UNIVERSITY OF MINNESOTA | EXTENSION

MAKING A DIFFERENCE IN MINNESOTA: ENVIRONMENT + FOOD & AGRICULTURE + COMMUNITIES + FAMILIES + YOUTH

Removing Barriers to Weed Management Diversification by Highlighting the Hidden Costs of Biological Time Constraints

Jeffrey L. Gunsolus
gunso001@umn.edu

TRENDS IN HERBICIDE USE IN MN
1990 - 2014

- Postemergence tactics were popular because it allowed farmers to decouple the time constraints of soil-applied herbicide application from planting date timing

- Decline of soil-applied residual herbicides was understandable considering that cool and wet soils in MN can delay crop planting and increase herbicide-induced crop injury and carryover to rotational crops

- In the mid-1990s, at the height of the ALS-herbicide market, reports of ALS-resistance became more common for: giant and common ragweed and common waterhemp

- These same species have now demonstrated resistance to glyphosate and multiple resistance is an issue

RATE OF ROUNDUP READY ADOPTION IN MN

- Sequential adoption of Roundup Ready soybean, corn and sugar beet in 1996,1998 and 2008, respectively, expanded the rate of adoption of postemergence tactics and the decline of diversified weed management strategies

- High percentage of MN acres are currently planted to:
  - RR soybean
    - Approximately 97% of acres are treated with glyphosate
    - Less than 25% of acres use a PRE herbicide
  - RR corn
    - Approximately 90% of acres are treated with glyphosate
    - Approximately 50% of acres use a PRE herbicide
  - RR sugar beet
    - Approximately 100% of acres are treated with glyphosate
    - Minimal use of PRE herbicides

MN CORN HERBICIDE USE TRENDS

Year	Corn Area Applied PRE (%)	Area Applied w/ glyphosate (%)
2009	50	85
2005**	49	49
2003	50	22
2002	43	11
1999	62	7
1996*	73	0
*ALS used on 33% of acres		
**ALS used on 12% of acres		

MN SOYBEAN HERBICIDE USE TRENDS

	Soybean Area Applied PPI/PRE (%)	Area Applied w/glyphosate (%)
2009**	2	98
2004	15	85
2002	23	79
1999	39	48
1996	62	7
1994*	71	4
*ALS used on 70% of acres		
**ALS used on <2% of acres		

Impact of Herbicide Resistance to Weed Management Strategies

- ISU Reports waterhemp responses to labeled herbicide rates indicate:

How will you know the frequency of resistant populations in any given field?

SO WHAT DO WE DO ABOUT HERBICIDE RESISTANT WEEDS?

- After a >20 year emphasis on postemergence tactics with a herbicide that lacks soil weed control we have to reconnect with the biological principles that influence and inform durable weed management strategies

- A higher level of weed management diversification needs to occur and a good place to start is by addressing:
  - Selection intensity, using the same weed management tactic again and again
    - » Need for diversification of weed management tactics
  - Allowing weed population size to increase in the seed bank
    - » Increases probability of a R-trait
    - » Need to prevent pollen and seed production

EDUCATIONAL APPROACHES TO DEMONSTRATE THE BENEFITS OF DIVERSIFICATION

- Goal is to deconstruct current herbicide-based strategies in order to assess the hidden costs that weed biology, competition and time of weed removal have on weed control and crop yield

- Focus on educational methodologies that will expose these hidden costs to farmers and remove some of the barriers associated with diversification of weed management

EDUCATIONAL APPROACHES TO DEMONSTRATE THE BENEFITS OF DIVERSIFICATION- A TEAM APPROACH

- Developed a Research and Education team to address these goals
  - Weed Management Working Group
  - Extension, IPM and Research & Outreach Center personnel

- Weed Management Working Group's Goals
  - Maintain information links to agribusiness
  - Develop educational methodologies that enhances extension activities and addresses specific farmer concerns
  - Evaluate integrated management systems for efficacy, economic viability, degree of risk to the farmer and rate of adoption

ASSESSING THE "HIDDEN COSTS" OF BIOLOGICAL TIME CONSTRAINTS

- At the interface between weed biology and the economics of crop production lies a critical communication point between the weed scientist and farmer
  - How to align the farmer's time and labor constraints with site-specific "biological time constraints" of weeds?
  - Biological time constraints are time-dependent properties that influence weed management and would include:
    - Periodicity of weed emergence
    - Rate of weed and crop growth
    - Crop sensitivity to early season weed competition

CONSIDER HOW RESIDUAL HERBICIDES CAN ADDRESS "HIDDEN COSTS" OF EARLY-SEASON WEED COMPETITION

Yield loss due to weeds is not always as visible to the farmer as is weed control, input costs and convenience

Expect:

- Residual herbicides to reduce timeliness issues associated with postemergence weed control
  - Periodicity of weed emergence – big impact on early-emerging weeds
  - Early season weed competition – "hidden costs"
  - Rapid weed growth and environment interactions = inconsistent control
  - Reduces weed density thus improving POST herbicide performance
- Residual herbicides do come with some risk to the farmer
  - Rainfall to activate the herbicide
  - Potential for early season crop injury (e.g. cold and wet weather)
  - Can limit crop rotations

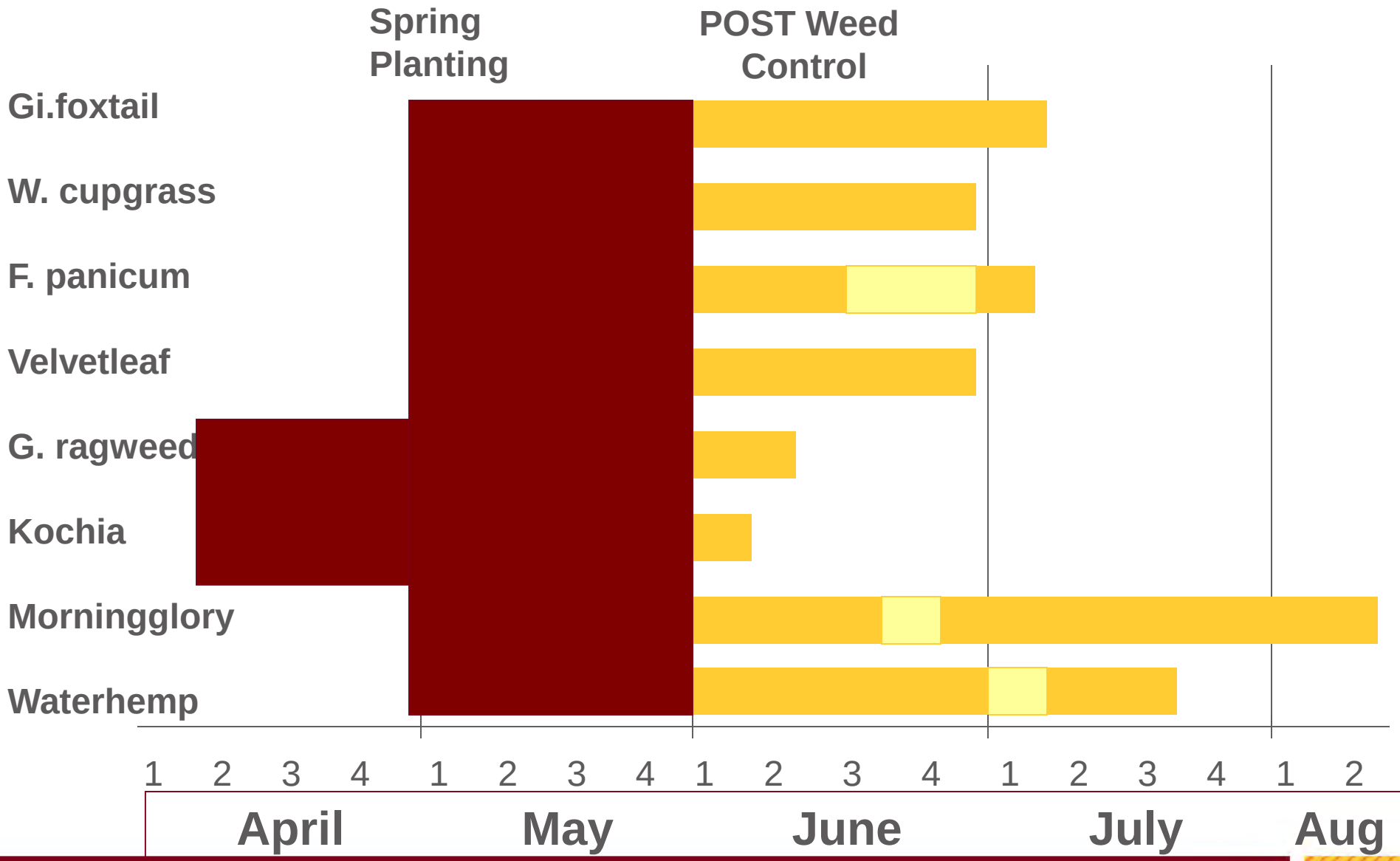
Weed Biology is Important to Weed Management

Biological Parameters



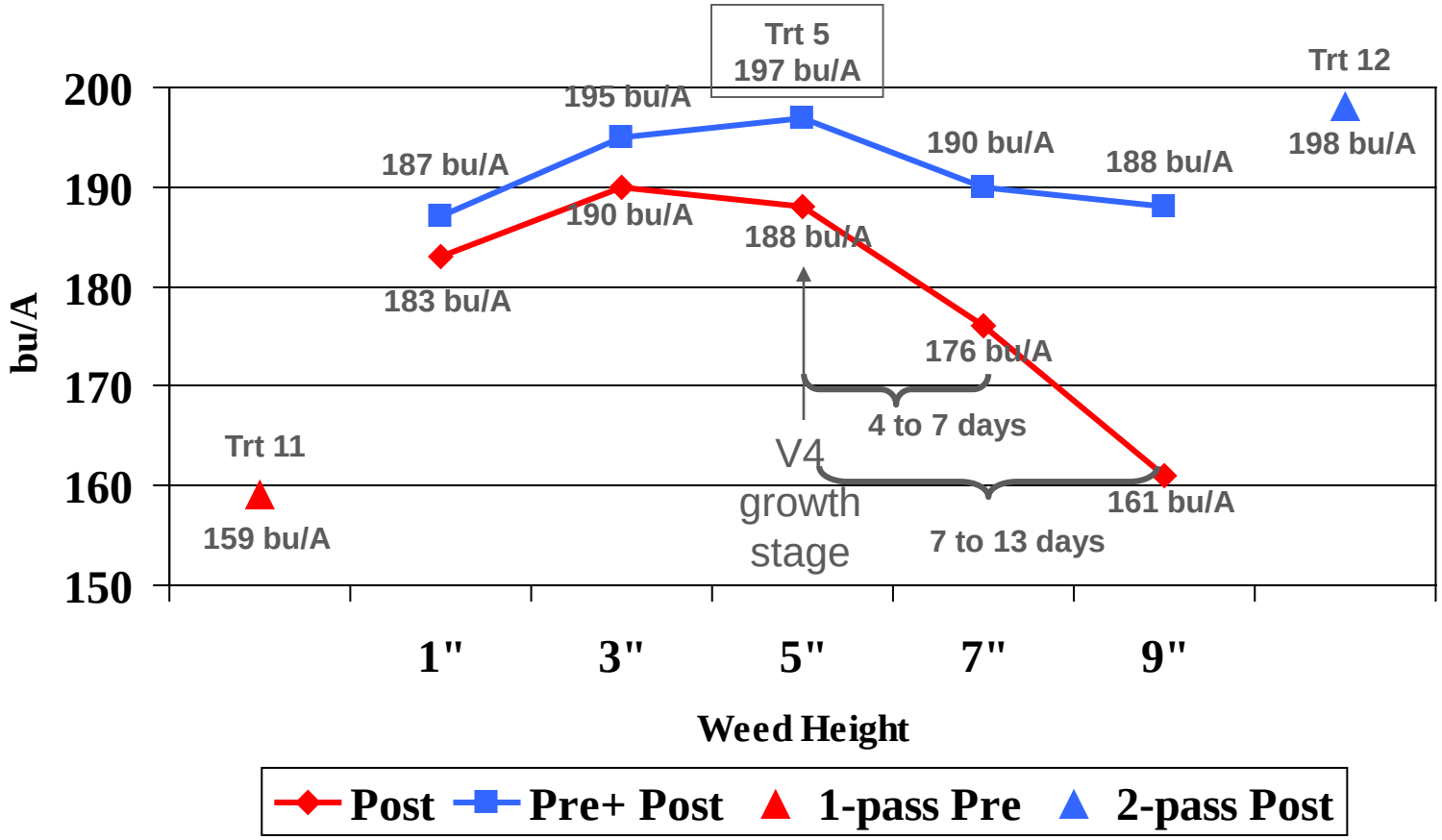

	Giant Ragweed	Lambsquarters	Common Ragweed	Waterhemp
Time of Emergence	**Early** 10% by 150 GDD	**Early** 10% by 150 GDD	**Moderate** 10% by 300 GDD	**Late** 5% by 150 GDD
Duration of Emergence	**Short**	**Moderate**	**Moderate**	**Prolonged**
Depth of Emergence	**< 6 inches**	**< 1 inch**	**<2 inches**	**< 1 inch**
Relative Competitiveness (0 – 10)	**10** **Our most competitive weed species**	**3**	**3**	**1.5**

Weed Emergence Patterns



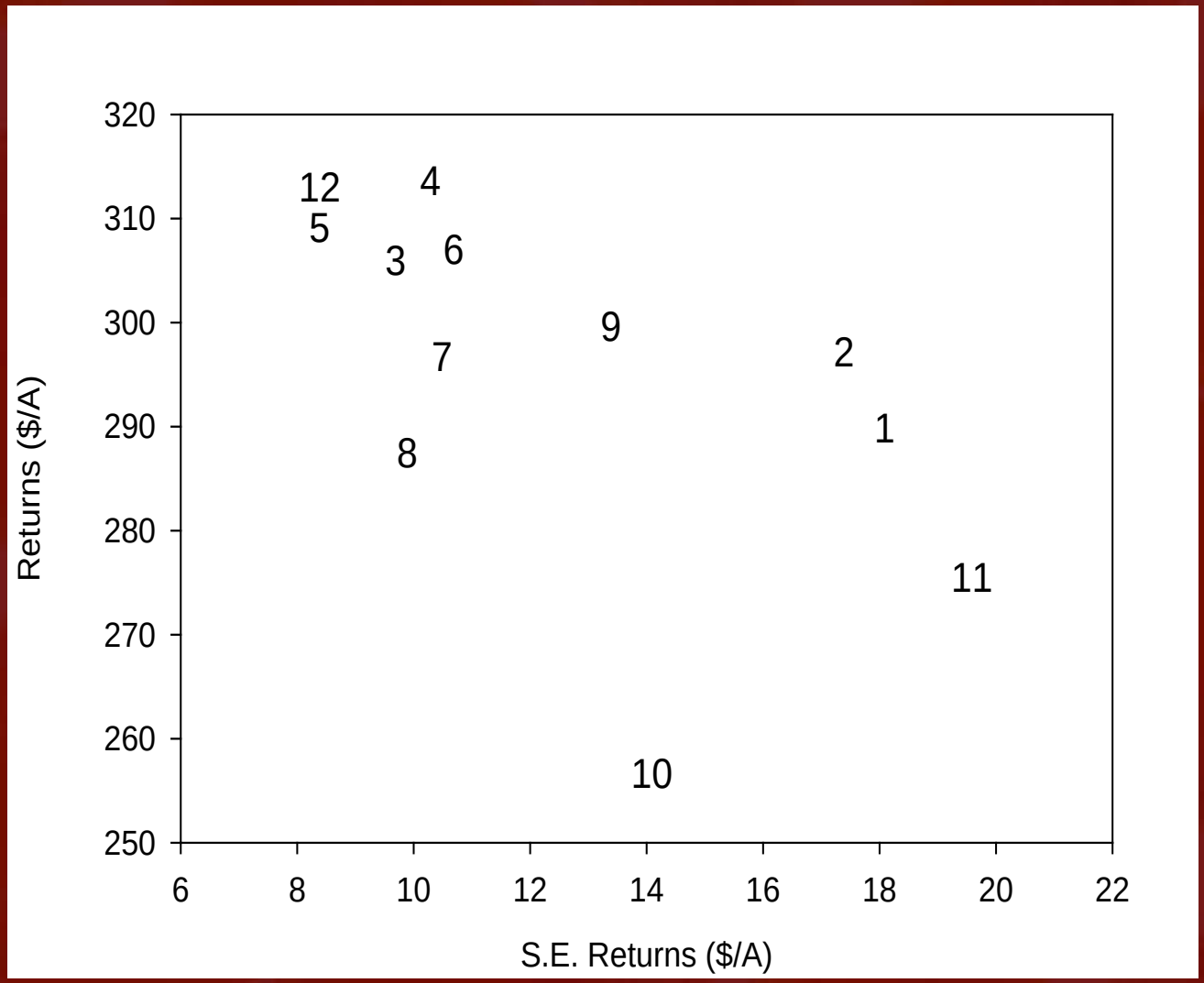
Adapted from Sandell, Hartzler and Buhler. Iowa State University.

GLYPHOSATE TIMING AND CORN YIELD ACROSS LOCATIONS 2004 - 2006



Post – Roundup WeatherMax (22 oz/A)
Pre + Post - Harness (1.25 pt./A) / Roundup WeatherMax (22 oz/A) + AMS
Trt 11 – Harness PRE
Trt 12 – Roundup WeatherMax + AMS / Roundup WeatherMax + AMS at 3"/ 2-4" regrowth

Mean returns vs standard error of mean returns for corn treatments across locations in 2004-2006



Trt 5 – Harness (1.25 pt./A) / Roundup WeatherMax (22 oz/A) + AMS at V 4 corn

Trt 12 – Roundup WeatherMax + AMS / Roundup WeatherMax + AMS at 3"/ 2-4" regrowth

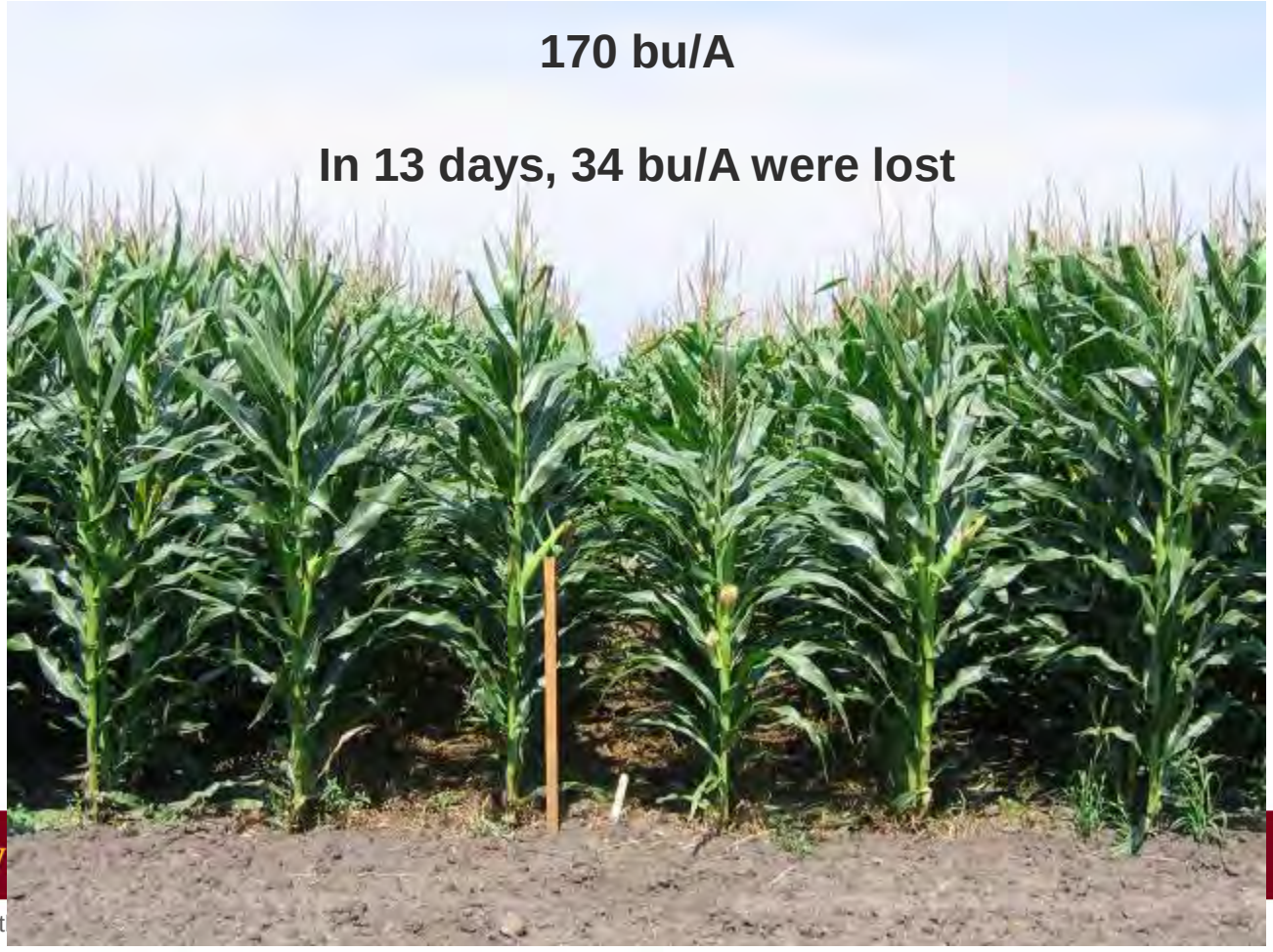
WEED EMERGENCE PATTERNS AND THE EFFECT OF TIME OF WEED REMOVAL ON CORN

Lamberton, 3-4 inch weed removal date - June 18, 2005

204 bu/A

WEED EMERGENCE PATTERNS AND THE EFFECT OF TIME OF WEED REMOVAL ON CORN

Lamberton, 9-12 inch weed removal date – July 1, 2005



WEED EMERGENCE PATTERNS AND THE EFFECT OF TIME OF WEED REMOVAL ON SOYBEAN

Roundup PowerMax 30 fl oz/a + **AMS** 8.5 lb/100gal
Applied at V1 on May 18, 2012

Roundup PowerMax 30 fl oz/a + **AMS** 8.5 lb/100gal
V3 on June 4, 2012

As weed densities increase early season weed control becomes very critical

As weeds get larger POST herbicide effectiveness decreases

Ineffective control with POST herbicides increases the probability of selecting for herbicide-resistance

2013 & 2014: Do you Plan to Use a Preemergence Herbicide in …….?

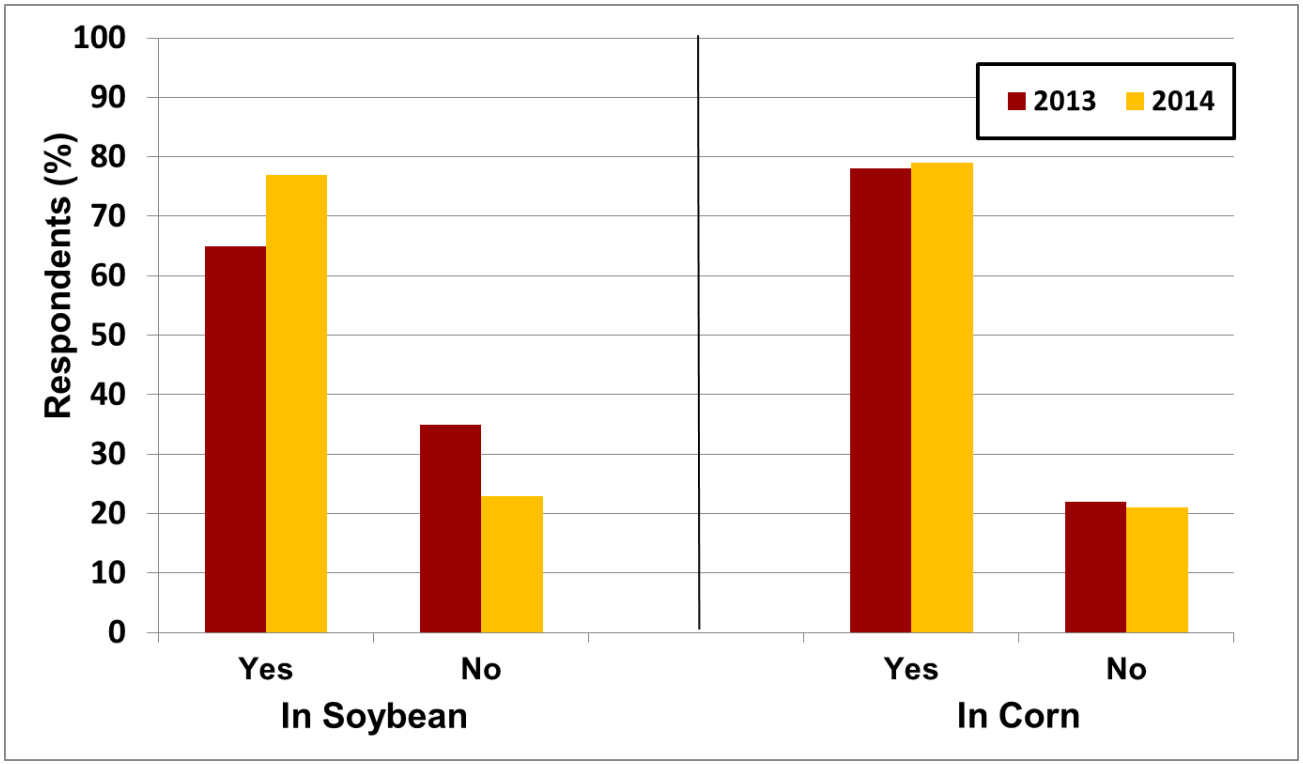
IPM Assessment Survey – Stahl et al.

Soybean

(636 & 568 responses)

Corn

(785 & 570 responses)



~25% Yes in 2011

~50% Yes in 2011

2013 & 2014: For Weed Control I Primarily…….?

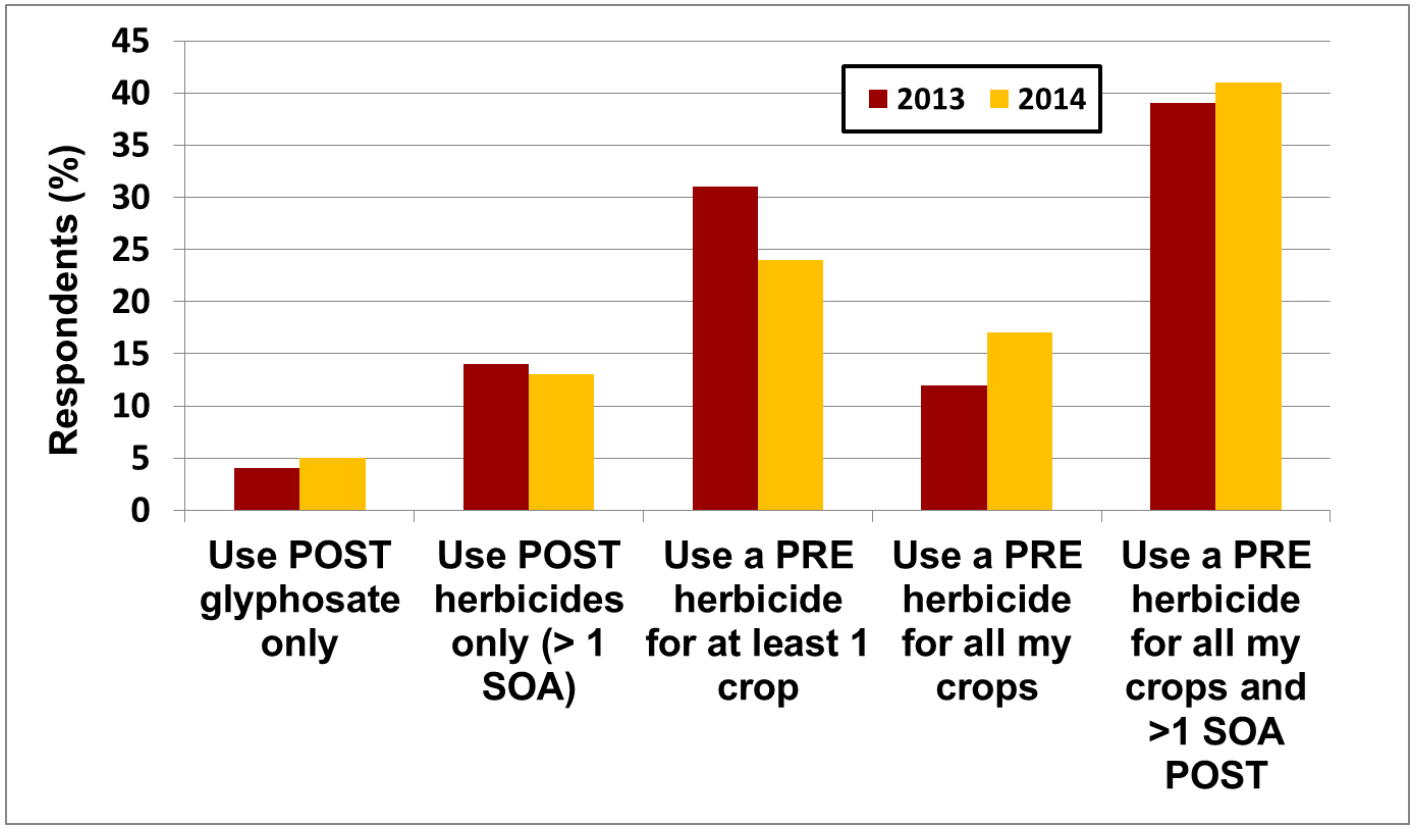
IPM Assessment Survey – Stahl et al.

2013

(713 responses)

2014

(679 responses)

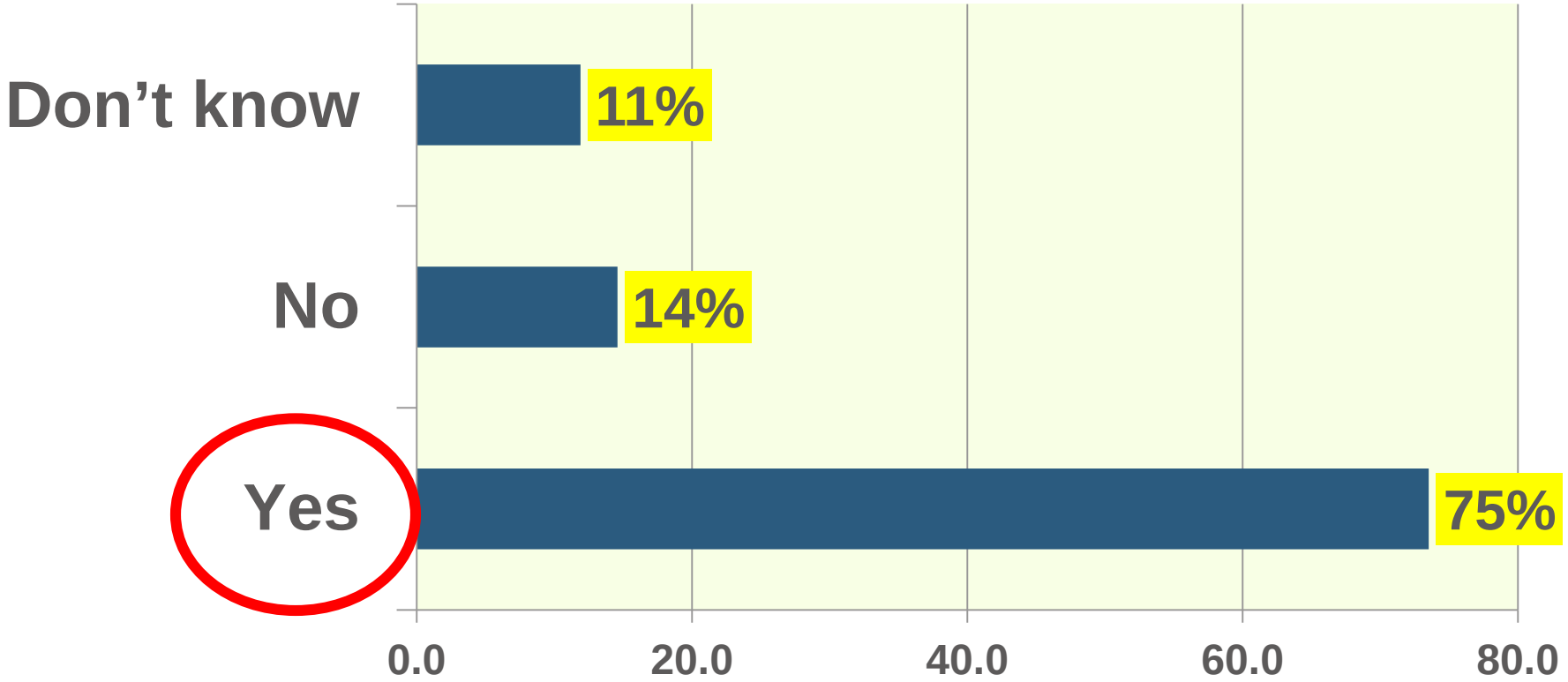


BARRIERS TO COMMUNICATION

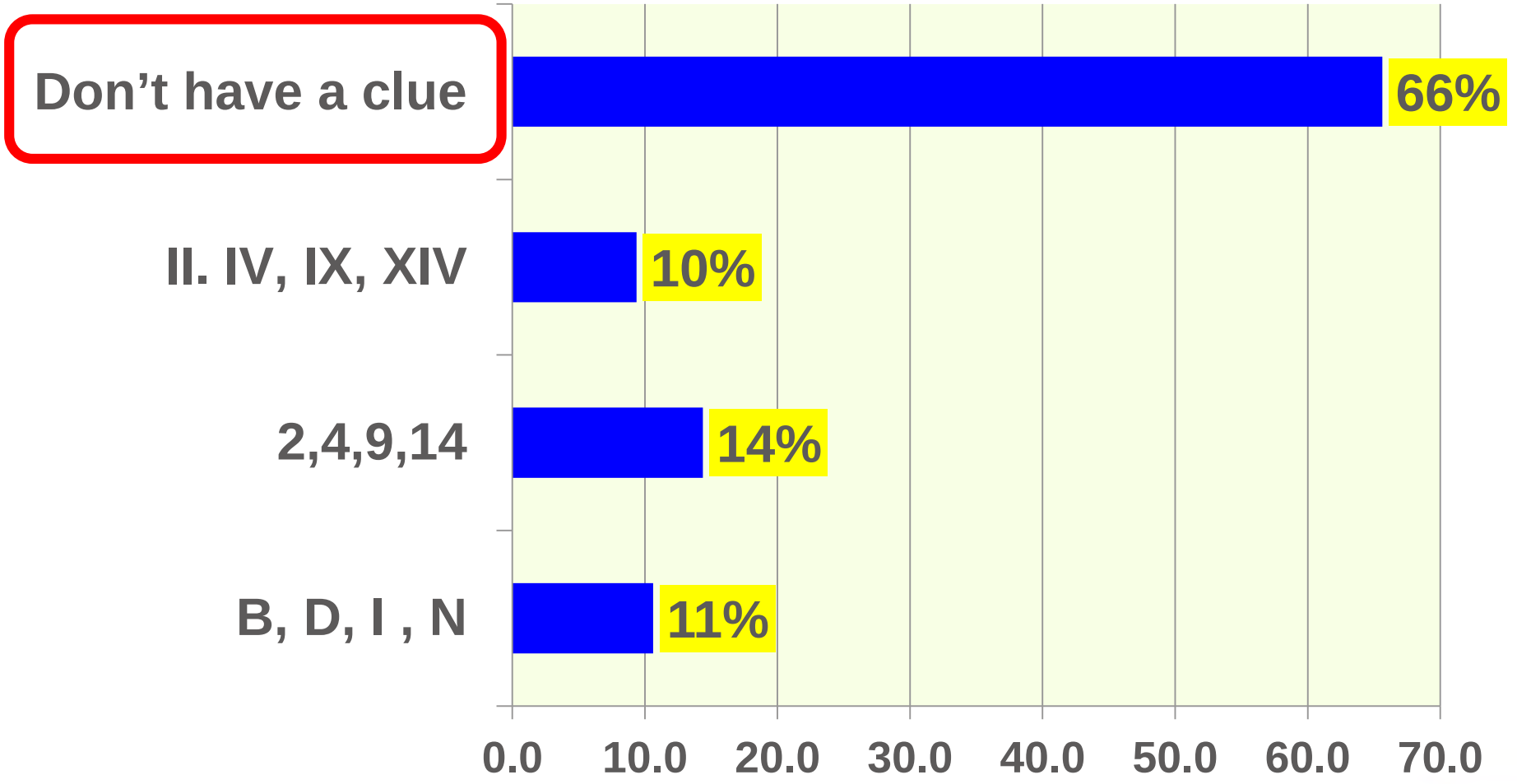
- **Impact of herbicide mode of action on weed management**
  - **Herbicide site of action**
  - **Systemic versus non-systemic herbicides**

- **Exponential rate of change**
  - **Not an intuitive concept and negatively influences timing of weed management decisions at the population and individual plant level.**

WHEN PLANNING WEED MANAGEMENT PROGRAMS, DO YOU PURPOSELY UTILIZE DIFFERENT HERBICIDE SOA'S?



HOW ARE HERBICIDE SOA'S CLASSIFIED?



Roundup POWERMAX® HERBICIDE

CROPSHIELD® FORMULA

Specially formulated for Roundup Ready® crops

GROUP	9	HERBICIDE

Dow AgroSciences

Enlist Duo™ Herbicide with COLEX-D TECHNOLOGY

®™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

For control of annual and perennial weeds and use on Enlist™ corn and soybeans; use as a non-selective burndown; chemical fallow; and use as a preplant or preemergence or postemergence herbicide on listed crops, for control of emerged weeds only.

2,4-D products that do not contain COLEX-D™ Technology are not authorized for use in conjunction with Enlist corn and soybeans.

Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees because severe injury or destruction may result.

Group	4	9	HERBICIDE

BASF The Chemical Company

Group 14 Herbicide

SPECIMEN

Sharpen®

GROUP	14 + 15	HERBICIDE

VALENT®

FIERCE® HERBICIDE

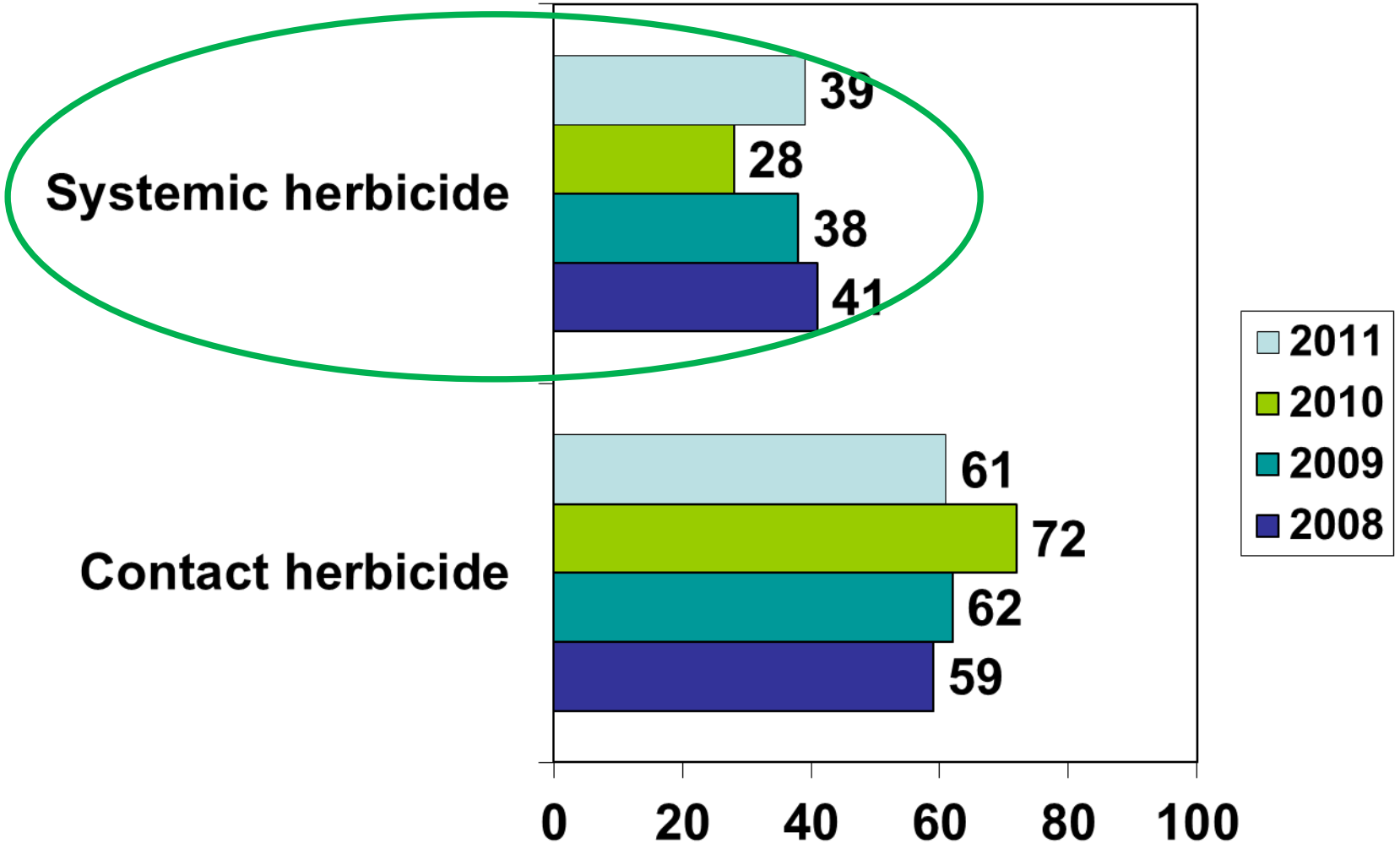
GROUP	14	HERBICIDE

VALENT®

ROUNDUP READY PLUS™ WEED MANAGEMENT SOLUTIONS

COBRA® HERBICIDE

Is Glyphosate (the active ingredient in Roundup) a contact or systemic herbicide?

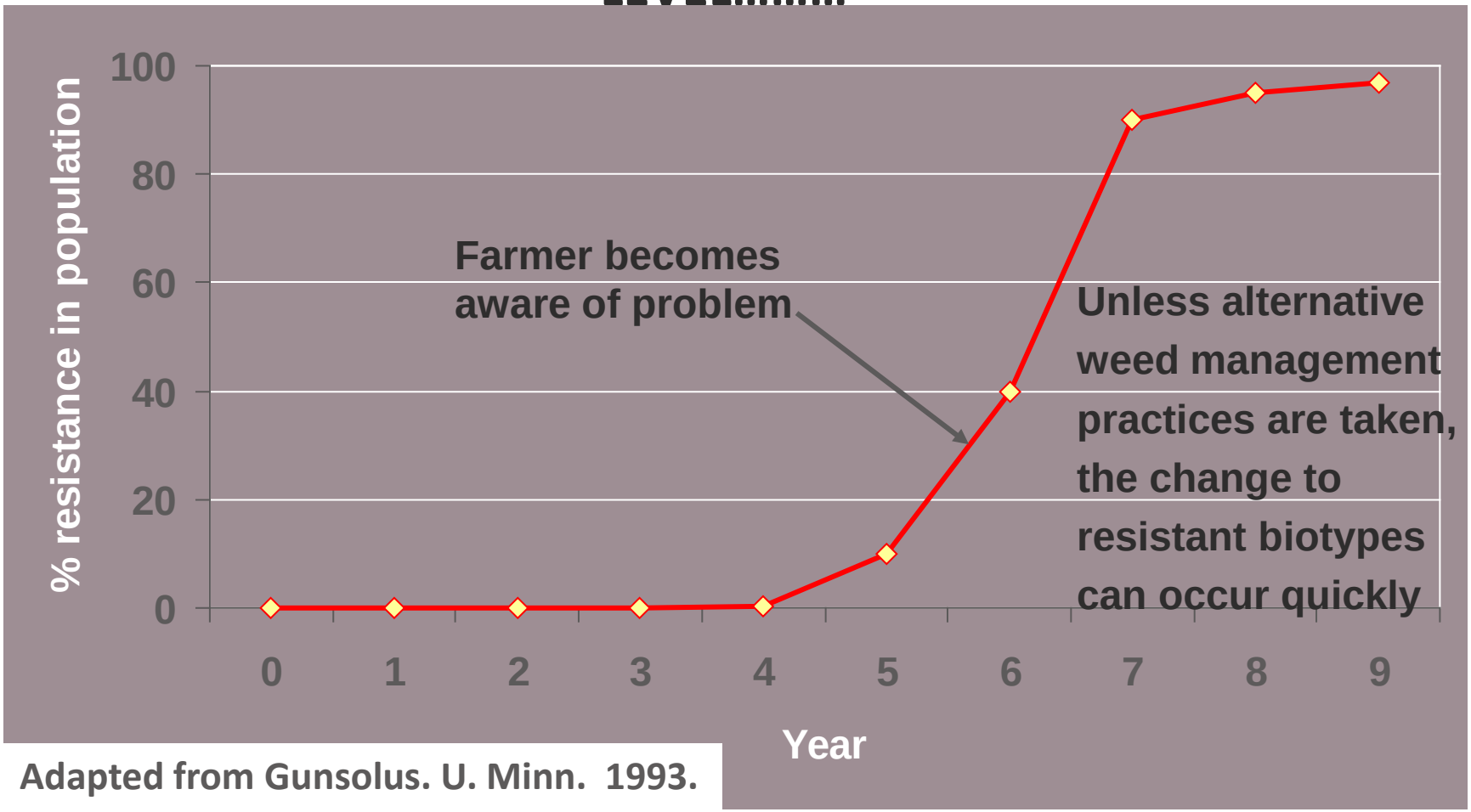


BARRIERS TO COMMUNICATION

- Impact of herbicide mode of action on weed management
  - –Herbicide site of action
  - –Systemic versus non-systemic herbicides

- **Exponential rate of change**
  - **– Not an intuitive concept and negatively influences timing of weed management decisions at the population and individual plant level.**

EXPONTENTIAL RATE OF CHANGE IS NOT INTUITIVE AND NEGATIVELY INFLUENCES TIMING OF WEED MANAGEMENT DECISIONS AT THE POPULATION AND INDIVIDUAL PLANT LEVEL……

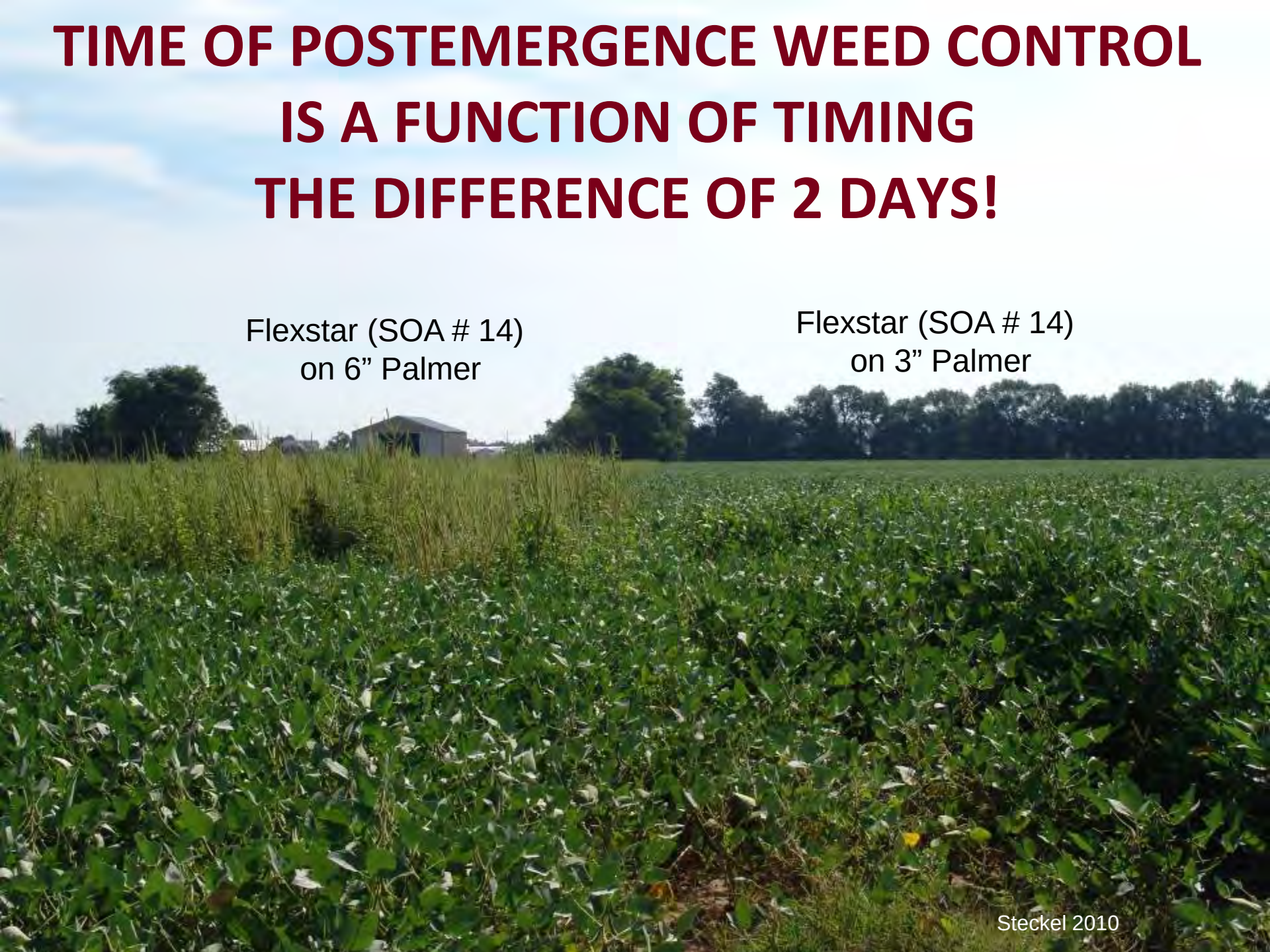


Adapted from Gunsolus. U. Minn. 1993.

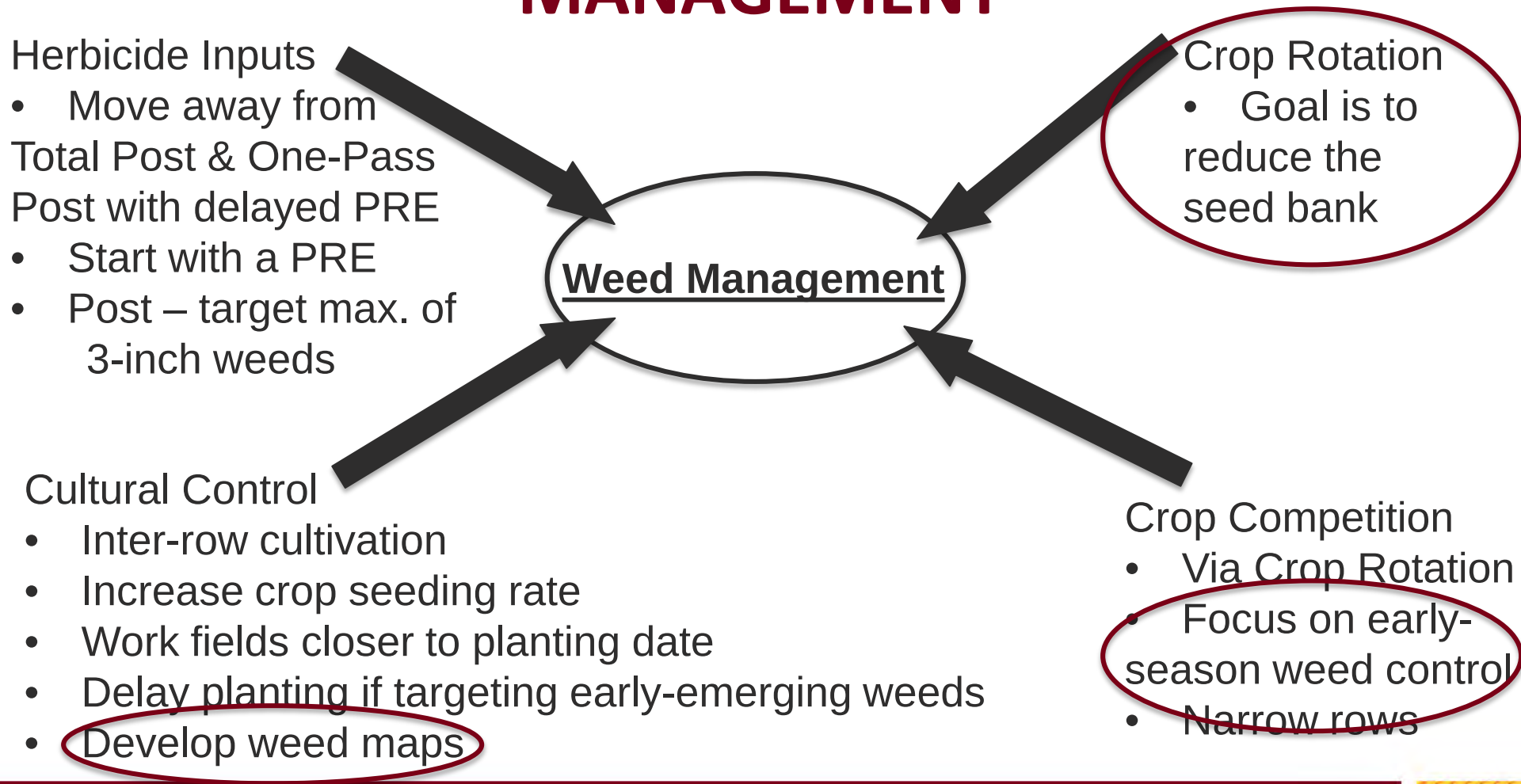
NOTE PALMER'S RAPID GROWTH RATE

Waterhemp on left, Palmer amaranth on right, both planted on the same day

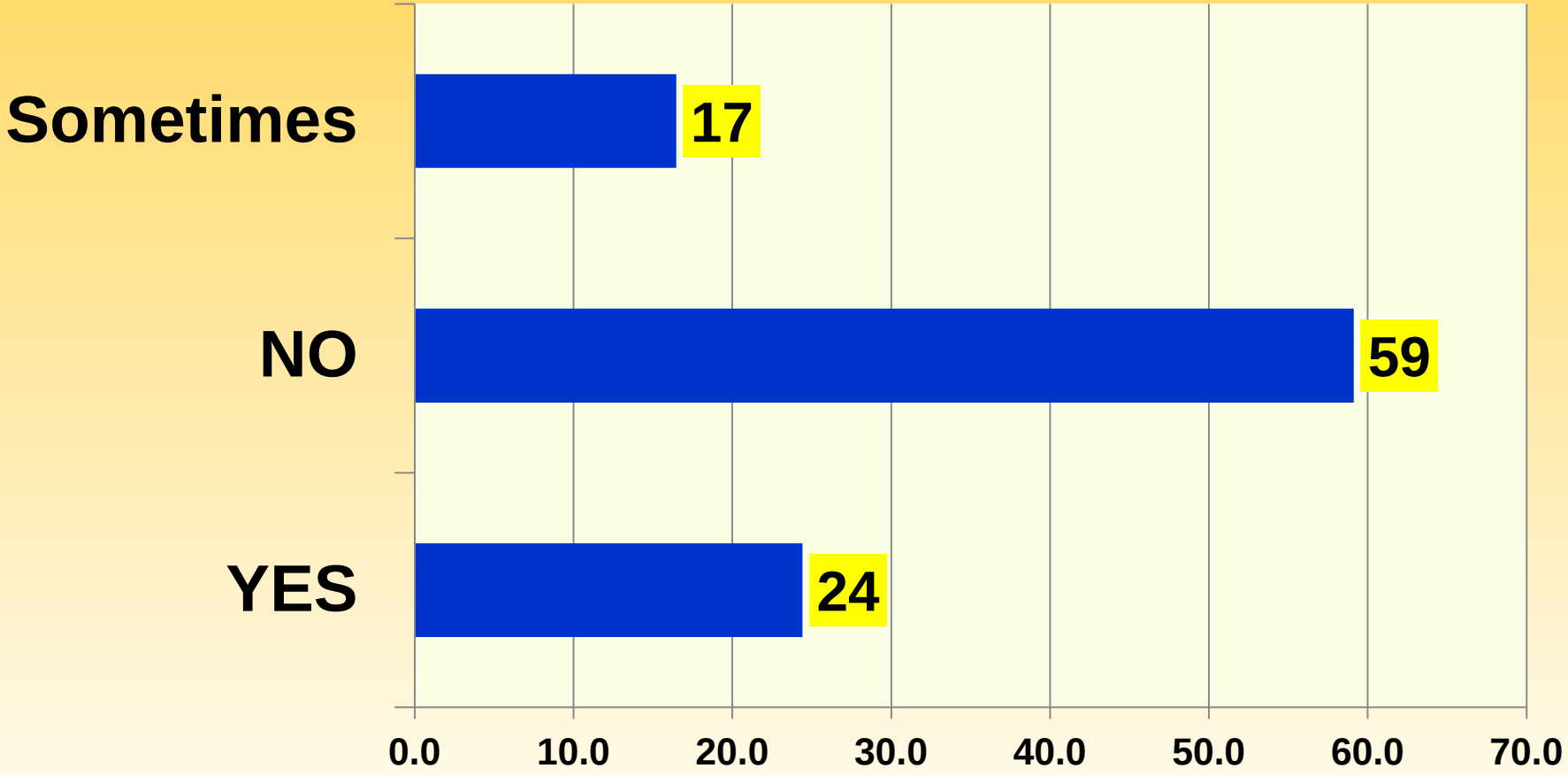
TIME OF POSTEMERGENCE WEED CONTROL IS A FUNCTION OF TIMING THE DIFFERENCE OF 2 DAYS!



INTEGRATED WEED MANAGEMENT IS MORE THAT INTEGRATED HERBICIDE MANAGEMENT



Do you map Weedy Spots and infestations in your fields?



WEED MANAGEMENT WORKING GROUP

Research & Outreach Centers

Tom Hoverstad – Waseca
Greg Johnson - Waseca
Travis Vollmer- Lamberton

Integrated Pest Management

Fritz Breitenbach – Rochester
Bruce Potter - Lamberton

Extension Regional Educators

Lisa Behnken - Rochester
Ryan Miller – Rochester
Dave Nicolai – Farmington
Liz Stahl - Worthington

Project Scientists

Brad Kinkaid – St. Paul Campus
Doug Miller – St. Paul Campus

Summary

- In-field, hands-on, educational methodologies that address the hidden costs of biological time constraints has been an effective teaching tool
- Field studies need to be very visual and treatments should make comparison of tactics readily identifiable
- If possible allow “open access” to these studies
- Addressing biological time constraints has helped farmers reframe their risk/benefit analysis

Pest resistance is not a major concern because new technologies will be developed to manage them.