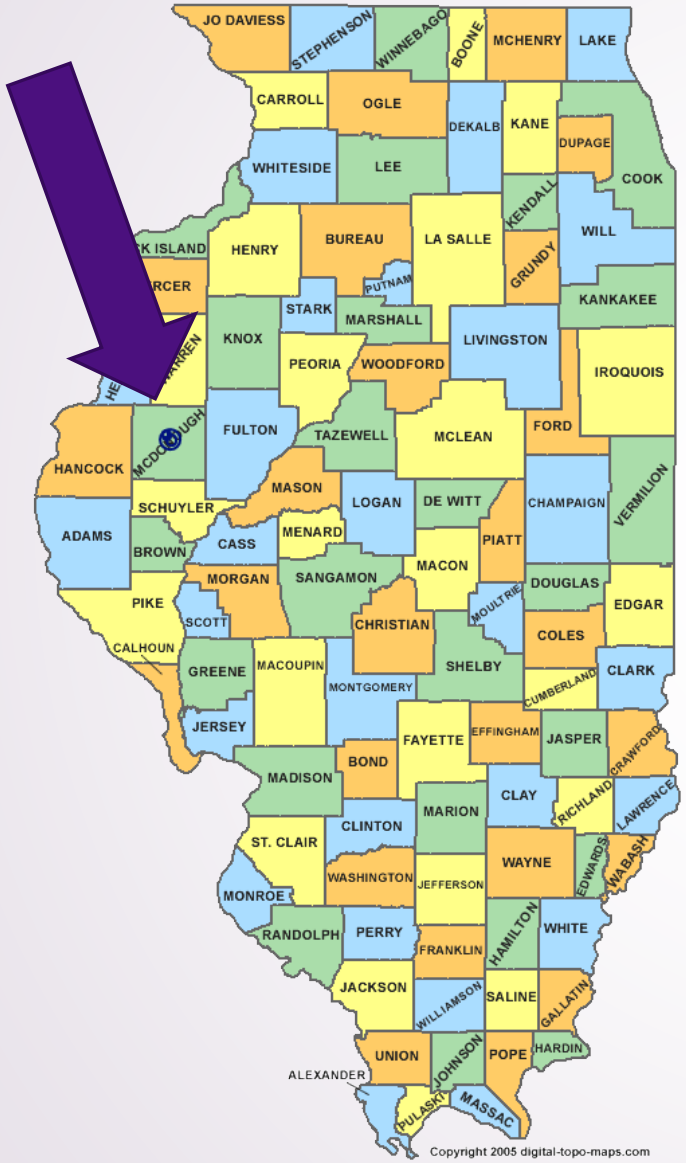
WESTERN ILLINOIS UNIVERSITY

Think Like a Weed – and How to Outsmart Them!

Mark Bernards

WESTERN ILLINOIS UNIVERSITY

Western Illinois University
Macomb, IL



School of Agriculture
- Ag Business
- Agronomy
- Animal Science
- Ag Education
- Horticulture
- Precision Agriculture
- Forestry

WESTERN ILLINOIS UNIVERSITY

WIU AFL Agronomy Farm

WIU Kerr Farm

Driver weeds on WIU farms

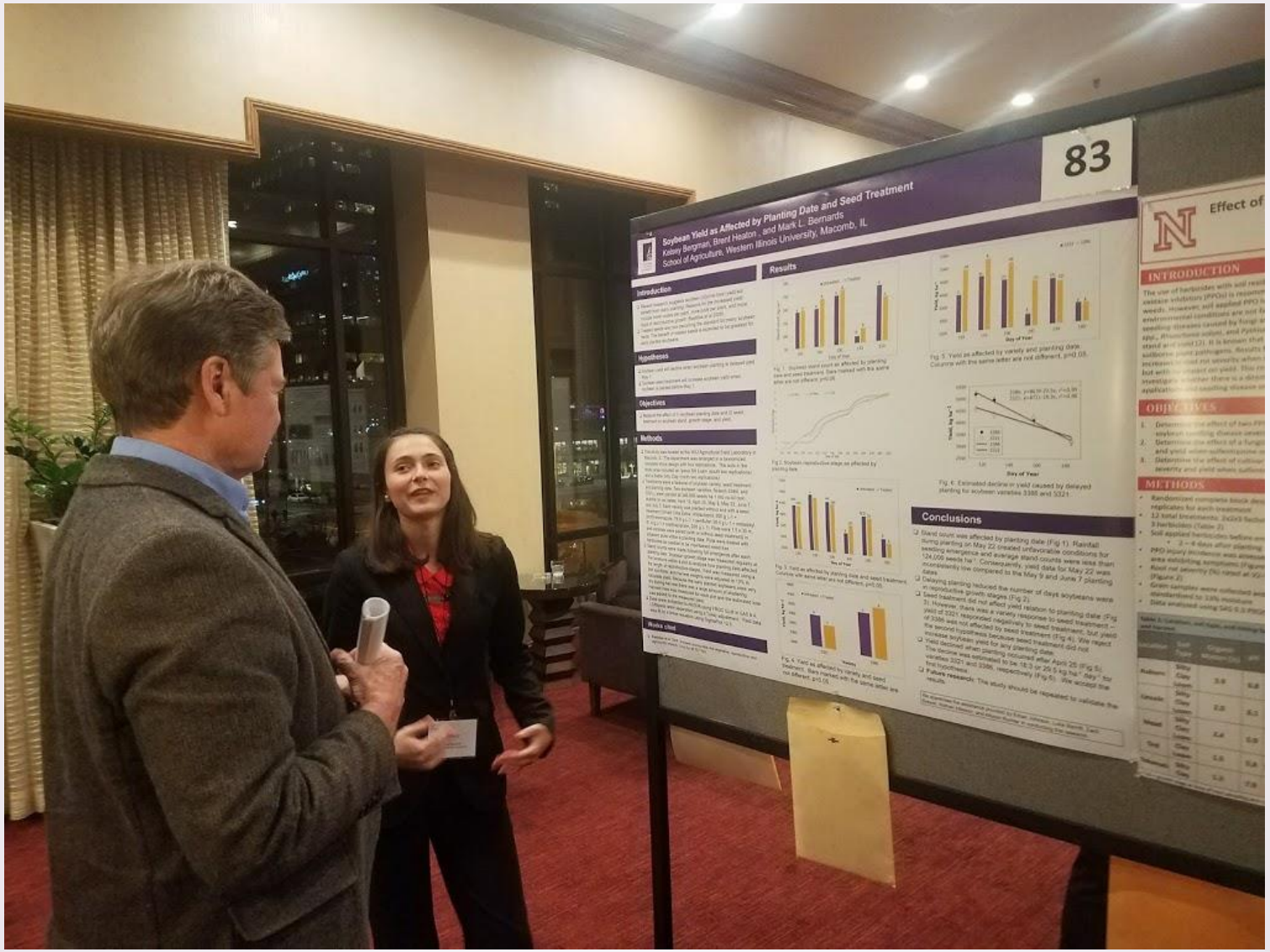
- Also
  - Morningglory
  - Giant foxtail
  - Chickweed

WESTERN ILLINOIS UNIVERSITY

School of Agriculture Greenhouses

WESTERN ILLINOIS UNIVERSITY

Student-centered learning



WESTERN ILLINOIS UNIVERSITY

Sources of funding for weed science at WIU

- Illinois Soybean Association
- Bayer
  - Balance GT soybean since 2013
- BASF
  - Engenia research since 2013
- Monsanto
  - Dicamba soybean since 2007
- Syngenta
- Dow
  - Enlist technology since 2013
- DuPont
- FMC
- Arysta
- AMVAC
- Various Adjuvant companies

Sources of funding at WIU

- Illinois Soyb
- Bayer
  - Balance G
- BASF
  - Engenia re
- Monsanto
  - Dicamba s
- Syngenta

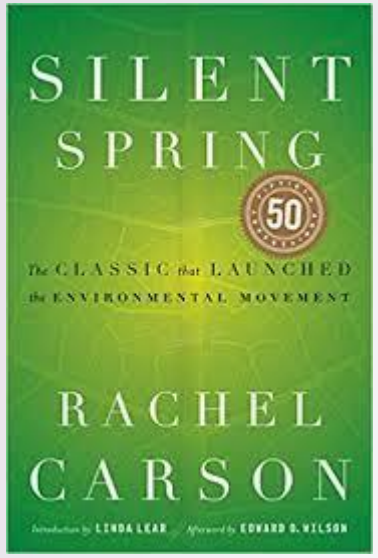
since 2013

companies

I Like Herbicides!

They make no-till possible, and save a whole lot of work.

WESTERN ILLINOIS UNIVERSITY



- "Single crop farming does not take advantage of the principles by which nature works; it is agriculture as an engineer might conceive it to be."

- "The whole process of spraying seems to be caught up in an endless spiral. . . Thus the chemical war is never won . . ."

- There "are biological solutions, based on understanding of the living organisms they seek to control, and of the whole fabric of life to which these organisms belong."

WESTERN ILLINOIS UNIVERSITY

Objectives:

- What are factors that favor weed success?
- Are there ways you can adjust your management systems to minimize the chances for weeds to succeed?

WESTERN ILLINOIS UNIVERSITY

Most important concept:

No weed seed return!

https://www.country-guide.ca/2016/03/03/we-need-to-get-our-herbicide-resistance-response-right/48359/

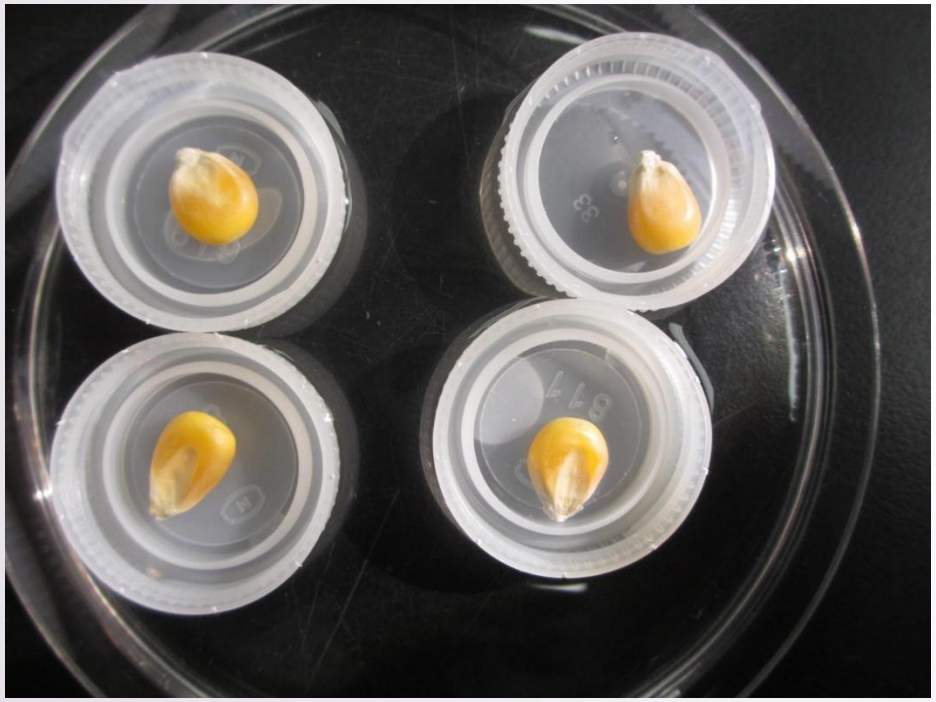
WESTERN ILLINOIS UNIVERSITY

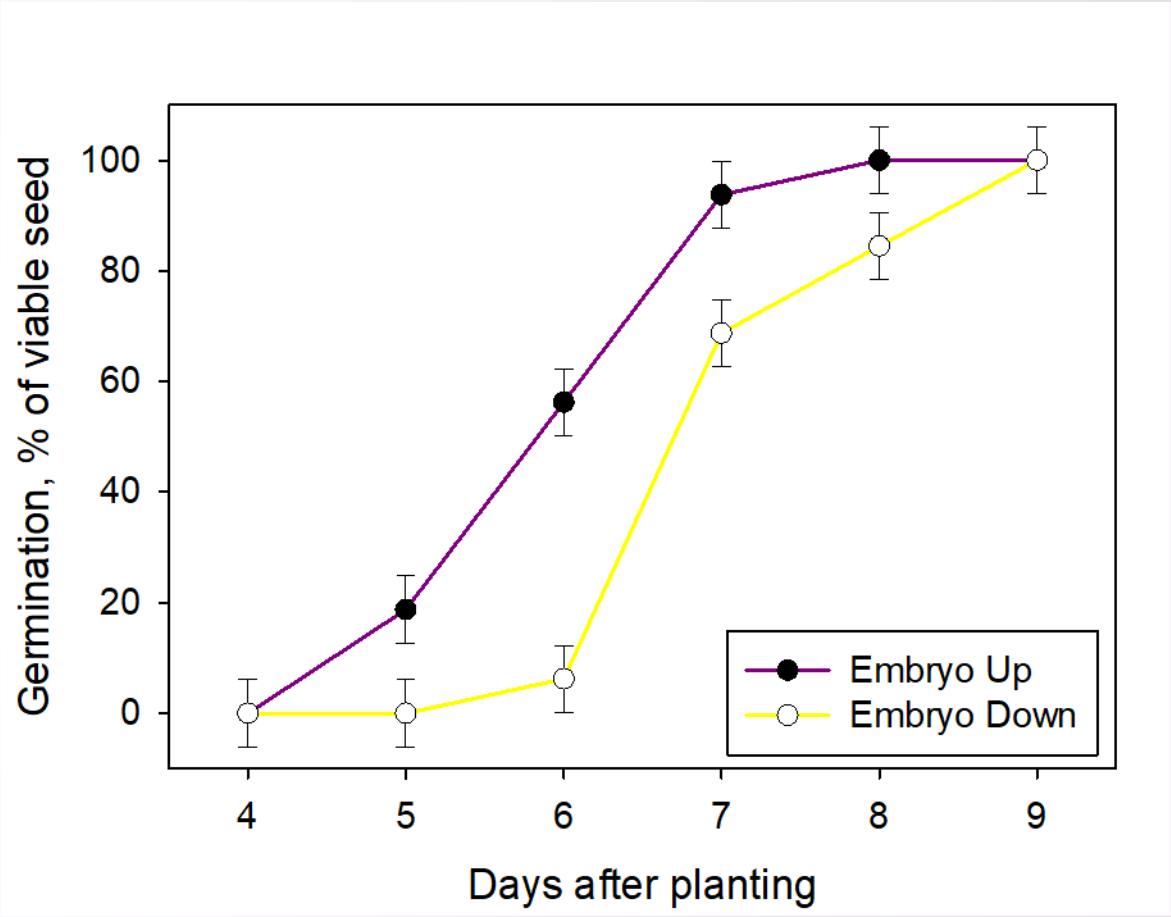
Germination

If you were a weed, what would you need and/or want to successfully germinate?

Moisture and seed germination

- 100% humidity





Miller and Bernards 2017

Moisture

- Seed-soil contact
- **Management strategy: Dust-mulch**

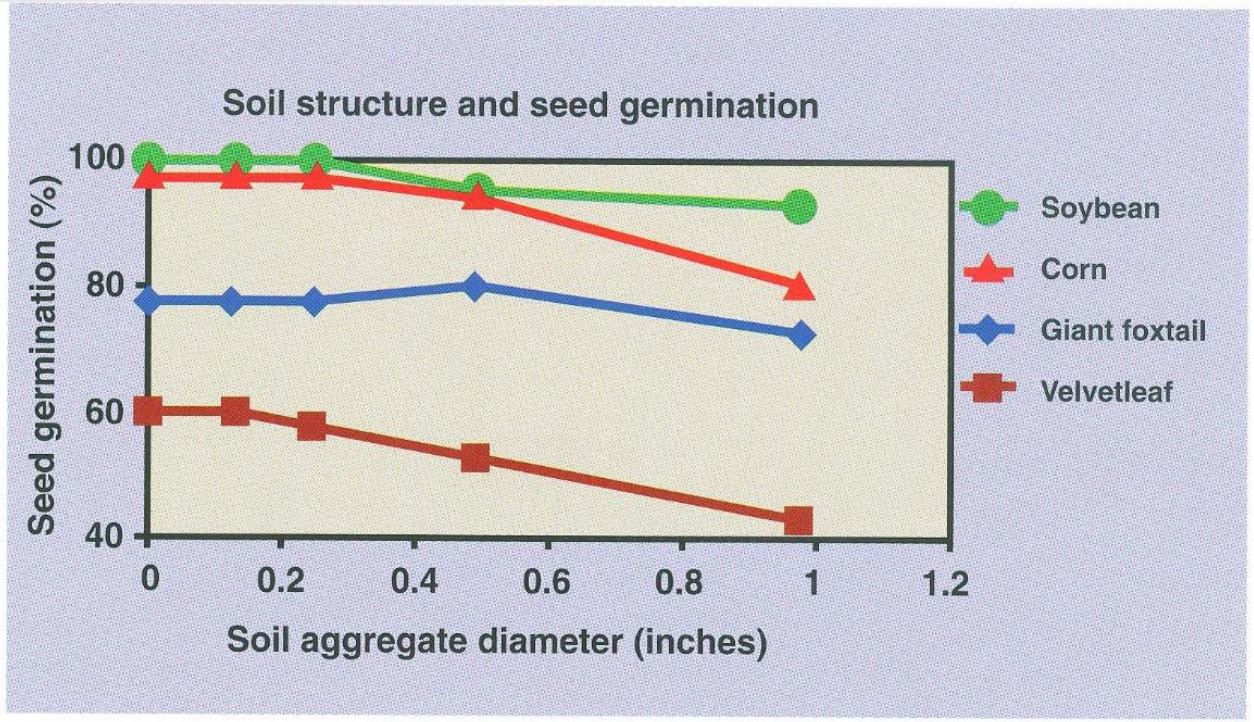


Figure 8. Effect of soil aggregate size on seedling germination. Source: Pareja and Staniforth, 1985.

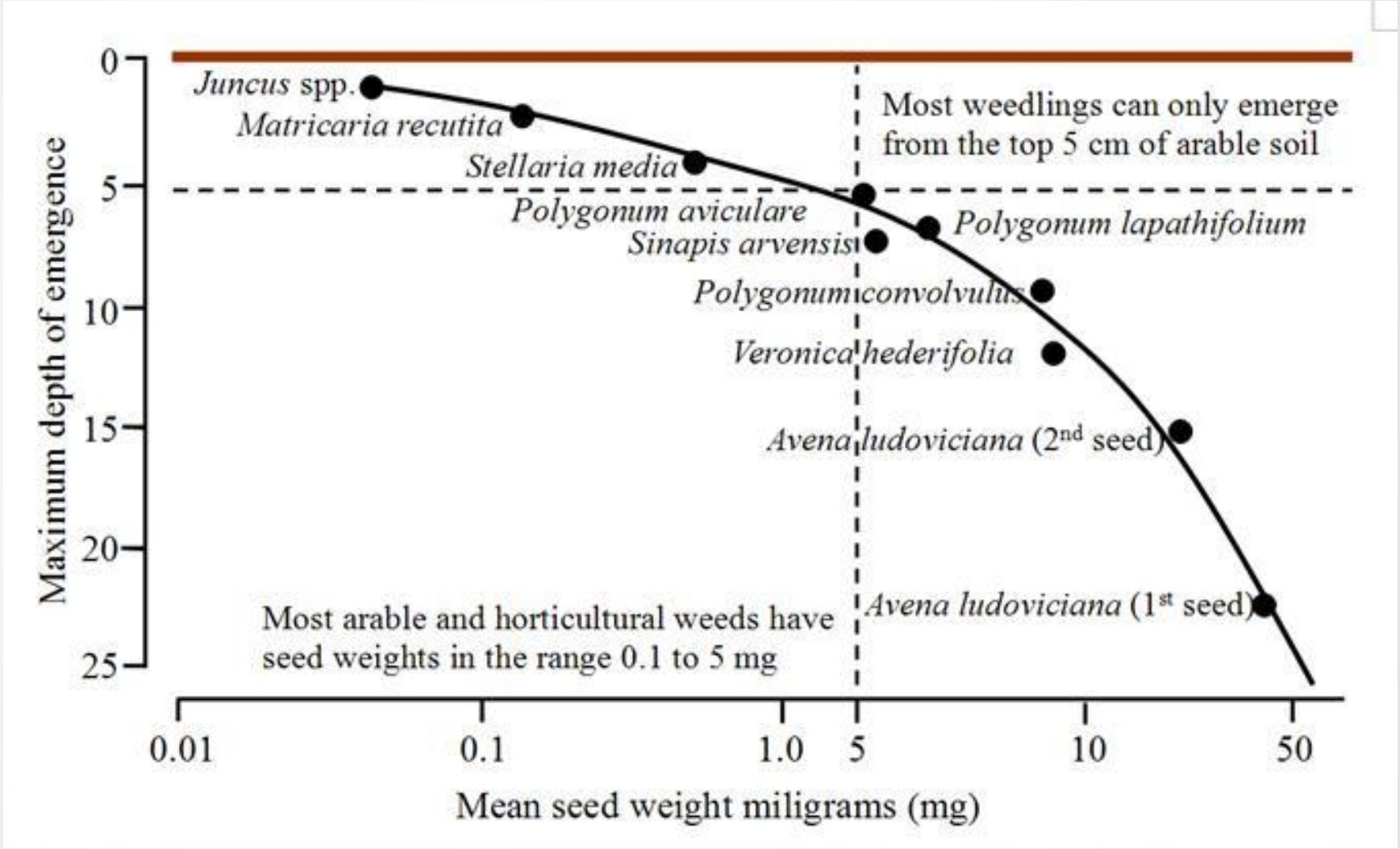
Figure 9. Weed seedling emergence track.

Figures from Davis et al. 2005. Integrated Weed Management: "One year's seeding . . . " Michigan State University Extension Bulletin E-2931.

Weed seed size and emergence depth

5 cm = 2 inches

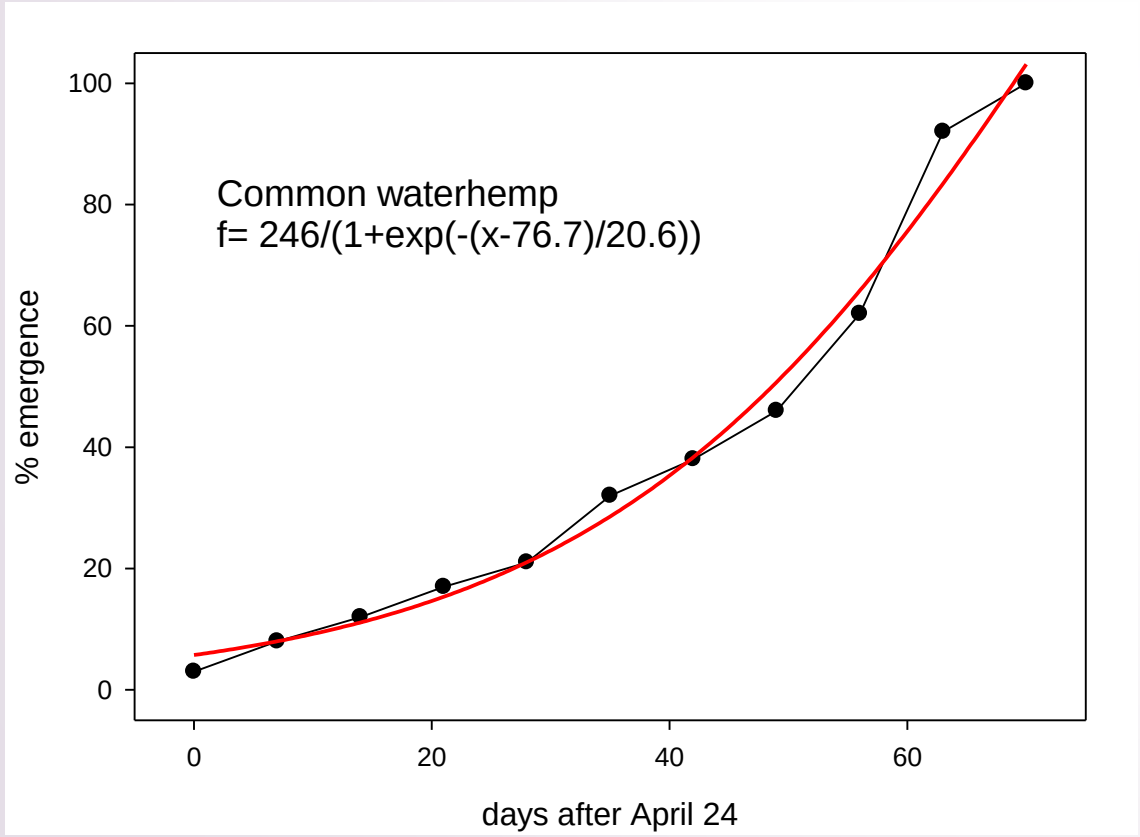
Management option (1 time): Plow to bury weed seed more than 2 inches

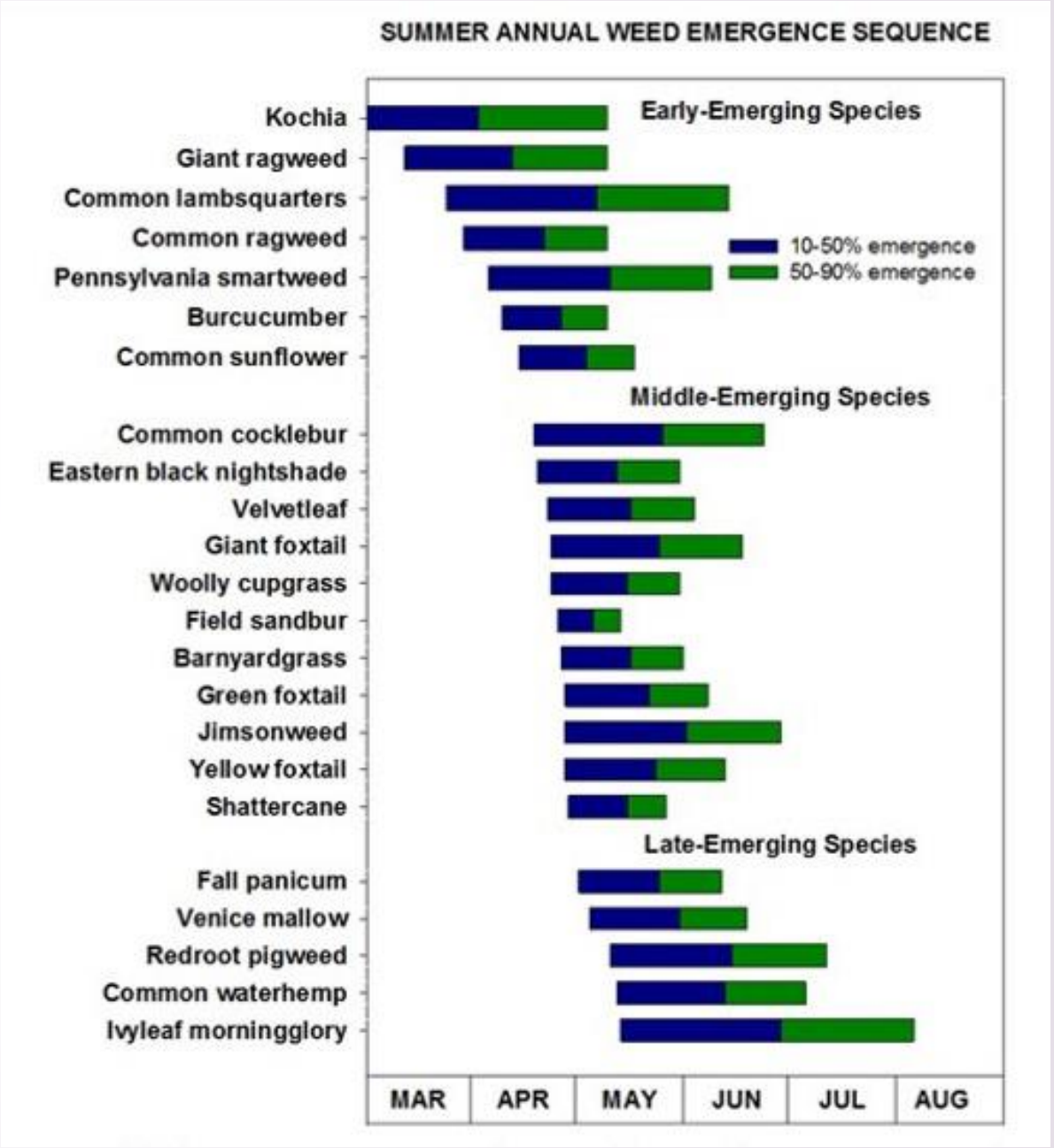


http://www.physicalweeding.com/information/index.html

GDD

- Emergence time
- Emergence duration





https://cropwatch.unl.edu/2017/keys-managing-herbicide-resistance-soybeans

Herbicide half-life

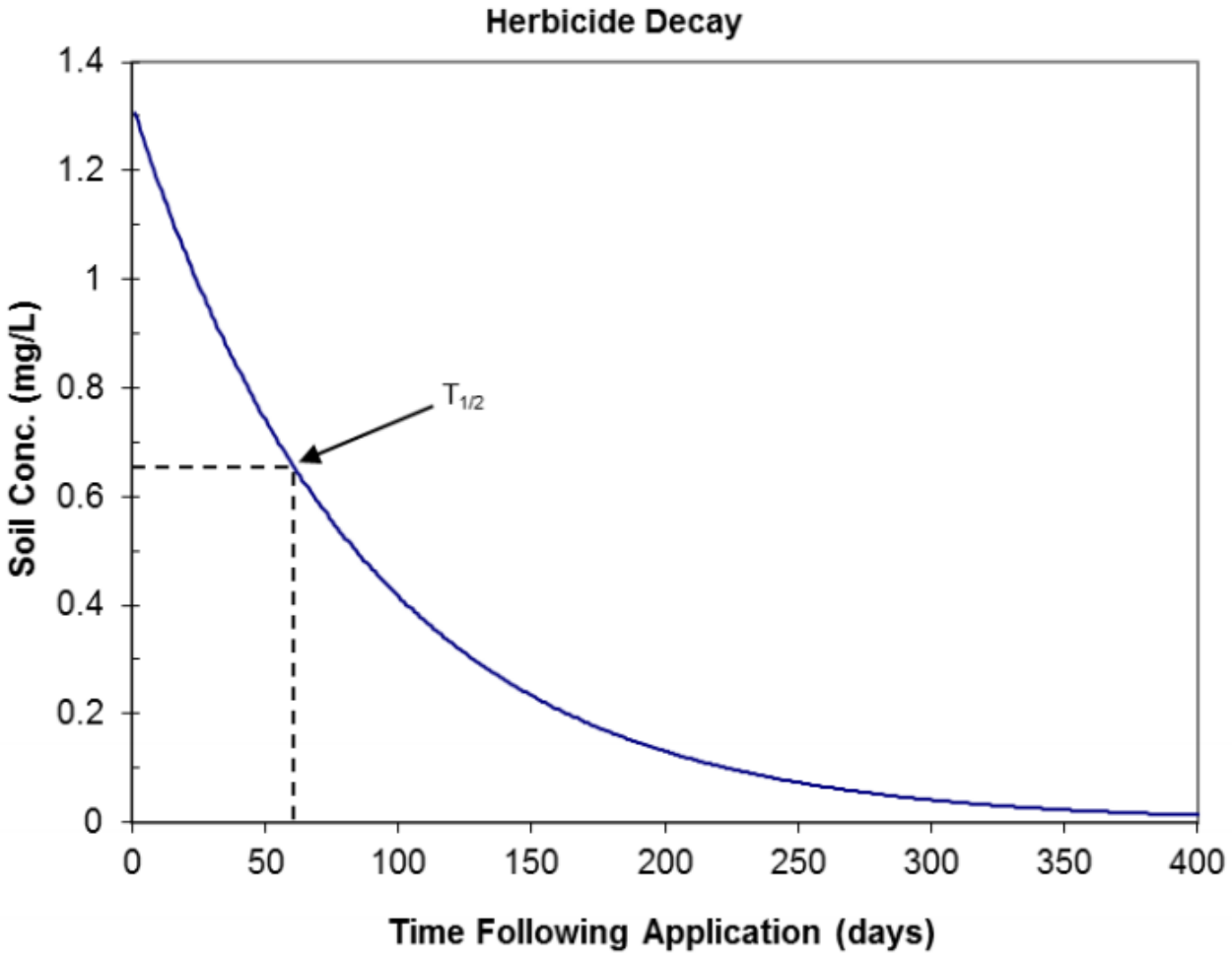


Figure 1. Idealized herbicide decay with the half-life indicated

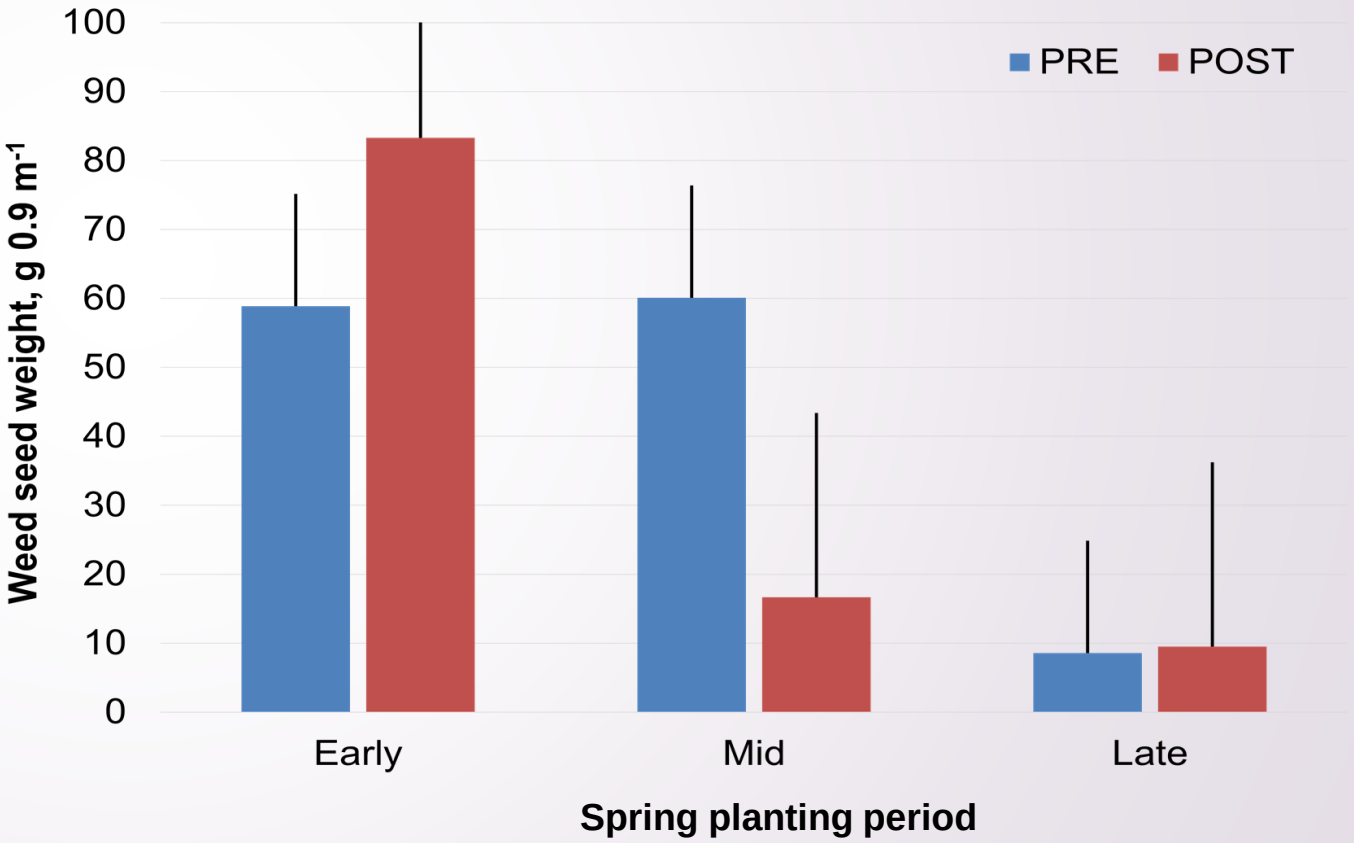
- Flumioxazin – 12-18 d
- Sulfentrazone – 121-302 d
- Saflufenacil – 1-36 d
- Fomesafen – 100 d
- Fluthiacet-methyl – 1-2 d

http://www.isws.uiuc.edu/pubdoc/CR/ISWSCR2011-07.pdf

Time weed management to emergence

- Overlapping residuals
  - PRE
  - 21-28 days after PRE
- Delay planting
  - Crop grows faster and better competes with weeds
  - Fewer weeds emerge in crop

Weed seed production and planting date

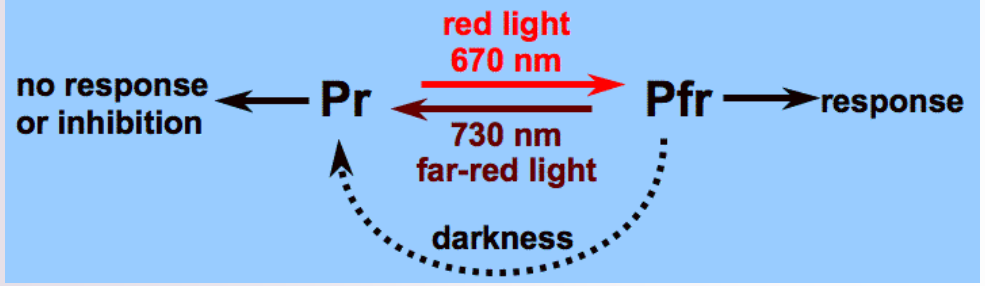


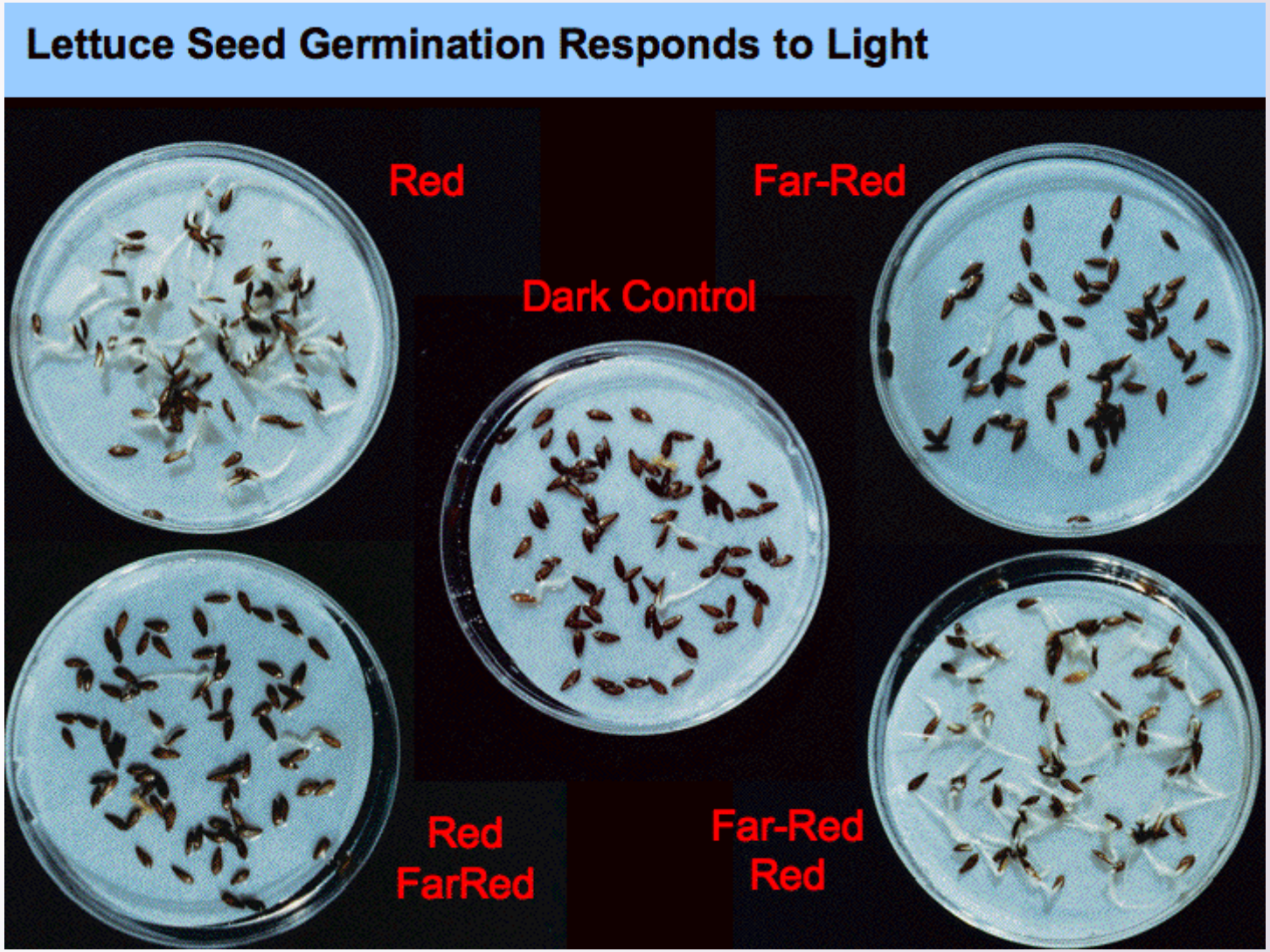
Merritt et al. 2017

WESTERN ILLINOIS UNIVERSITY

Red light

Phytochrome is a Pigment with Two interconvertible forms
The two forms elicit different responses



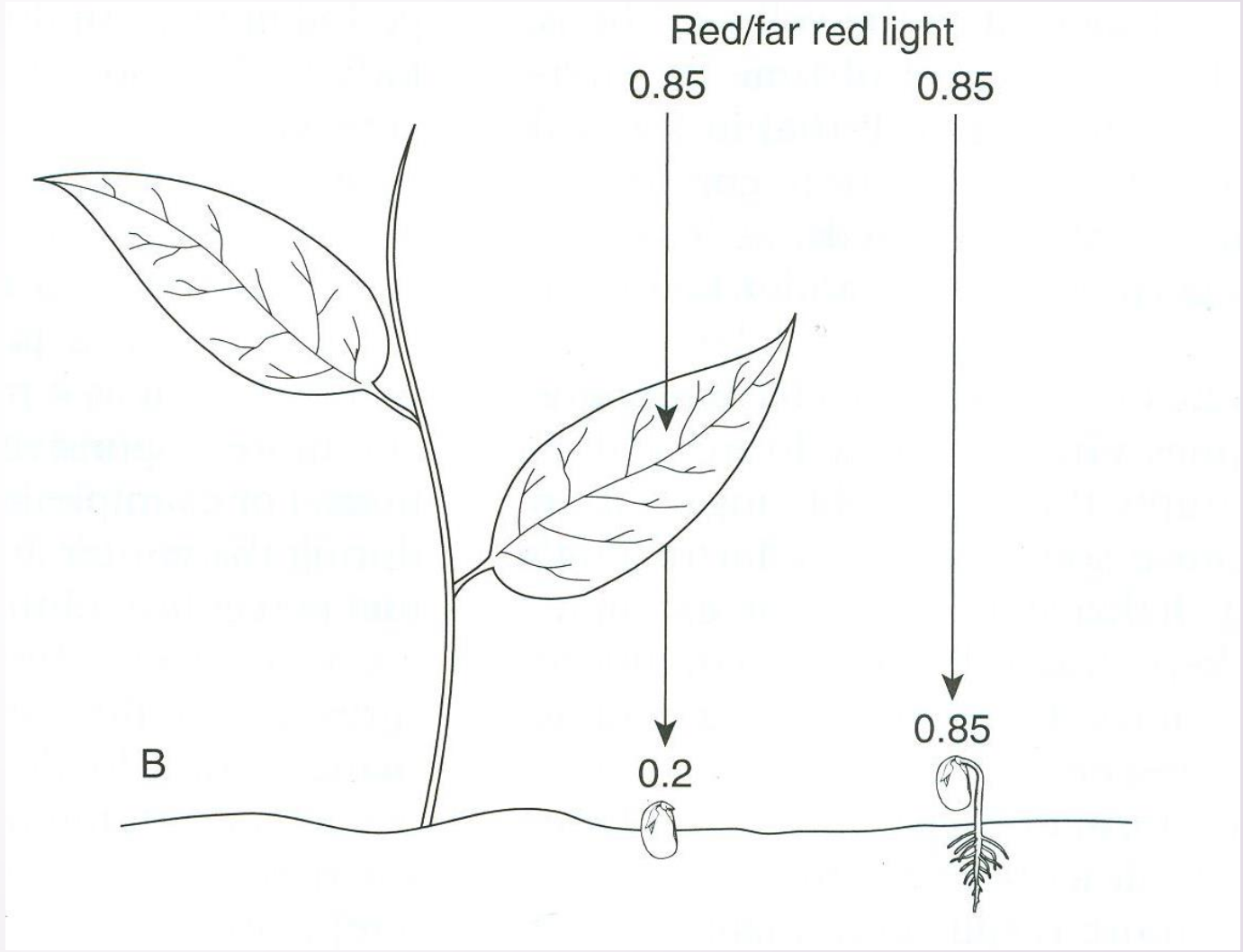


http://plantphys.info/plant_physiology/phytochrome.shtml

Red light and management options

- Till in the dark
- Residue mulch
- Cover crops

Common chickweed pseudo-cover crop



Ross MA, Lembi CA. 2009. Applied Weed Science

WESTERN ILLINOIS UNIVERSITY

Early season growth

If you were a young weed seedling, what conditions would you want to grow rapidly?

Light

Palmer amaranth was transplanted on the same day. Two months later growth under a corn canopy (on left) versus open field (on right).

Prevent weeds from seeing light

- Narrower row spacing
- Higher soybean populations
- Effective PRE herbicides
- Cover crops with adequate residue
- Delay planting to allow more weeds to emerge before planting
  - see Merritt et al. 2017

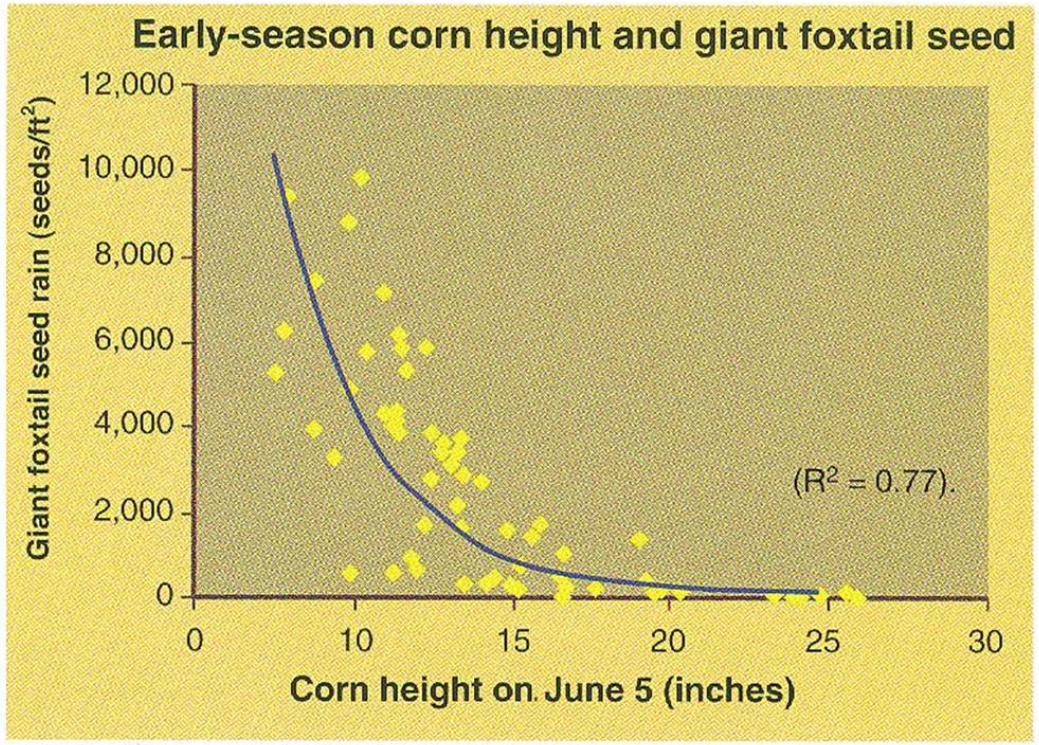


Figure 2. As early-season corn growth increases, weed seed production declines exponentially. Source: Davis and Liebman, 2003.

Figure from Davis et al. 2005. Integrated Weed Management: “One year’s seeding . . . “ Michigan State University Extension Bulletin E-2931.

Nutrient placement and weed growth

- Weeds are luxury consumers of nutrients
  - Higher nutrient levels in weed biomass than in crop biomass

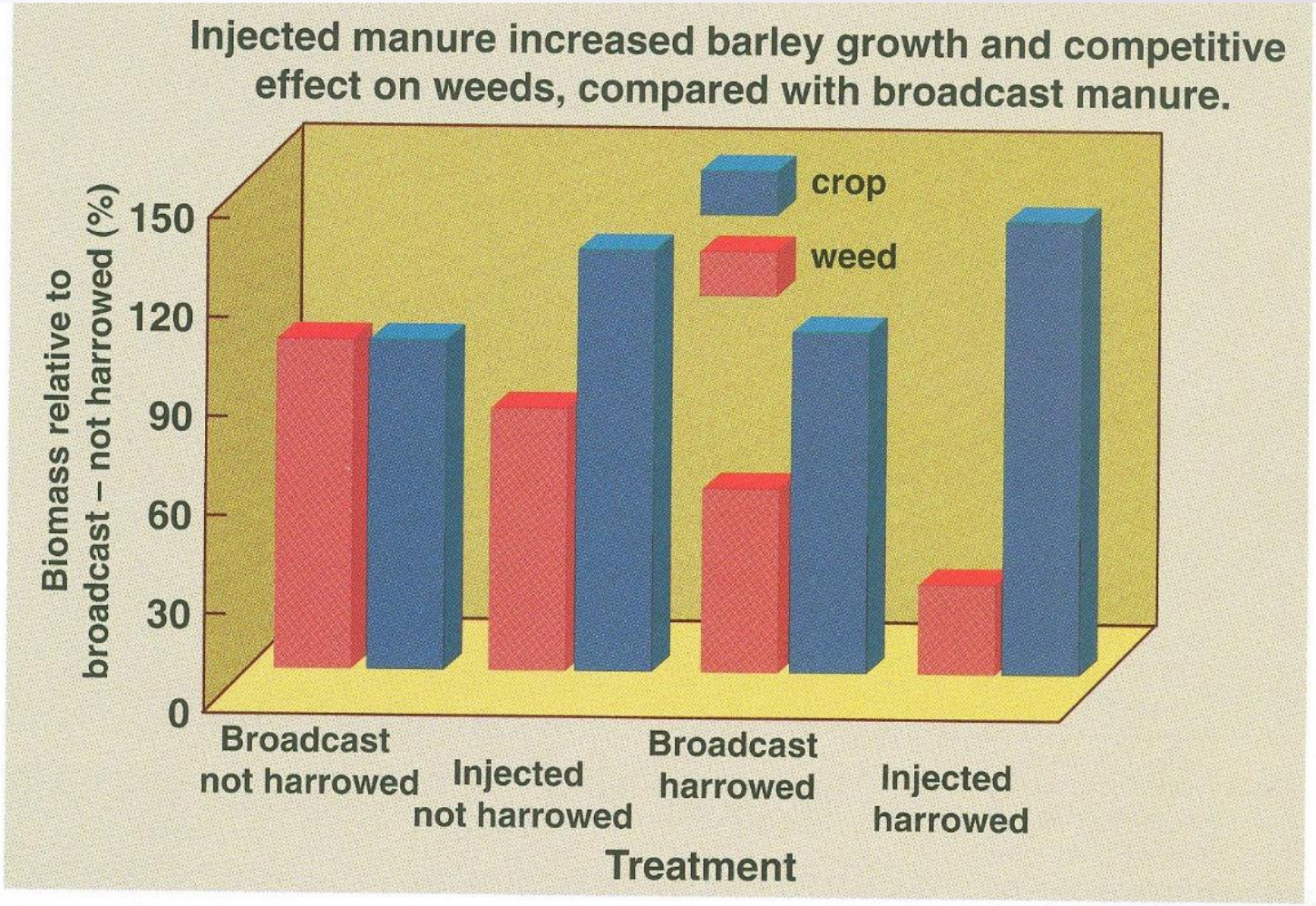
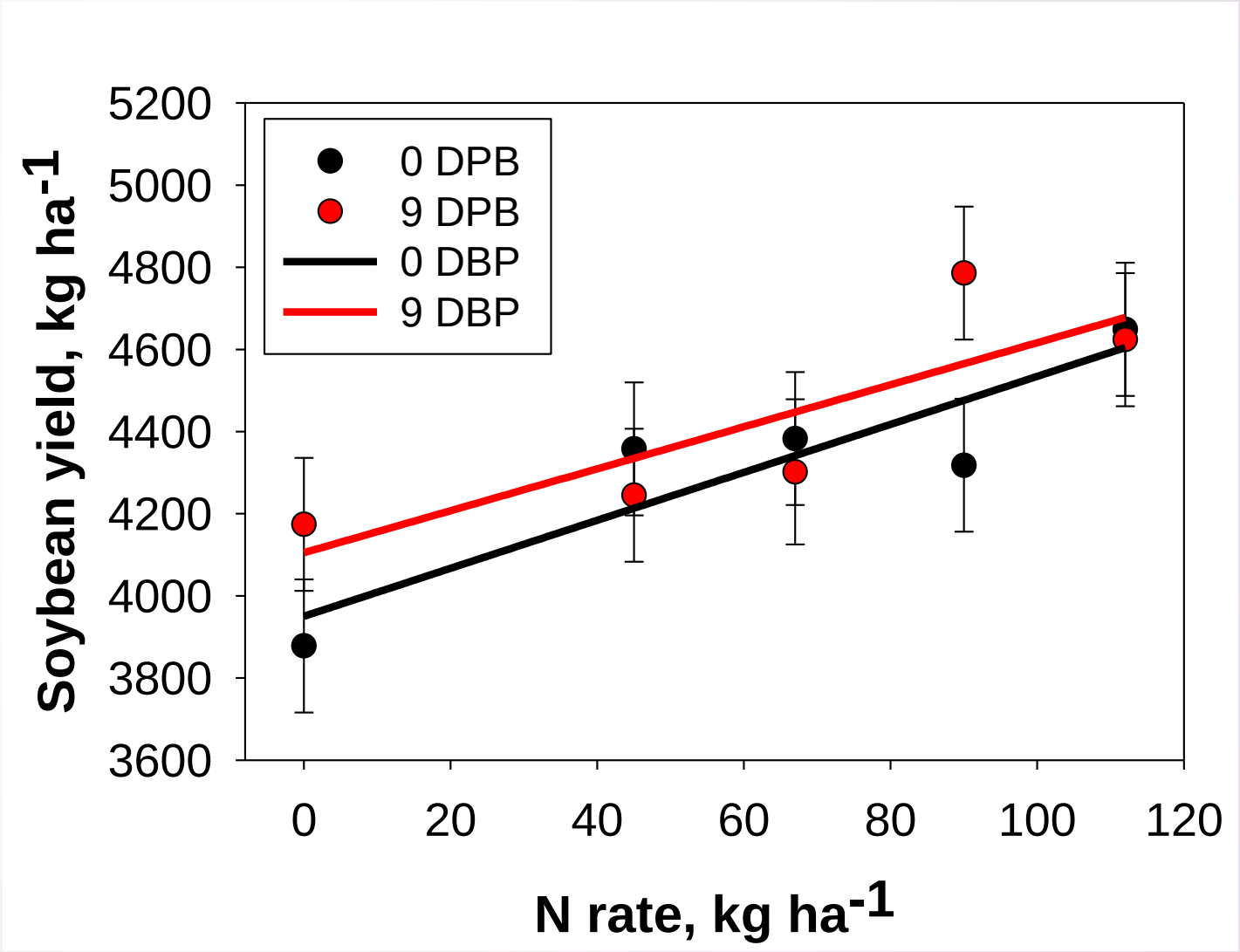


Figure 6. Injected manure increased crop growth and reduced weed biomass compared with broadcast manure. Harrowing was done with a spring-tine harrow. Source: Rasmussen, 2002.

Figure from Davis et al. 2005. Integrated Weed Management: "One year's seeding . . . " Michigan State University Extension Bulletin E-2931.

Nitrogen and “planting green”

- Dribbled N next to row at planting



Miller et al. 2018

Disturb emerged weeds early

- Weed seedlings are fragile
  - Interrow cultivation
  - Herbicides
    - Sufficient volume for coverage

http://www.wiscweeds.info/post/waterhemp-management-in-soybeans/

WESTERN ILLINOIS UNIVERSITY

Seed dispersal

If you were a weed, what would you do to maximize the dispersal and success of your offspring?

Dispersal adaptations

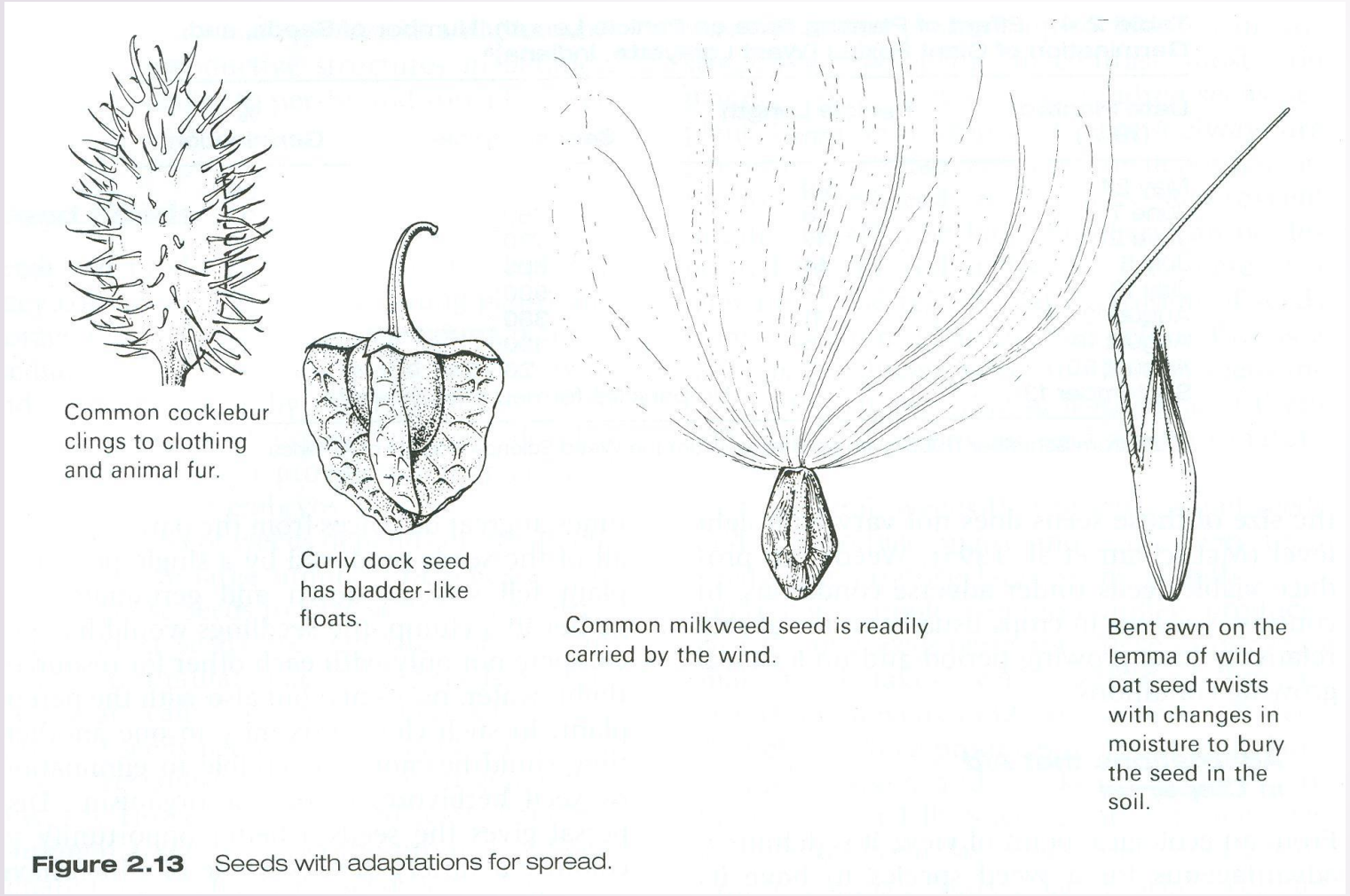


Figure 2.13 Seeds with adaptations for spread.

Ross MA, Lembi CA. 2009. Applied Weed Science

J. Jeffrey Mullahey - https://www.forestryimages.org/browse/detail.cfm?imgnum=1624037

Dispersal methods and distances

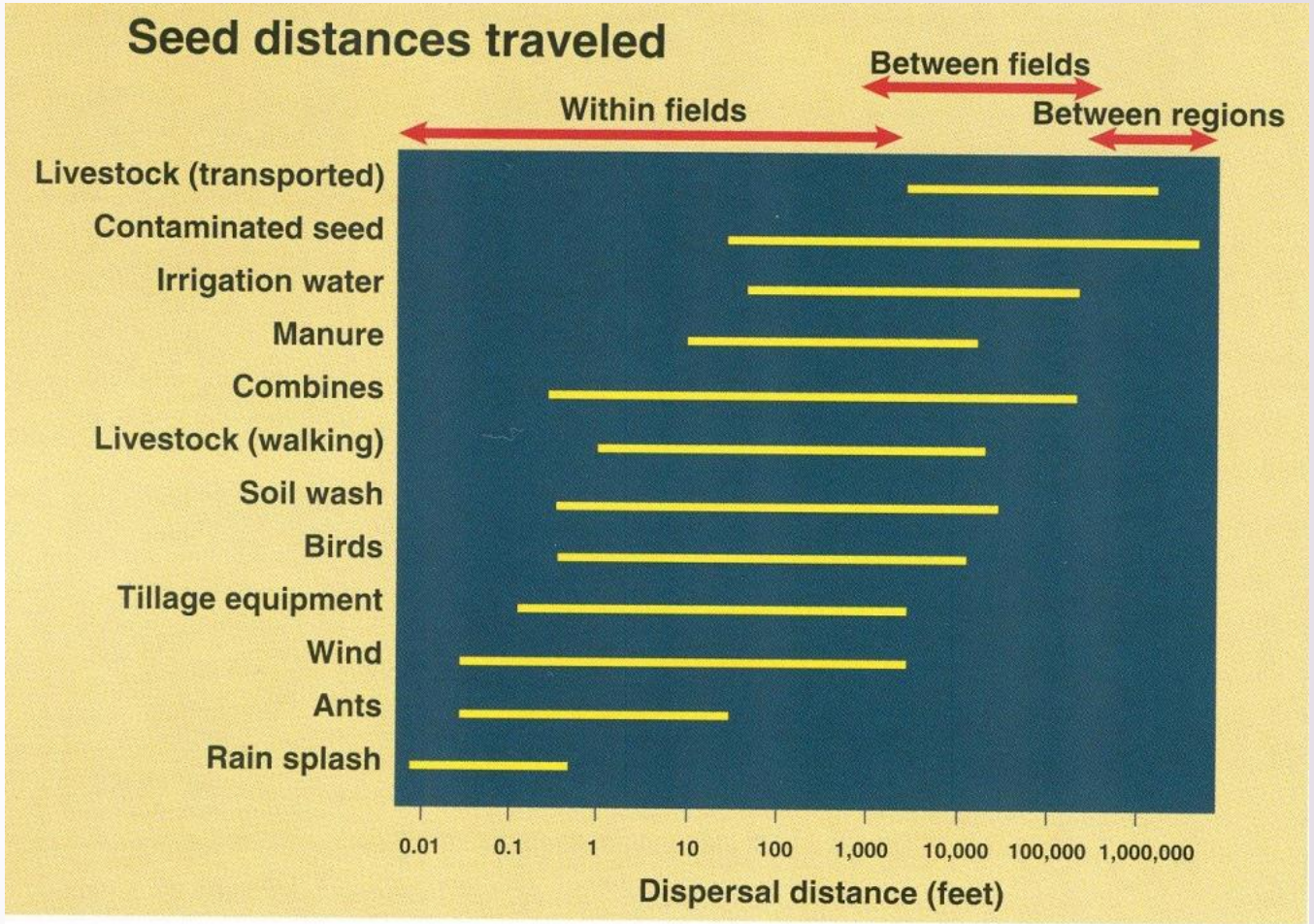


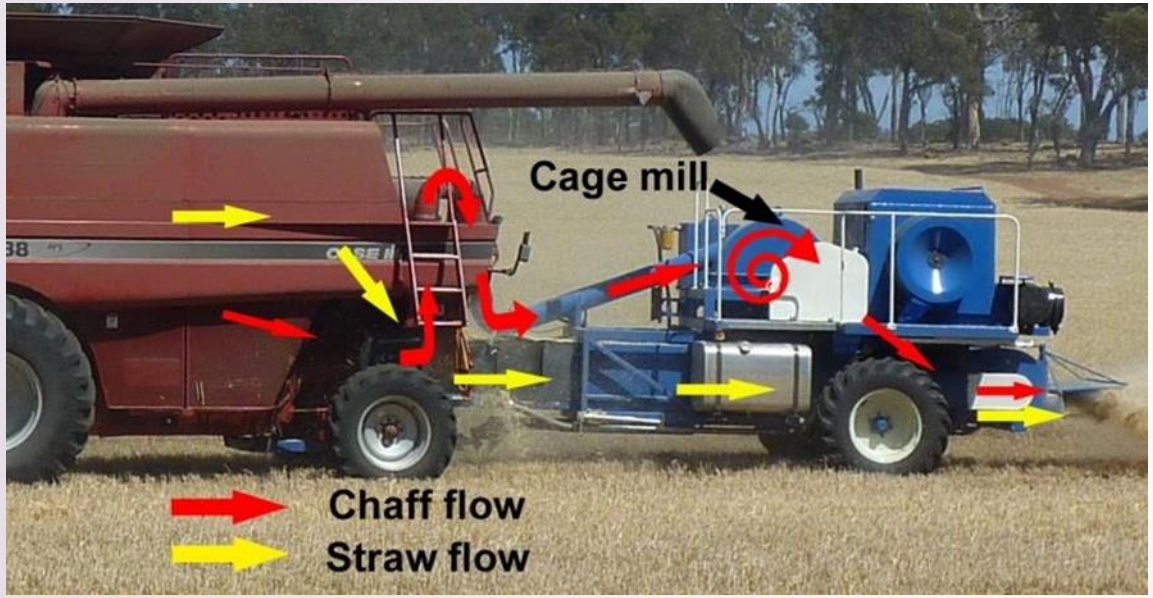
Figure 9. Various methods of transport move weed seeds over a range of distances, depending on weed species. Source: Mohler, 2001.

Davis et al. 2005. Integrated Weed Management “One Year’s Seeding…” Michigan State University Extension E-2931

Disrupting weed seed dispersal

Prone to shattering

- Walking beans



Non-shattering

- Cremate
- Capture
- Crush

Walsh et al. 2012. Crop Sci 52:1343-1347.

WESTERN ILLINOIS UNIVERSITY

Seedbank dynamics

If you were a weed seed, what conditions would you want to maximize your survival in the soil?

Safe seedbanks

- Fall tillage and burial in soil
- No cover for insects

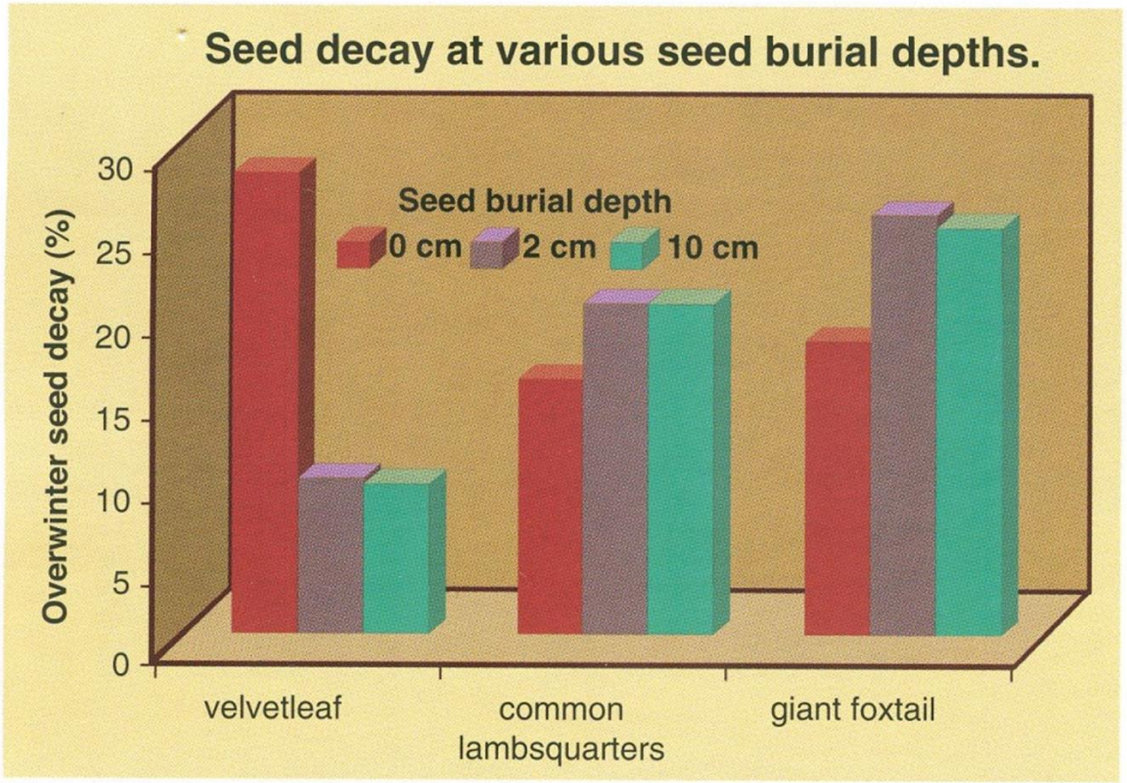


Figure 8. Burial depth affects weed seed decay of various weed species in different ways. Source: NC202 Weed Research Group, unpublished data.

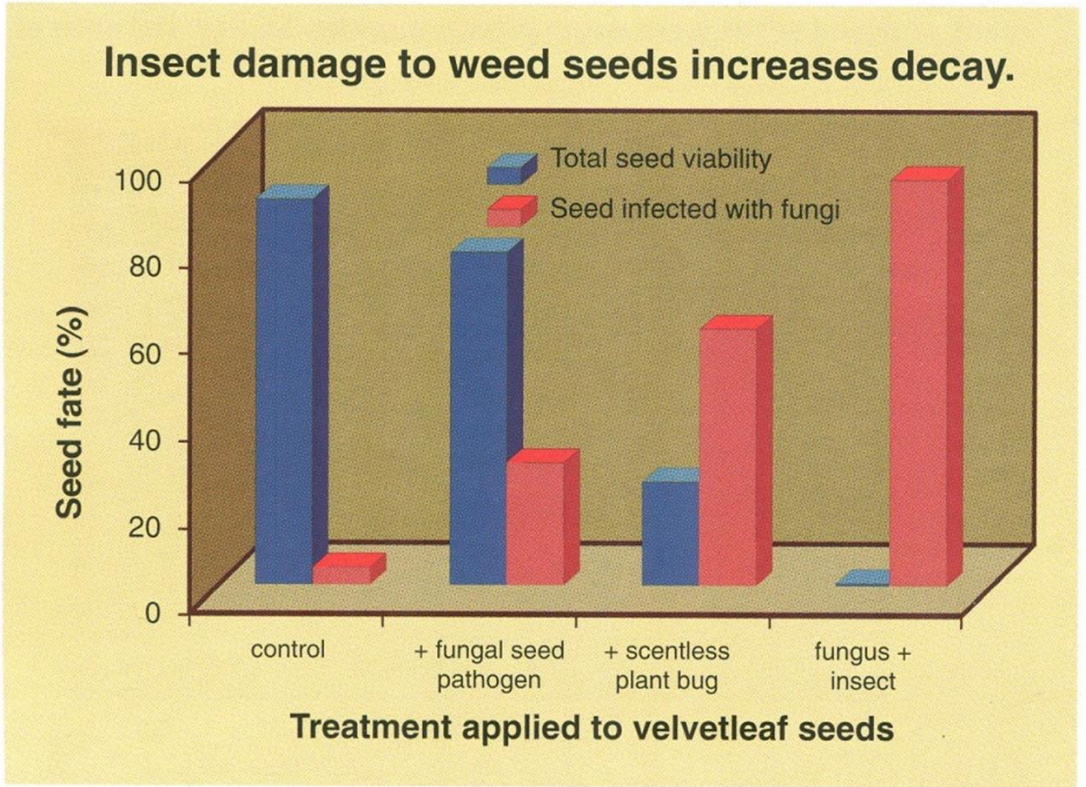


Figure 9. Damage to weed seeds by predispersal predators can increase rates of infection with fungal pathogens and seed decay. Adapted from Kremer and Spencer, 1989.

Davis et al. 2005. Integrated Weed Management "One Year's Seeding…" Michigan State University Extension E-2931

Safe seedbanks

- Limited crop diversity
- No cover crops
  - Less insect activity
  - Less microbial activity

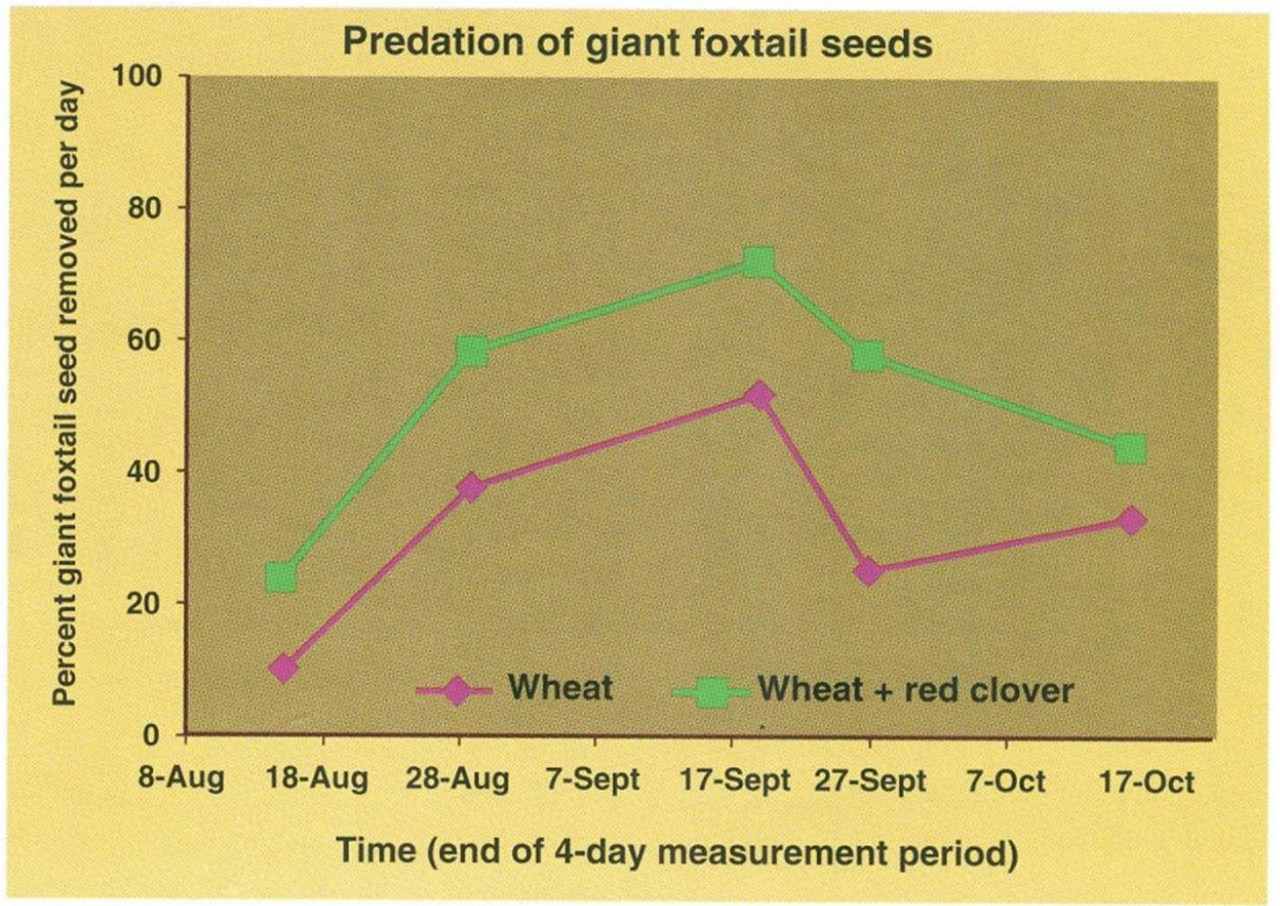


Figure 7. Predation of giant foxtail seeds in wheat was increased by overseeding wheat with red clover. Source: Davis and Liebman, 2003.

Davis et al. 2005. Integrated Weed Management “One Year’s Seeding…” Michigan State University Extension E-2931

Disrupting weed seedbank dynamics

- Create a favorable environment for desirable species
  - Seed predation
  - Seed decay

https://wimastergardener.org/article/ground-beetles/

WESTERN ILLINOIS UNIVERSITY

Herbicide response

If you were a weed, what herbicides would you want to have sprayed on the your field?

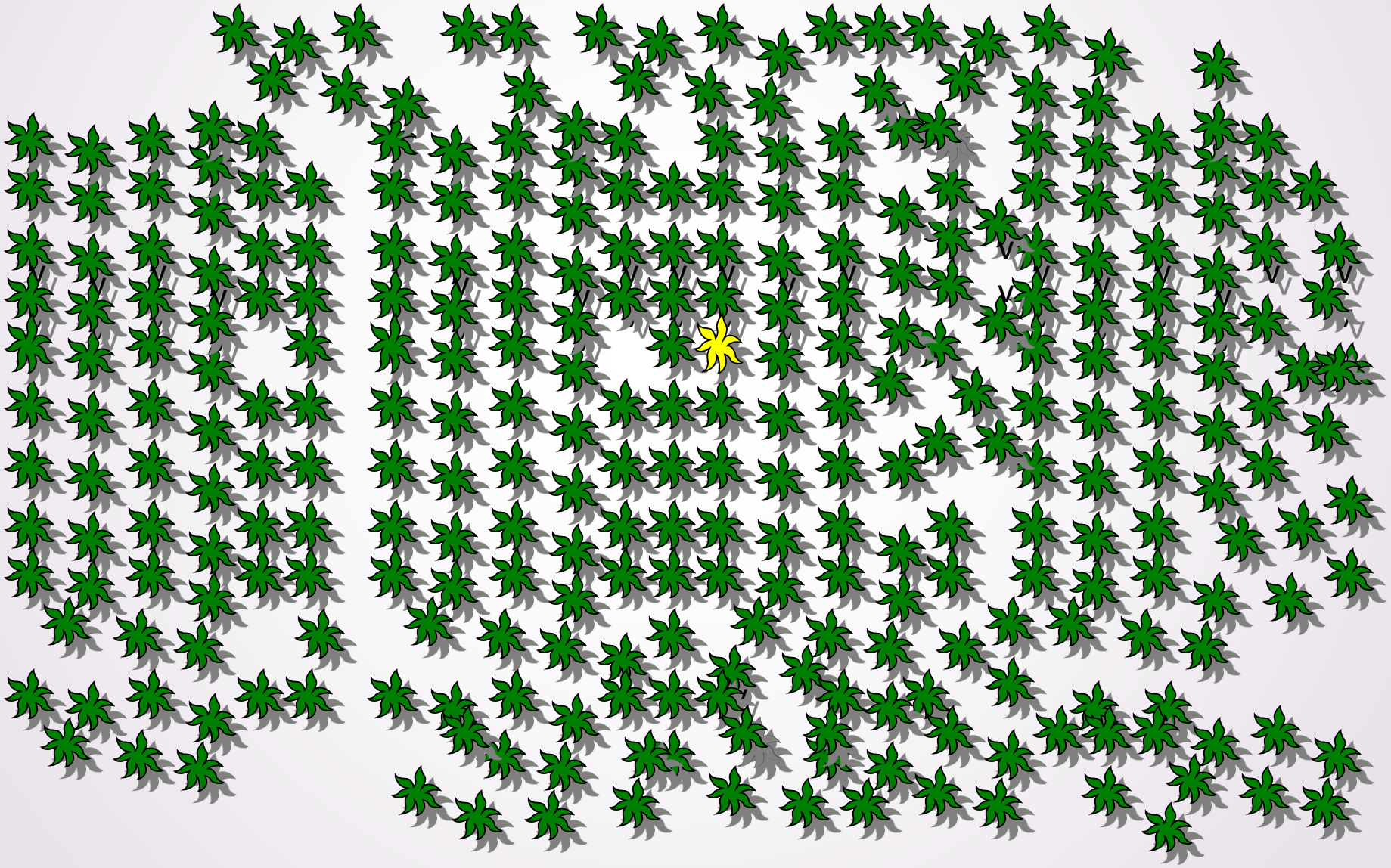
WESTERN ILLINOIS UNIVERSITY

Herbicide systems that favor weeds

- Single application time
  - PRE-only or POST-only
- Short residual
  - (or weak residual activity during germination window)
- Single mechanism of action

WESTERN ILLINOIS UNIVERSITY

Year 1 - Spring application of herbicide X

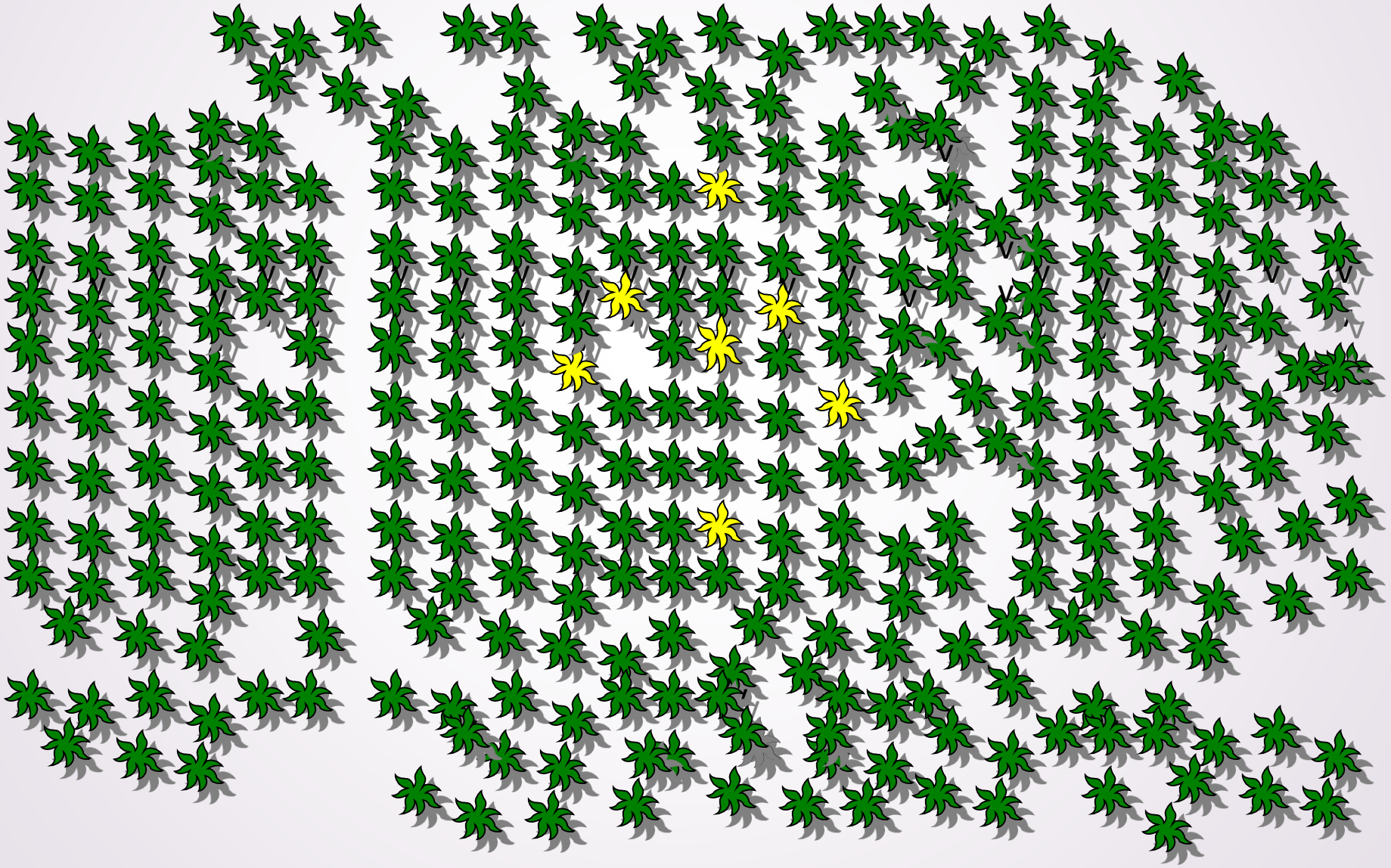


WESTERN ILLINOIS UNIVERSITY

Year 1 – Field at Harvest

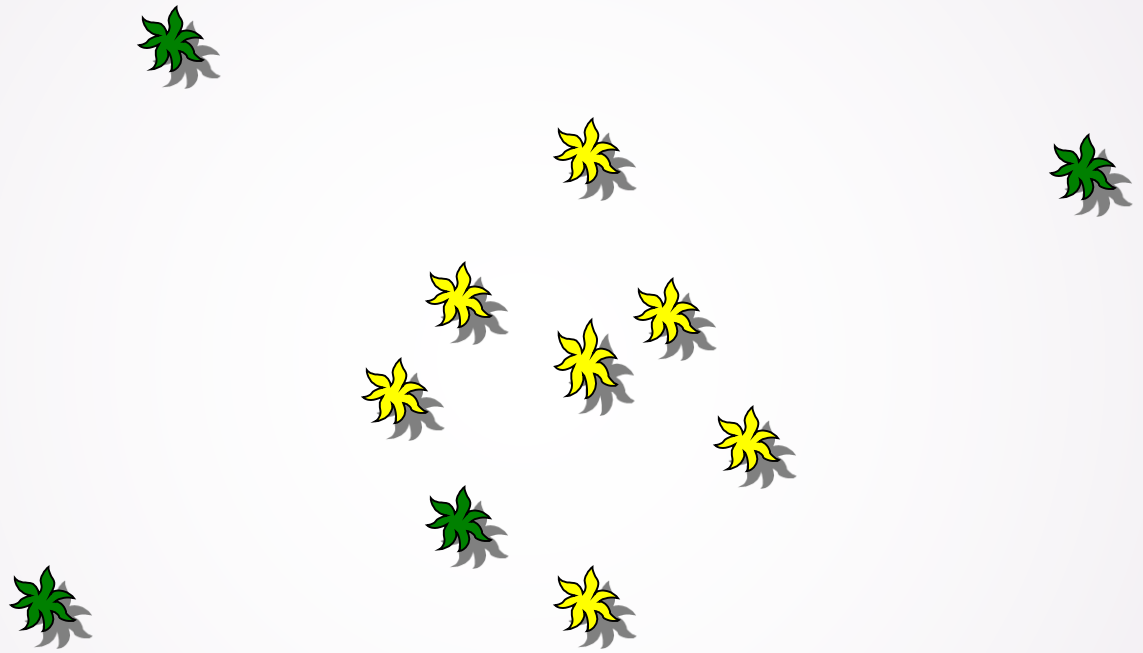
WESTERN ILLINOIS UNIVERSITY

Year 2 – Spring application of herbicide X



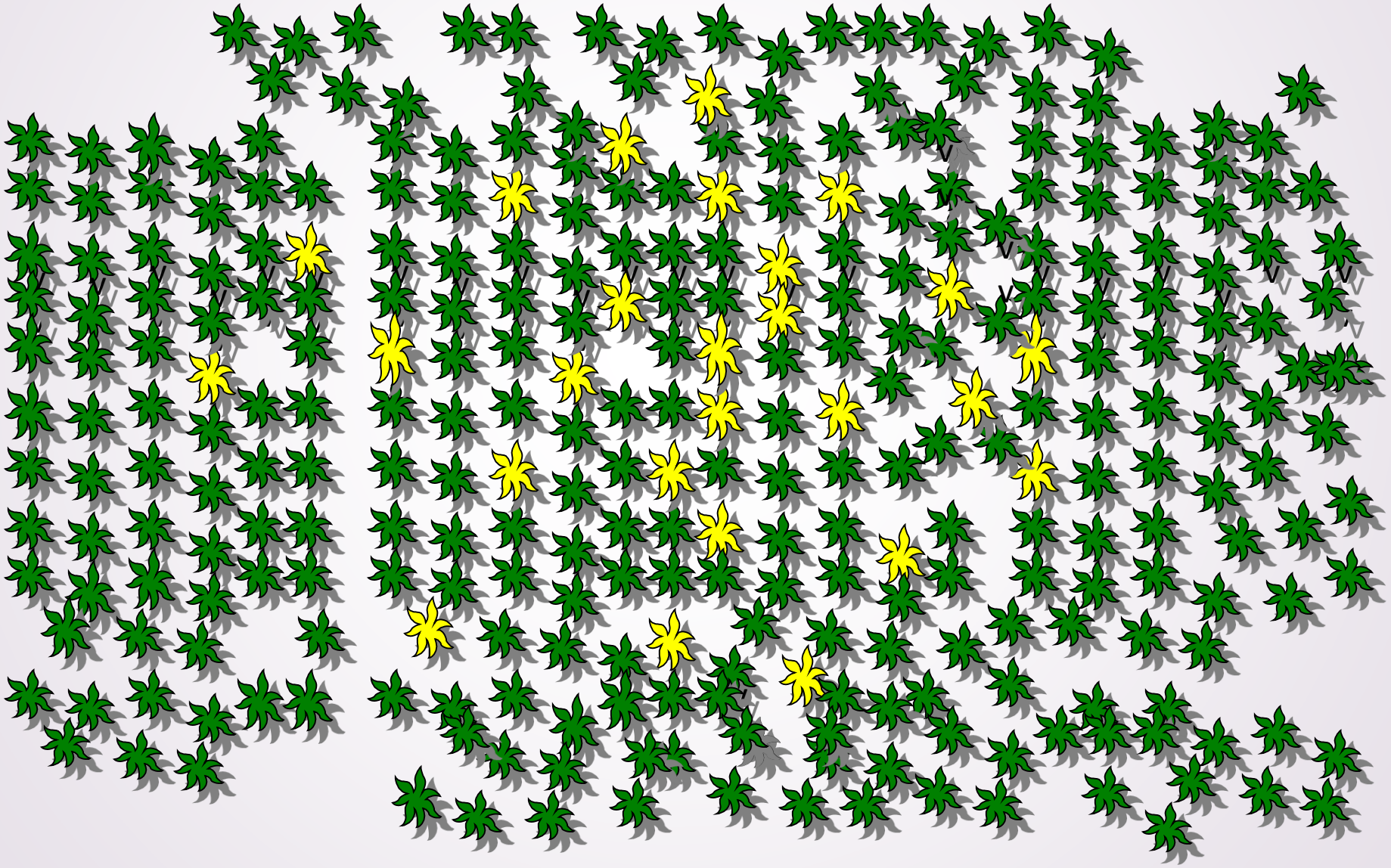
WESTERN ILLINOIS UNIVERSITY

Year 2 – Field at Harvest



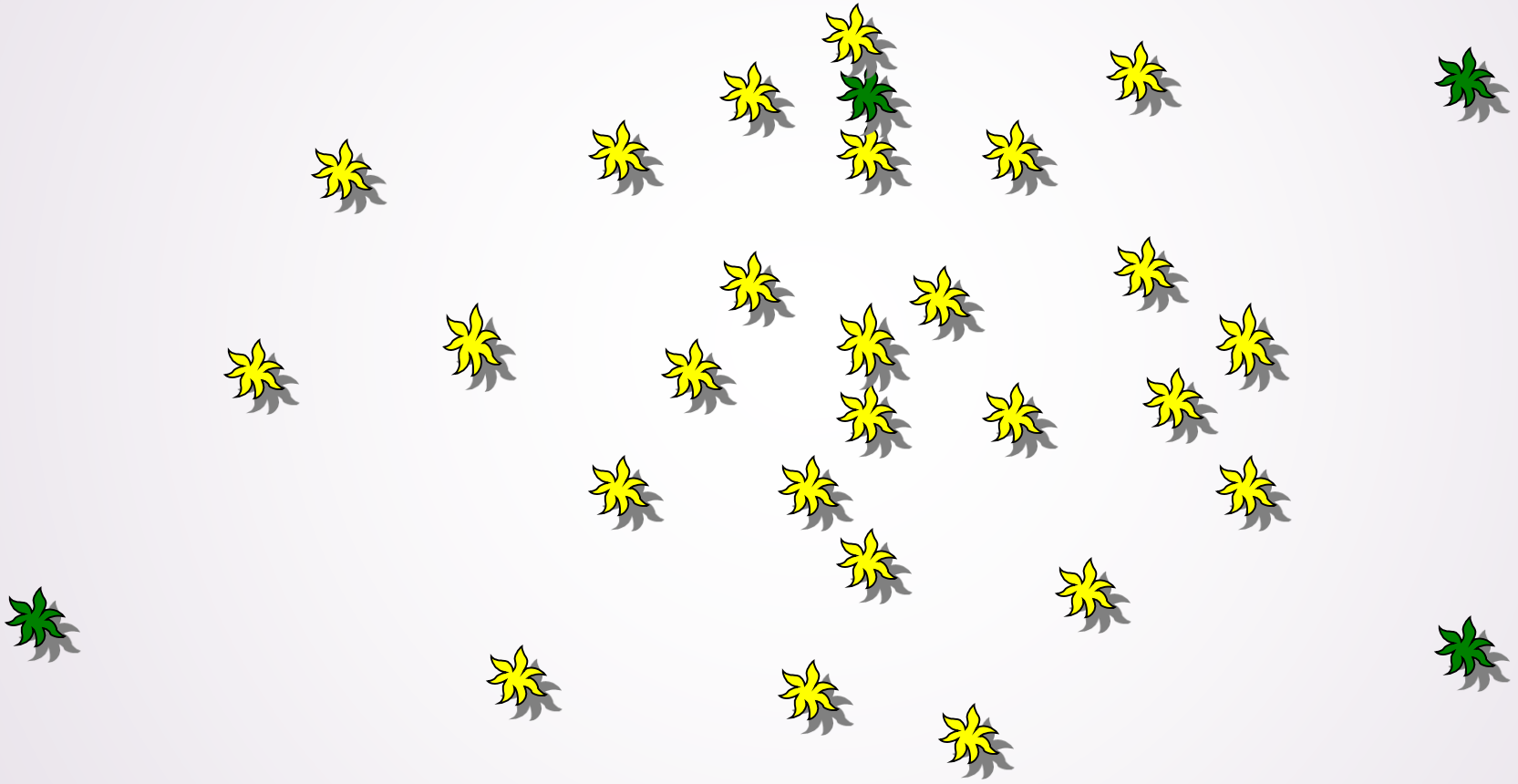
WESTERN ILLINOIS UNIVERSITY

Year 3 – Spring application of herbicide X



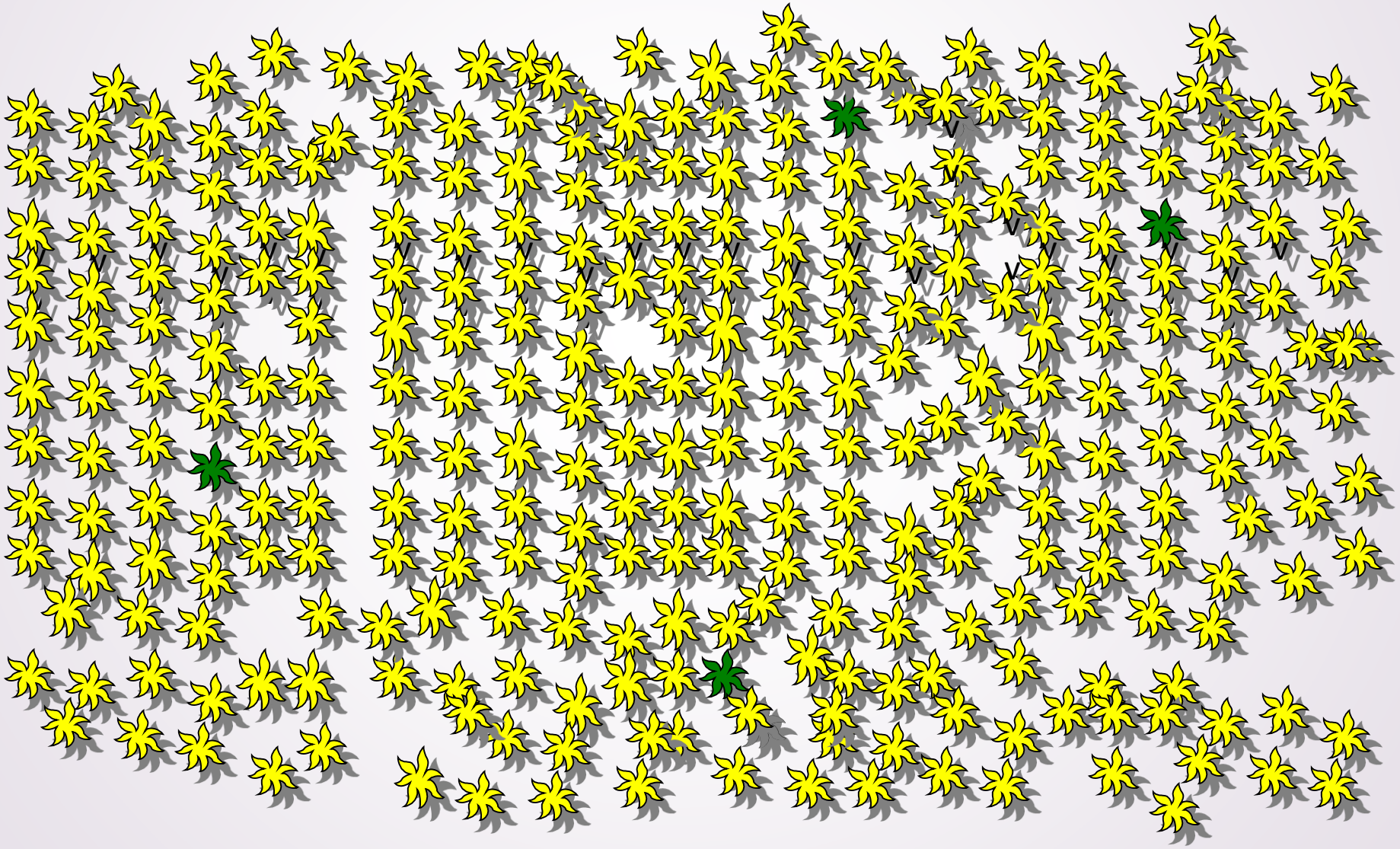
WESTERN ILLINOIS UNIVERSITY

Year 3 – Field at Harvest



WESTERN ILLINOIS UNIVERSITY

Year 8 – Field at Harvest



WESTERN ILLINOIS UNIVERSITY

Herbicide-resistant Waterhemp – One year before disaster?

WESTERN ILLINOIS UNIVERSITY

How does herbicide resistance evolve?

- Most often:
  - Repeated use of a single herbicide or single herbicide mechanism of action (MOA)
- Less often:
  - Cross-resistance = Resistance to one herbicide confers resistance to others
    - Example: Metabolism of more than one MOA
      - Enlist Corn

WESTERN ILLINOIS UNIVERSITY

Herbicide Resistance Response

- “Integrated herbicide management”
  - Manage the problem by applying more herbicides
    - Preemergence herbicide
    - Tank-mix products
  - Easiest to adopt
  - Incentives
    - Cash back for using certain combinations of products
  - Temporary fix

WESTERN ILLINOIS UNIVERSITY

- "The whole process of spraying seems to be caught up in an endless spiral. . . Thus the chemical war is never won . . ."
- There "are biological solutions, based on understanding of the living organisms they seek to control, and of the whole fabric of life to which these organisms belong."
- *What can you do to implement weed management solutions that reflect better understanding of the biology of the weeds in your fields?*

WESTERN ILLINOIS UNIVERSITY

Questions and Comments