**Resistance vs. Tolerance vs. Avoidance**

Herbicide resistance
- The evolved capacity of a previously herbicide-susceptible weed population to withstand a herbicide and complete its life cycle when the herbicide is used at its normal rate in an agricultural situation (Heap and LeBaron, 2001)
- Nebraska example: ALS-resistant common waterhemp

Herbicide Tolerance
- The native capacity of a weed population to withstand a herbicide and complete its life cycle when first exposed to that herbicide at its normal use rate in an agricultural setting
- Nebraska example: Fosetyl and 2,4-D

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**Factors Influencing Resistance Selection**

**PLANT**
1. Plant lifecycle and growth
2. Fecundity
3. Plasticity
4. Genetic diversity

**SELECTION AGENT (herbicide)**
1. Frequency
2. Dose

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**Mechanisms of Resistance**

1. Target site mutation/increased expression
   - ALS & triazine resistance

2. Metabolism/detoxification of herbicide
   - ACCase resistance

3. Reduced movement (translocation) to active site/sequestration
   - Glyphosate resistance

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**Single Gene Interaction**

- Single Gene
- Single Gene
- Single Gene
- Single Gene
- Single Gene
- Single Gene
Multiple Gene Interaction

Herbicide combinations for resistance management

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<td>++</td>
<td>++</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>++</td>
<td>++</td>
</tr>
<tr>
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</tr>
<tr>
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<td>0</td>
<td>+</td>
<td>0</td>
<td>++</td>
</tr>
</tbody>
</table>

Each herbicide has a different mode of action. Combination(s) of which two herbicides would provide the best treatment to counter herbicide resistance.

Herbicide rotation for resistance

Influence of herbicide rotation on the evolution of resistance

Frequency of Resistant Plants

Time (generations)

[Graphs showing the influence of herbicide rotation on the evolution of resistance]