutan + — S/R
cycloate — Ro-Neet — S/R
EPTC — Eradican — S/R
triallate — Far-Go — S/R

Group 19. Auxin transport inhibition
1. Phthalates
   naptalam — Alanap — R/F
2. Semicarbazone
diflufenpyr — Distinct — F

Cell Wall Synthesis Inhibition

Group 21. Benzamides
isoxaben — Gallery — R/S

Group 20. Nitriles
dichlobenil — Casoron — R/F

Growth Regulators

Group 4. Synthetic auxins
1. Phenoxyacetic acids
   2,4-D — many — F/R
   2,4-DB — Buycryac — F
dichlorprop — many — F
MCPA — many — F/R
mecoprop — many — F
2. Benzoic acids
dicamba — Banvel/Clarity — F/R/S
3. Pyridine carboxylic acids
   aminopyralid — Milestone — F/R
clopyralid — Stinger — F/R
fluoroxypry — Starane — F
picloram — Tordon — F/R
triclopyr — Garlon — F/R
4. Quinoline carboxylic acids
   quinclorac — Paramount — F/S
5. Pyrimidine carboxylic acids
   aminoclopyralchlor — Imprelis — F/R

Photosynthesis Inhibition (Photosystem II) — Classes differ in binding behavior

Group 5. C₃ class
1. Triazines
   ametryn — Evik — R/F
   atrazine — AAtrex — R/F
   prometon — Pramitol — R/F
   simazine — Princep — R
2. Triazinones
   hexazinone — Velpar — R/F
   metribuzin — Sencor — R/F
3. Phenylcarbamates
desmedipham — Betanex — F
phenmedipham — Spin-Aid — F
4. Uracils
   bromacil — Hyvar — R
terbacil — Sinbar — R
5. Pyridazinones
   pyrazon — Pyramide — R/F

Group 7. C₂ class
1. Phenylureas
diuron — Karmex — R
linuron — Lorox — R/F
siduron — Tupsersan — R
tebuthiuron — Spike — R

Group 6. C₅ class
1. Benzothiadiazinones
   bentazon — Basagran — F
2. Nitriles
   bromoxynil — Buctril — F
3. Phenylpyridazine
   pyridazine — Tough — F

Cell Membrane Disruption

Group 14. PPO inhibition
1. Diphenylethers
   acifluorfen — Blazer — F
   fomesafen — Reflex/Flexstar — R/F
   lactofen — Phoenix/Cobra — F
   oxyfluorfen — Goal — R/S
2. N-phenylphthalimides
   flumiclorac — Resource — F
   flumioxazin — Valor — S/F
3. Triazinones
   sulflurazone — Authority/Spartan — R
carfentrazone ethyl — Aim — F
4. Thiadiazoles
   fluthiacet methyl — Cadet — F
5. Phenylpyrazoles
   pyraflufen-ethyl — Vida — F
6. Trifluoromethyl uracils
   safuronil — Kitor — R/F/S

Group 22. Photosystem I electron diversion
1. Bipyridyls
   dichlobenil — Casoron — R/F/S
   saflufenacil — Kixor — R/F/S

Unclassified or Unknown

1. Triazole
   amitrole — Amitrole — F

Nitrogen Metabolism Inhibition

Group 10. Glutamine synthetase inhibition
1. glufosinate — Liberty — F

Unclassified or Unknown

1. Organoarsenicals
   DSMA — many — F
   MSMA — many — F
2. Other
   endosulfan — Aquathol — R/F
difenzoquat — Avenge — F
   fosamine — Krenite — F