Herbicide Resistance Management in Tomato

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What is Herbicide Resistance?

• Tolerant
  – A plant is naturally tolerant to a herbicide dose typically used to control other plant species

• Susceptible
  – Plant population dies at doses that do not injure other plant species

• Resistant
  – The ability of a formerly susceptible plant to survive and reproduce following exposure to an herbicide dose that would normally killed susceptible plants.
Why Herbicides Don’t Work

• PLANT CHARACTERISTICS
  • Tolerance
  • Plant size
  • Not actively growing
  • Limited movement to underground plant parts
Why Herbicides Don’t Work

• APPLICATION ERRORS
  • Improper calibration
  • Wind or rain
  • Poor coverage
  • Water quality
  • Tank mix of products known to inhibit one another
  • Improper use of surfactants
Water pH

– pH 3-6 adequate for short term storage
– pH 6.1 to 7 ok for immediate spraying
– pH 7 or above add a buffer or acidifier

• Sulfonylurea (Sandea) herbicide works better in slightly basic conditions
Water pH

• Herbicides that break down quickly when pH is greater than 7
  – 2,4-D amine
  – Glyphosate (Roundup)
  – Glufosinate (Ignite)
  – Flumioxazin (Chateau)
Example:
Flumioxazin (Chateau, Broadstar)

<table>
<thead>
<tr>
<th>pH</th>
<th>5</th>
<th>7</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half Life</td>
<td>days</td>
<td>24 hrs</td>
<td>15 minutes</td>
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Options
1. Test pH
2. Read the herbicide label
3. Limit time products are stored in tanks once mixed with water
4. Add acidifiers or buffering agents when needed
Why Herbicides Don’t Work

• APPLICATION ERRORS
  • Improper calibration
  • Wind or rain
  • Poor coverage
  • Water quality
  • Tank mix of products known to inhibit one another
    – Sandea + Select + surfactant
  • Improper use of surfactants
Prior to any Herbicide Application:
Where a weed is not abundant

- Rates of mutation: 1 in $10^5$ - $10^6$ for single, nuclear gene
YEAR 1: Prior to any Herbicide Application

Where Weeds are Abundant
YEAR 1: Following a Single Herbicide Application
YEAR 2: Prior to the Second Herbicide Application
YEAR 2: Following the Second Herbicide Application
Amino Acids: Plant Lives

No Amino Acids: Plant Dies

Herbicide cannot bind.

Herbicide cannot bind.

Amino Acids: Plant Lives

Kansas State University
http://plantandsoil.unl.edu/croptech2005/pagesincludes/printModule.jsp?informationModuleId=998689386
Resistance by MOA

Number of Species vs Year

- ACCase Inhibitors (1)
- ALS Inhibitors (2)
- EPSP Synthase Inhibitors (9)
- Synthetic Auxins (4)
- PSII Inhibitors (5,6,7)

Note: PSII Inhibitors Combined

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Resistance by Crop Category

Crop or Situation | Number of Herbicide Resistant Species
--- | ---
Wheat | 73
Corn (maize) | 61
Rice | 51
Soybean | 47
Roadsides | 32
Winter wheat | 32
Spring Barley | 30
Orchards | 27
Canola | 21
Cotton | 18
Pastures | 18
Railways | 15
Vegetables | 14
Peas | 13
Grapes | 11
Why fewer cases of resistance in vegetables

- Tillage
Why fewer cases of resistance in vegetables

- Tillage
- Fumigation
Why fewer cases of resistance in vegetables

• Tillage
• Fumigation
• Plastic mulches
• Hand weeding
Resistance Could be a Serious Problem in Vegetables

- Few registered modes of action
- Rarely achieve a competitive canopy
- Vegetables tend to be very susceptible to competition
- Common weeds of vegetables have developed resistance in other crops
Glyphosate Resistant Weeds

Increase in Glyphosate-Resistant Weeds Worldwide

Number of Species

Year

Dr. Ian Heap, WeedScience.org, 2016
American Black Nightshade
- Paraquat
American Black Nightshade
- Paraquat
American Black Nightshade
- Paraquat
Goosegrass
- Paraquat
Goosegrass
- Paraquat
Goosegrass
- Paraquat
Ragweed Parthenium
- glyphosate
Ragweed Parthenium
- glyphosate
Detection of Resistance

- Good weed control except in localized areas
- Only one species is not controlled
- A previously susceptible species is no longer controlled by a given herbicide and the number of weeds of that species increases over time
- Uncontrolled species occurs in patches
- Dead plants of the same species are intermixed with plants that survived the herbicide application
How to Delay the Development of Herbicide Resistance

• Chemical
  – Rotate modes of action
Fallow - glyphosate

Fumigation

Under the Plastic - S-metolachlor

Row Middle - flumioxazin

Post-Transplant - halosulfuron

Crop termination - paraquat
How to Delay the Development of Herbicide Resistance

• Chemical
  – Rotate modes of action
  – Tank mix multiple modes of action
    • Flumioxazin + pendimethalin in row middles
  – Retreat suspected resistant plants with a different mode of action
How to Delay the Development of Herbicide Resistance

• Cultural and Physical
  – Crop rotation (cover crops)
  – Remove resistant individuals
  – Prevent spread of resistant biotypes
  – Alternate physical/cultural methods with herbicides
Steps to take if you suspect resistance

1. Call your Extension Agent to investigate.
2. Preserve a few plant specimens for further testing.
3. Eradicate all surviving plants.
   – Tillage, herbicides, or hand removal
4. Do not let survivors produce seed!
5. Prepare a weed control program for next year that will address this problem.