Case Histories of Weed Resistance to Glyphosate

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(Photo courtesy of Univ. Missou

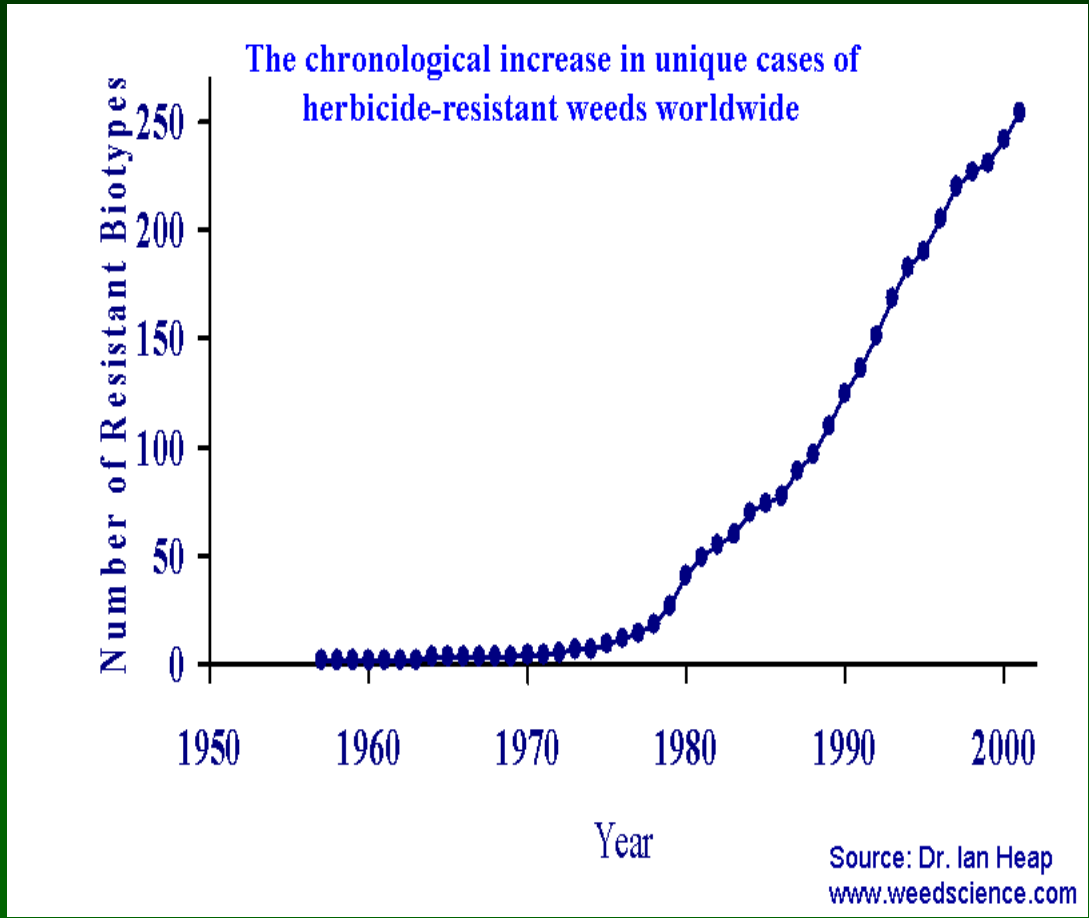
Presentation Outline

- What is resistance?
- Occurrence of herbicide-resistant weeds in WI
- Increase of glyphosate-resistant weeds
- Case histories of glyphosate-resistant weeds
- What is the potential for selection of glyphosate-resistant weeds in Wisconsin?

(Photo courtesy of Univ. Missou

What is resistance?

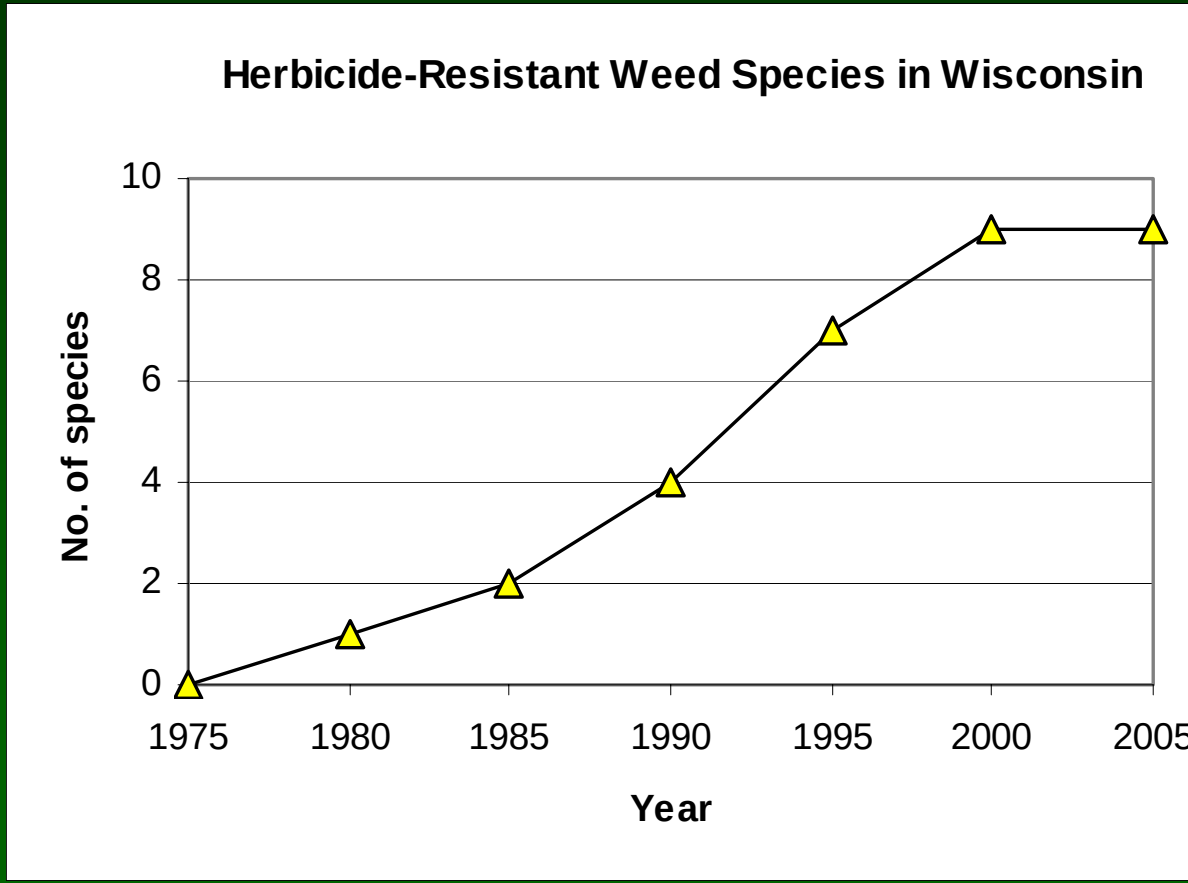
It's the inherited ability of a plant to survive and reproduce following exposure to a herbicide dose normally lethal to the wild type.



(Weed Science Society of America 1998)

Herbicide-Resistant Weeds in Wisconsin

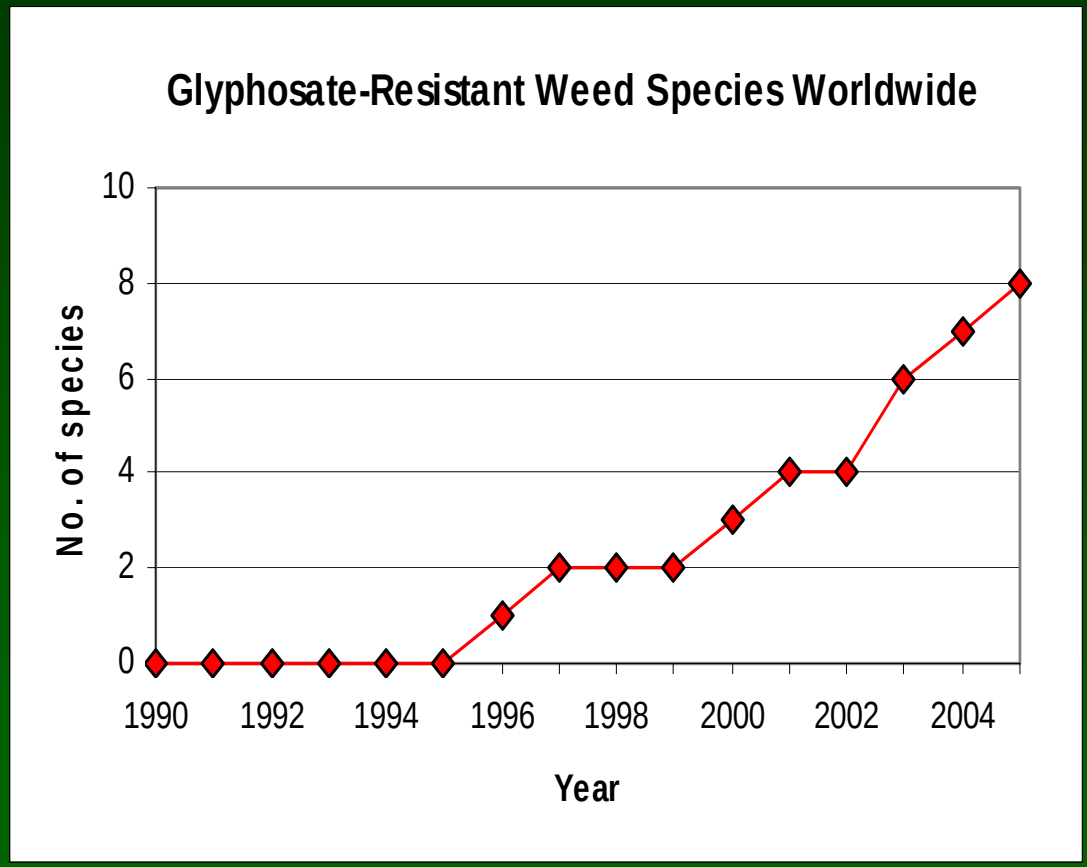
- Triazine herbicides
  - Lambsquarters (1979)
  - Smooth pigweed (1985)
  - Kochia (1987)
  - Velvetleaf (1990)
- ACCase inhibitors
  - Giant foxtail (1991)
  - Large crabgrass (1992)
- ALS inhibitors
  - Kochia (1995)
  - Giant foxtail (1999)
  - Green foxtail (1999)
  - E. black nightshade (1999)
  - Common waterhemp (1999)



(Heap 2005,

Confirmed Cases of Glyphosate-Resistant Weeds

- Rigid ryegrass (1996)
- Goosegrass (1997)
- Horseweed (2000)
- Italian ryegrass (2001)
- Hairy fleabane (2003)
- Buckhorn plantain (2003)
- Common ragweed (2004)
- Palmer amaranth (2005)



(Heap 2005, www.weedscience.c


Case Histories
W.S. Curran
Penn State University

Glyphosate-Resistant Horseweed

- First observed in Delaware (2000)
  - No-till, Roundup Ready soybean
  - Little or no glyphosate used before 1997
  - Glyphosate only in 1998-2000
    - Applied PRE and POST
  - Management problem by 2000
    - Some plants survived total of 3.0 lb ae/acre in field
  - 8- to 13-fold resistance in greenhouse
- Level of concern?
  - Rapid spread across eastern U.S.
    - Found in 12 more states by 2005
  - Recommendation to consider all horseweed as resistant in eastern U.S.
  - Multiple resistance to other herbicides
    - Resistance to glyphosate and ALS-

(Heap 2005,

(VanGessel, Univ. Delawar

Glyphosate-Resistant Horseweed

- Why such a rapid spread?
  - Glyphosate use intensity
    - Widespread adoption of no-till, glyphosate-resistant soybean
  - Horseweed biology
    - Prolific seed production
    - Wind dispersal of seeds
      - Potentially many miles away

(VanGessel, Univ. Delawar

(www.weedscience.or

Glyphosate-Resistant Common Ragweed

- Discovered in Missouri (2002)
  - No-till system
  - Roundup Ready soybean since 1996
  - Inadequate control observed by 2002
    - Glyphosate applied several times over 6 yr
  - Nearly 10-fold resistance in greenhouse experiments
- Distribution limited mostly to field of origin
  - 50 acre area
  - Some spread along adjacent road
  - Non-confirmed report in Arkansas
- Level of concern?
  - Wind pollination and introgression with other ragweed species
  - Potential for multiple resistance
    - ALS-inhibitors and triazines

Glyphosate-Resistant Palmer Amaranth

- Confirmed in Georgia (2005)
  - Roundup Ready cotton since 1997-98
  - Conventional tillage
  - Glyphosate predominant herbicide used
    - Applied 2-3 times/year
  - High level of resistance by 2005
  - About 500 acres infested in field of origin
- Level of concern?
  - A serious threat to cotton production
    - The most competitive of pigweed species
  - Wider distribution under investigation
    - Confirmed in 10 more fields in GA
    - Non-confirmed reports in TN and NC
  - Hybridization between Palmer amaranth and other pigweed species
  - Potential for multiple resistance

WeatherMax 132 oz/A

(Culpepper, Univ. Georgia)

Potential Resistance to Glyphosate
Common lambsquarters

- Inadequate control in Ohio (2002)
  - Plants survived glyphosate applied one or more times in several fields
  - Roundup Ready soybean systems
  - Characterized as “less sensitive” to glyphosate in 2003
  - Since then several biotypes characterized as “resistant”
- Increasing occurrence expected in Ohio
  - Selection from over-reliance on glyphosate
- Variable response to glyphosate observed in several states
  - Includes Wisconsin 2003-05
  - Resistance to glyphosate has not been confirmed
    - Several factors appear to contribute

Non-treated 1X 4X
(Glyphosate 1X = 0.75 lb ae/acre)

Potential Resistance to Glyphosate
Common waterhemp

- Iowa, Illinois, Missouri 2001
  - Inconsistent control reported in several fields
  - Individual plants within populations survive exposure to glyphosate
    - Response variable at population level
  - Resistance trait appears to be heritable
- Potential resistance in Missouri 2005
  - Continuous Roundup Ready soybean since 1996
  - Glyphosate sole herbicide used
  - Plants survived up to 6 lb ae/acre glyphosate in greenhouse experiments
- Level of concern?
  - No. 1 weed problem in corn and soybean in MO
  - Potential for multiple resistance
    - ALS-inhibitors and triazines

(www.weedscience.org)

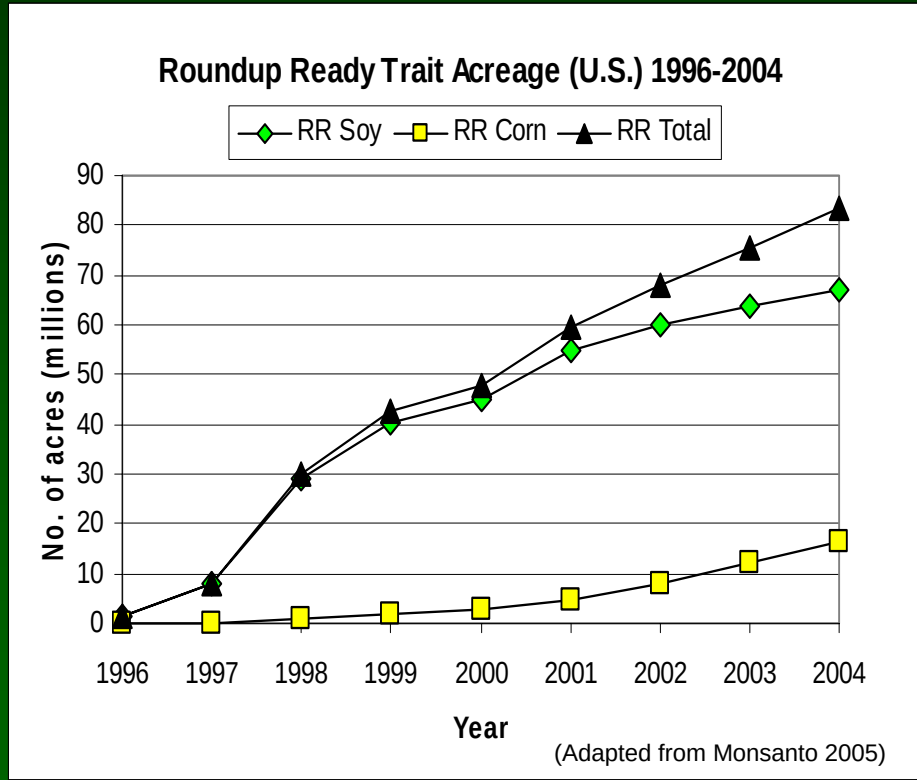
Potential Resistance to Glyphosate
Giant Ragweed

- Variable control observed in Ohio (2004)
  - Roundup Ready soybean system
  - Glyphosate only for at least 4 years
- Reduced sensitivity confirmed (2005)
  - Some plants survived multiple applications of glyphosate totaling up to 4.5 lb ae/acre in the field
  - Viable seed produced from plants treated with up to 3.0 lb ae/acre
- Level of concern?
  - Extent of problem not known
    - Likely to occur in other fields with similar levels of glyphosate selection intensity?
  - Wind pollination and introgression with other ragweed species
  - Potential for multiple resistance

(Loux 2006, Stachler et al. 2005, Ohio State U

Summary

- Resistance to glyphosate has occurred in several weed species over a broad geographic range
  - About 1 species/year since 1996 worldwide
  - Potential resistance of several more species
- Glyphosate selection intensity appears to be a common factor among these occurrences
  - A high level of reliance on glyphosate over time
- What is the potential for selection of glyphosate-resistant weeds in Wisconsin?
  - Over-reliance?
  - Integration with other practices?



(Adapted from Monsanto 2005)