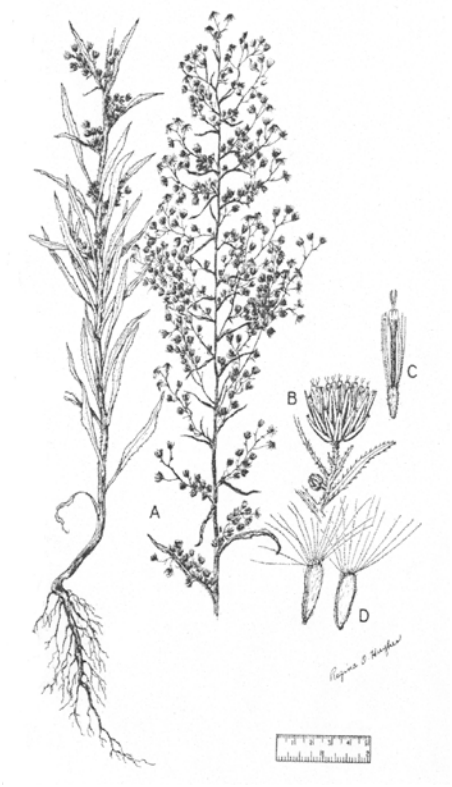
Twenty Years of Trying to Manage Glyphosate-Resistant Horseweed



Mark VanGessel

Weed / Crop Management

UNIVERSITY OF DELAWARE
COOPERATIVE EXTENSION

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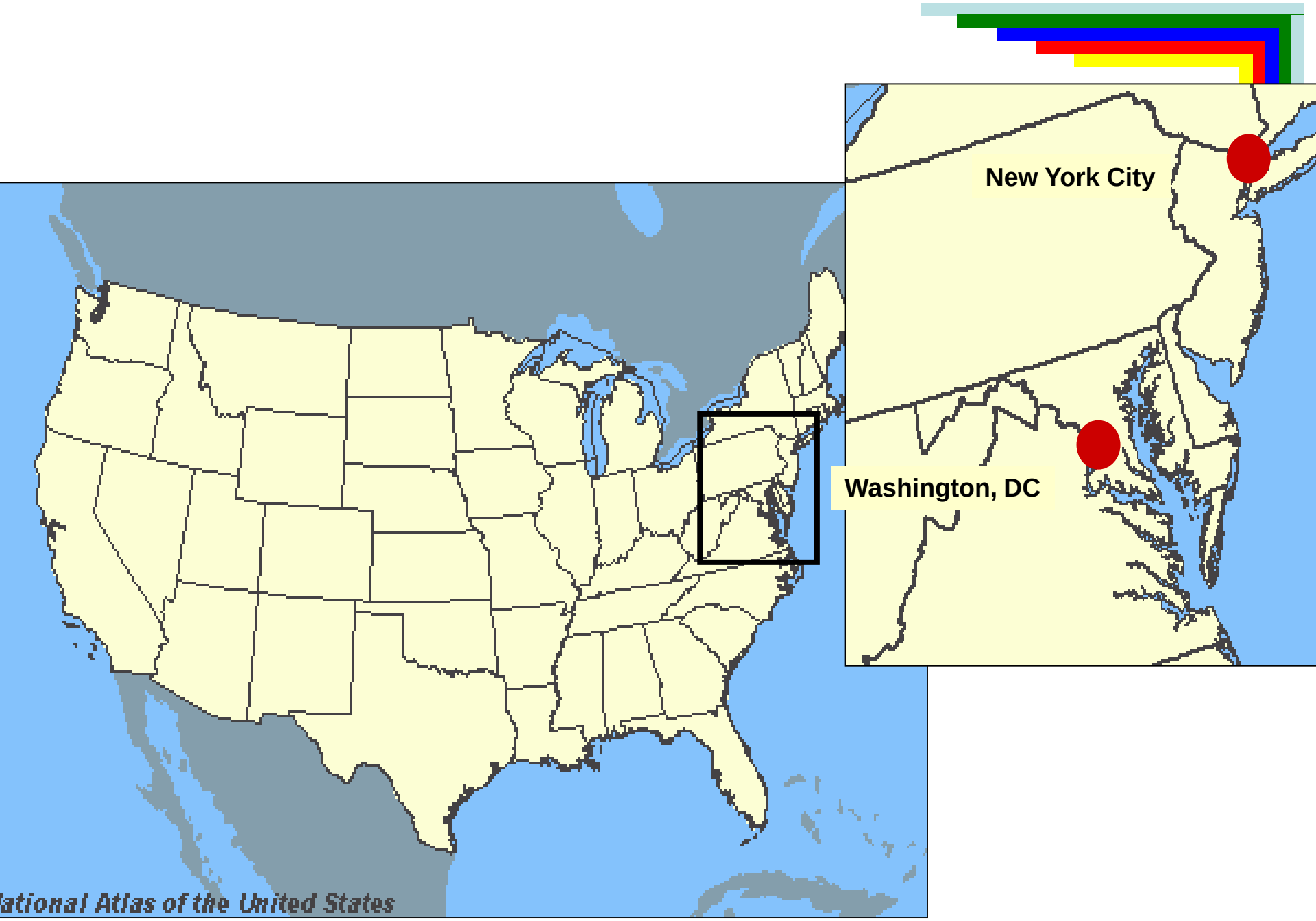
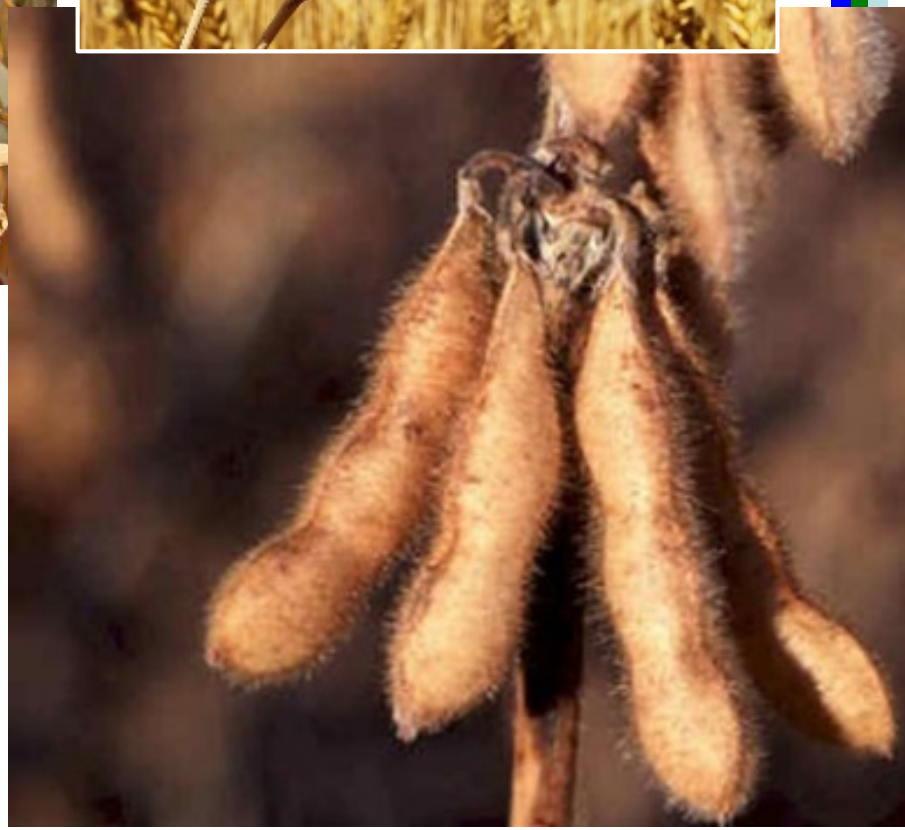
Topics

- Introductions
- Horseweed – what's the fuss about?
- What do we know about horseweed?
- How are we managing it?


New York City
Washington, DC
ational Atlas of the United States



Recent DE Agric. Statistics

Names

- *Erigeron canadensis* L. (code ERICA)
- *Conyza canadensis* (L.) Cronq.
- *Leptilon canadense* Britton

- Fleabane

- Horseweed, marestail, stickweed, bitterweed, prideweed, blood-stanch

A MANUAL OF WEEDS

WITH DESCRIPTIONS OF ALL OF THE MOST PERNICIOUS AND TROUBLESOME PLANTS IN THE UNITED STATES AND CANADA, THEIR HABITS OF GROWTH AND DISTRIBUTION, WITH METHODS OF CONTROL

BY

ADA E. GEORGIA

ASSISTANT IN THE FARM COURSE, NEW YORK STATE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY

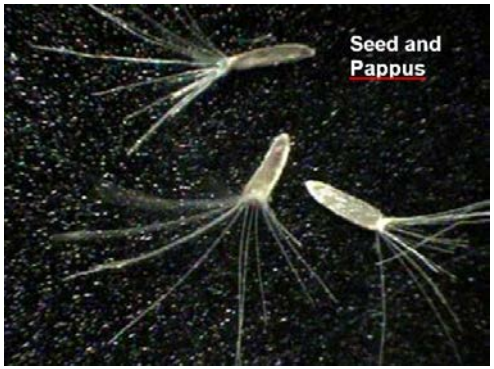
Published in 1919

Horseweed

- Summer annual, winter annual
  - Some sources refer to it as a biennial
- Fall emergence forms basal rosettes
  - Bolting occurs late spring
- Spring emerging plants do not form rosettes
- Stems are erect, unbranched
- Attains heights up to 2 m (6 ft)
- Taproot
- Flowering appears to be synchronized, regardless of emergence

Continued:

- Flowers are small, yellowish flower heads
- Seeds are “tiny” with pappus at end
- Large percentage of resources allocated to seed production
- From A. Georgia “. . . made buoyant by a parachute of fine, downy plumes on which they are lifted and wafted away on even the gentlest breeze.”



Conyza species

- Asteraceae family
- Genus contains about 50 species world-wide
- *Conyza canadensis* and *Conyza sumatrensis* most wide spread across the globe
- *Conyza canadensis* and *Conyza bonariensis* are most common species US

Other *Conyza* Species in US

- *Conyza bonariensis*
  - hairy fleabane, flaxleaf fleabane; *C. crispa*
- *Conyza floribunda*
- *Conyza laevigata*
- *Conyza ramosissima*
- *Conyza parva*

Figure 3. Horseweed seedling (left); hairy fleabane seedling (above). *Photos:* K. Hembree.

Identification to species can be difficult for *Conyza* species
Hybridization is suspected based on genetic research in Brazil

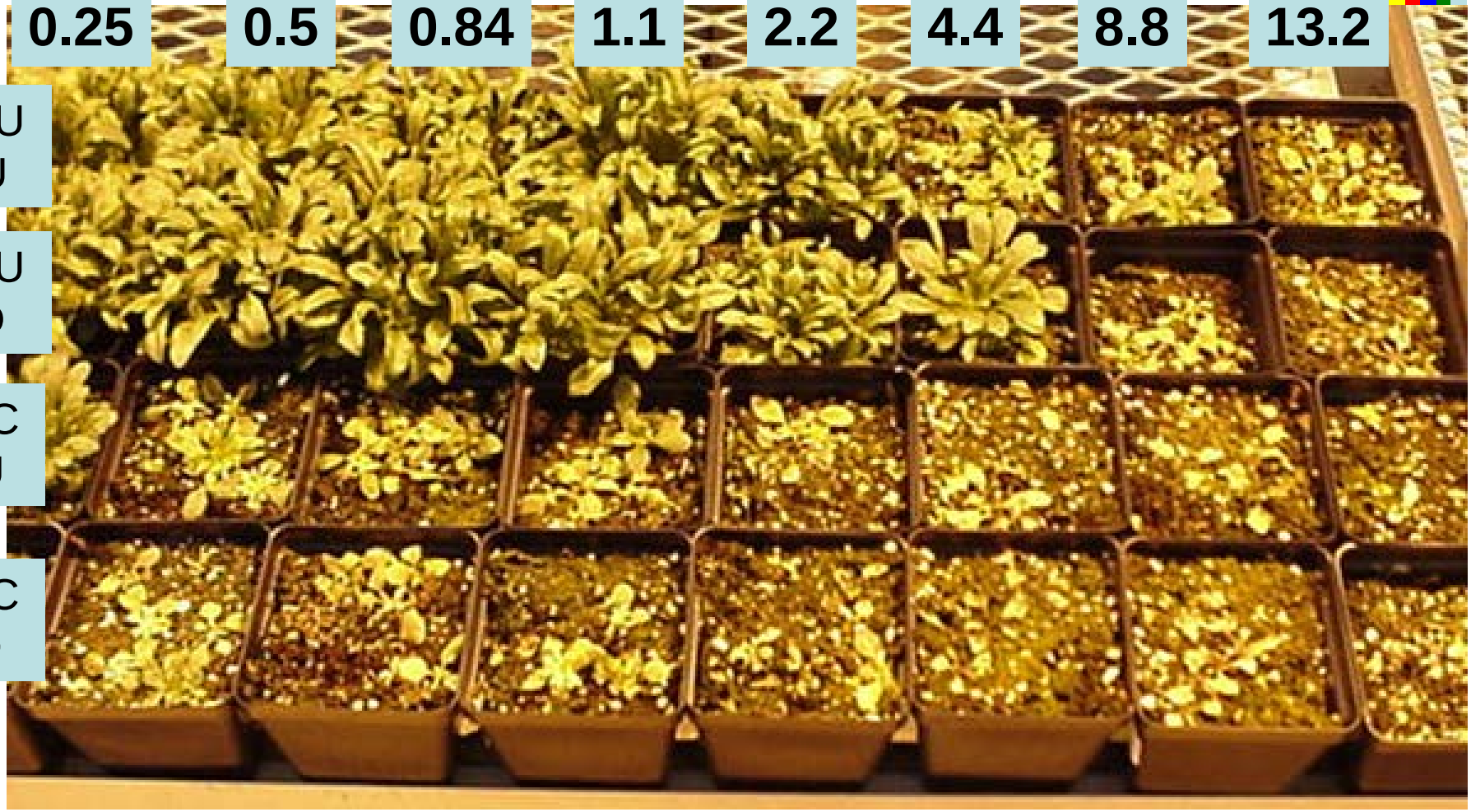
Horseweed

- Virtues:
  - From A. Georgia ". . . volatile oil of fleabane, used in making "**mosquito dope**" for the use of persons who have to go where mosquitoes are troublesome."
    - Azeem etal. 2019. Chemical composition and repellent activity of native plants essential against dengue mosquito, *Aedes aegypti.* Industrial Crops and Products DOI: 10.1016/j.indcrop.2019.111609
  - Medicinal to treat gastrointestinal problems

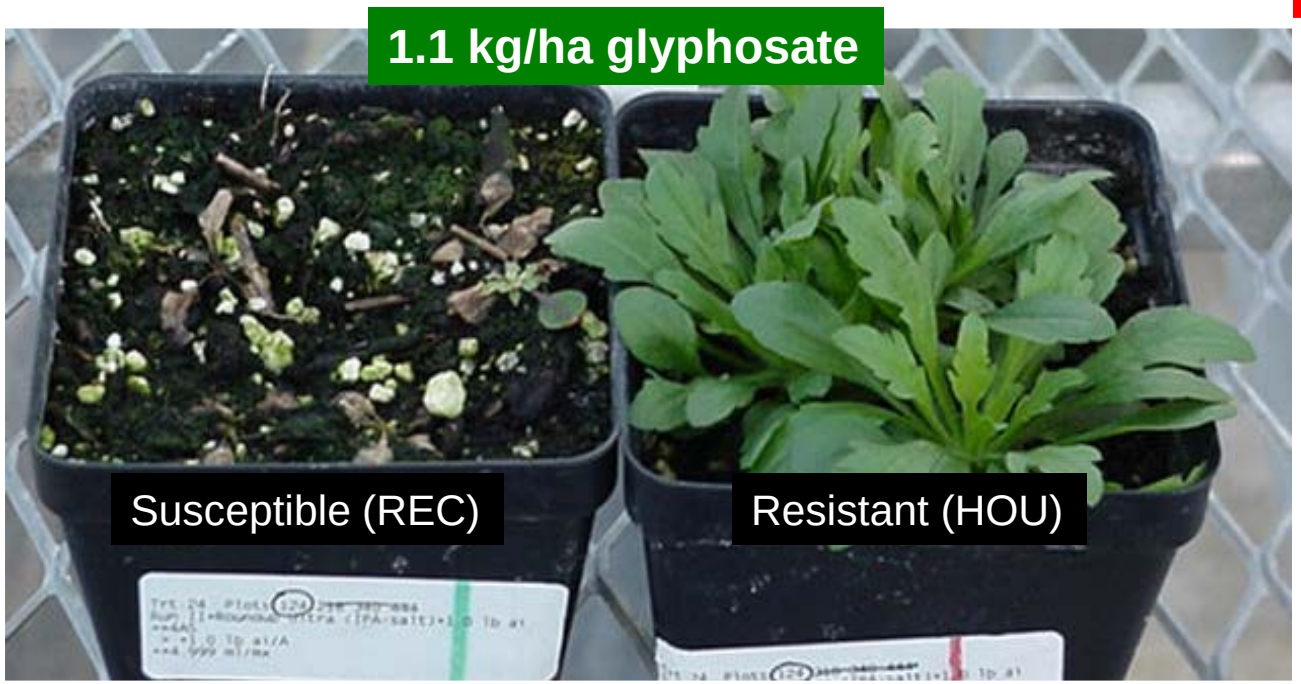
Infested sites

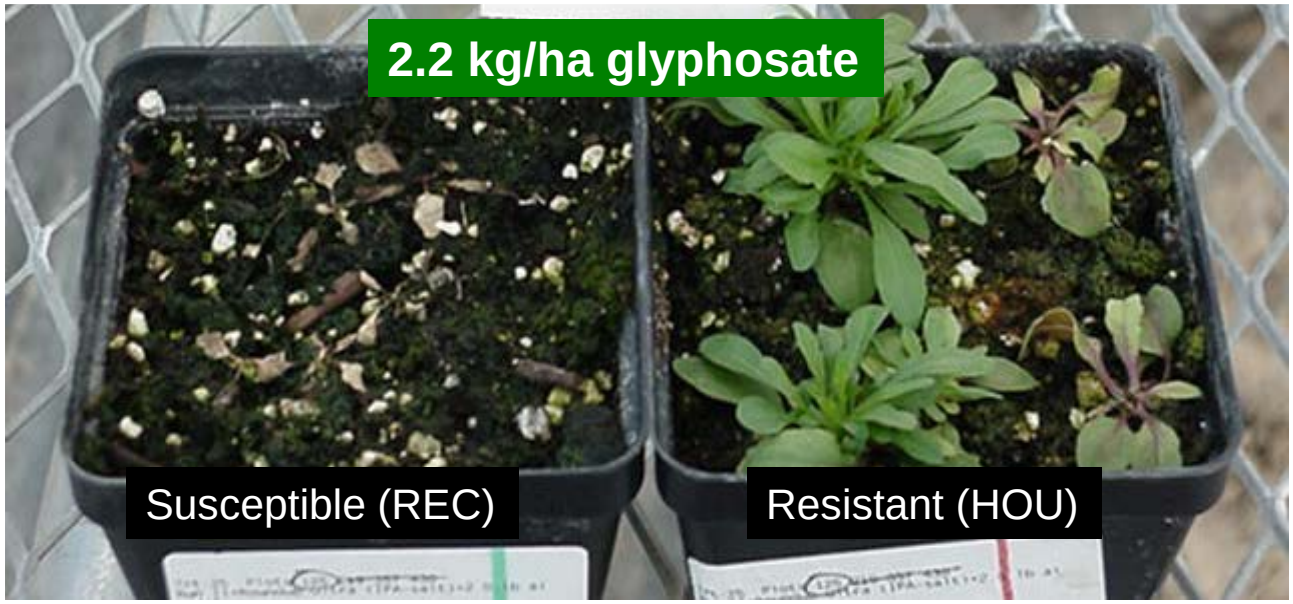
- Grain and row crops
  - corn, soybeans, cotton, wheat
- Perennial crops
  - orchards, grapes, nut crops, berries
- Nurseries
- Forests
- Industrial sites, roadsides, fencelines, railways, natural areas

Glyphosate rates (kg/ha)



RU= Roundup Ultra
TD= Touchdown


1.1 kg/ha glyphosate
Susceptible (REC)
Resistant (HOU)


2.2 kg/ha glyphosate
Susceptible (REC)
Resistant (HOU)

What Factors Led to GR-ERICA?

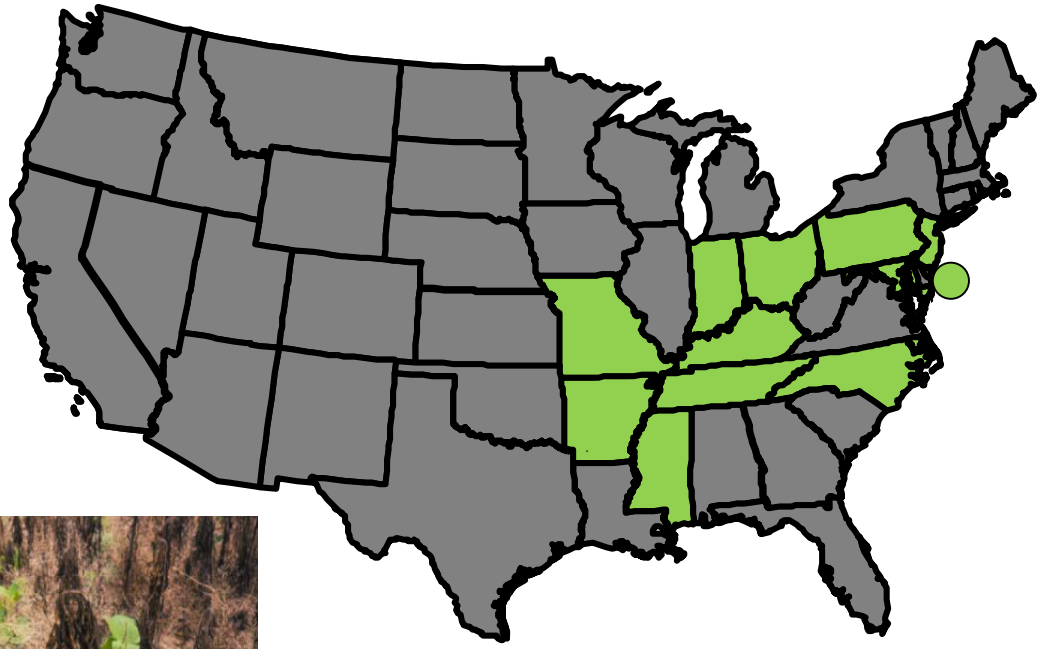
- Explosion of RR soybeans and cotton – concurrent increase in NT
- Costs of glyphosate dropped dramatically
- Stagnant crop prices, emphasis on reducing input costs
- Reliance on single herbicide (2 to 3 applic per yr)
  - No longer using tank-mixtures with “burndown”
  - Many common PRE herbicides had good horseweed control

Glyphosate-resistant horseweed in the U.S.

2001: 2 states

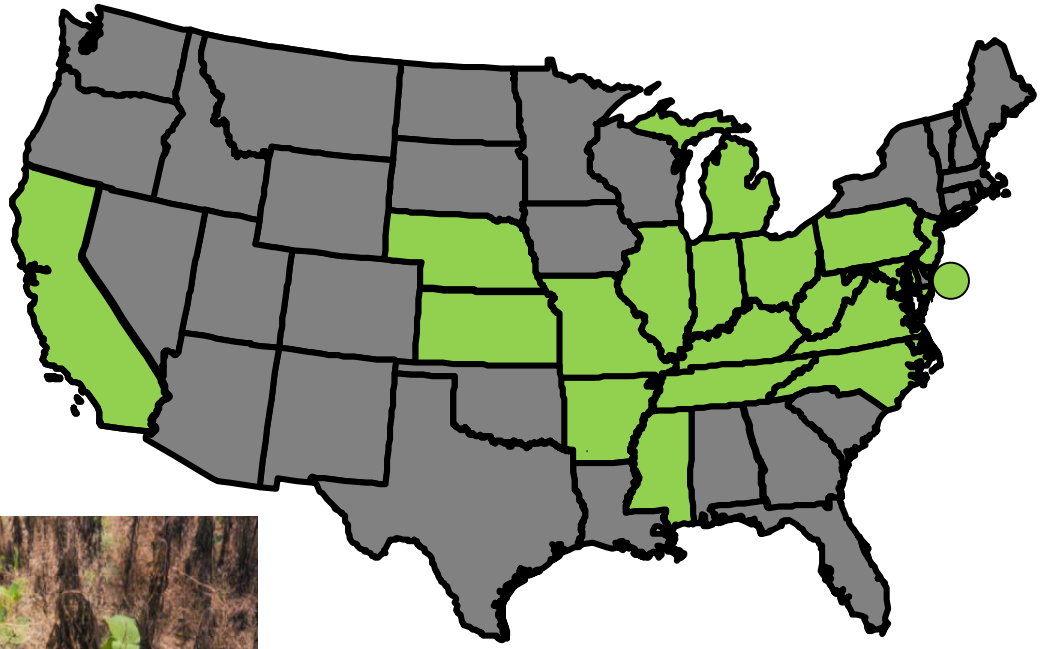
Glyphosate-resistant horseweed in the U.S.

2003: 13 states



Glyphosate-resistant horseweed in the U.S.

2008: 19 states



Glyphosate-resistant horseweed in the U.S.

2018: 25 states

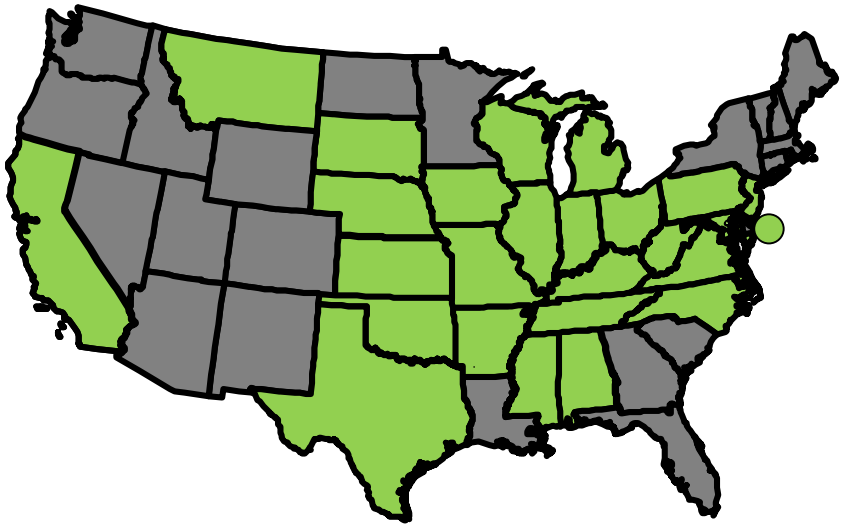
Herbicide Site of Action

World wide – 18 countries

Herbicide group	Site of Action	Active ingredient	1st US report	Multiple
9	EPSP	glyphosate	2000	9/22, 9/2
22	PS I Electron diverters	paraquat	1994	22/9
5	Photosystem II	atrazine	--	5/2
2	ALS	chlorimuron	2001	2/9, 2/5
7	Photosystem II	linuron	2002	

First Report in 1980, Group 22
65 cases reported world wide, 18 countries
Group 5 resistance not reported in US

weedscience.org Jan 2020



- Resistance developed at multiple sites independently
- No apparent lost of fitness

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WITH 385 ILLUSTRATIONS

BY

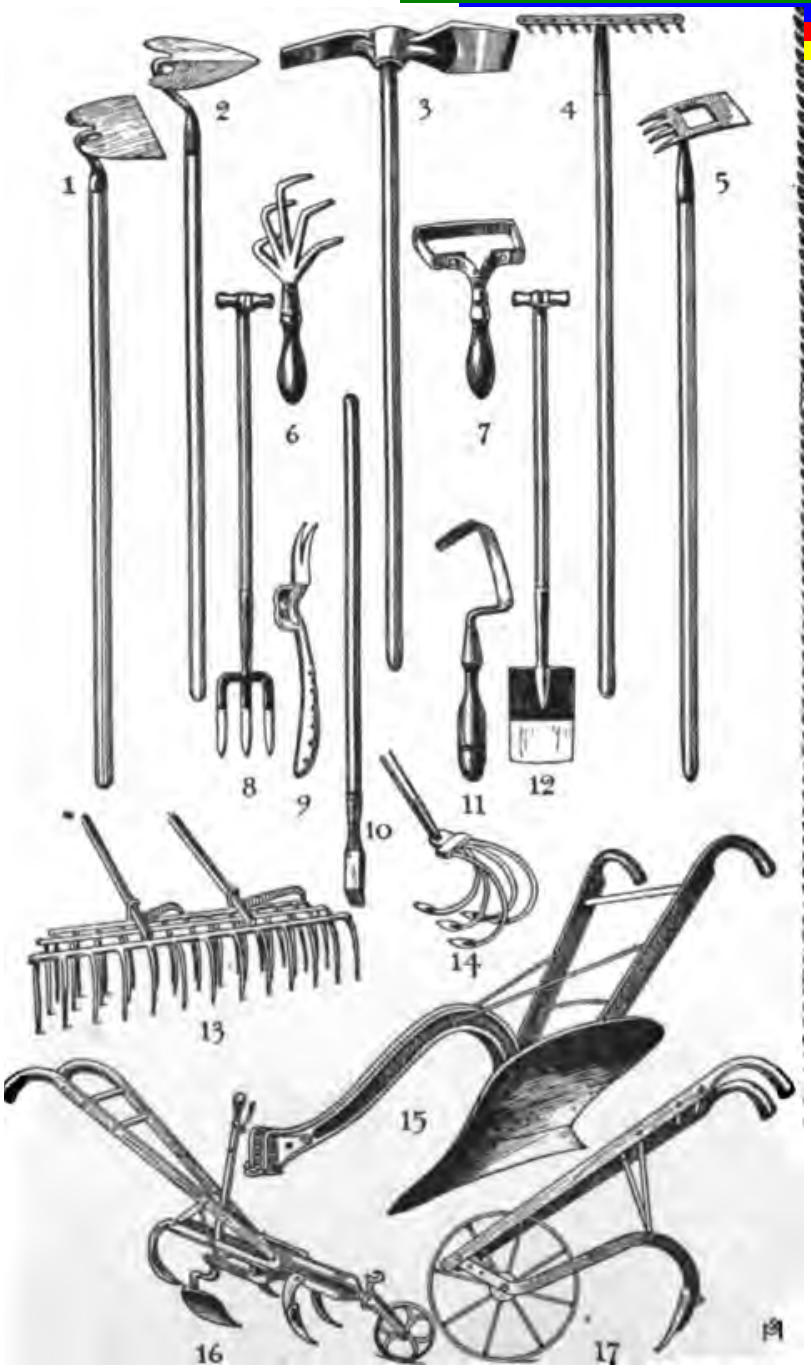
F. SCHUYLER MATHEWS

AUTHOR OF "FIELD BOOK OF AMERICAN WILD FLOWERS"

New York

THE MACMILLAN COMPANY

1919

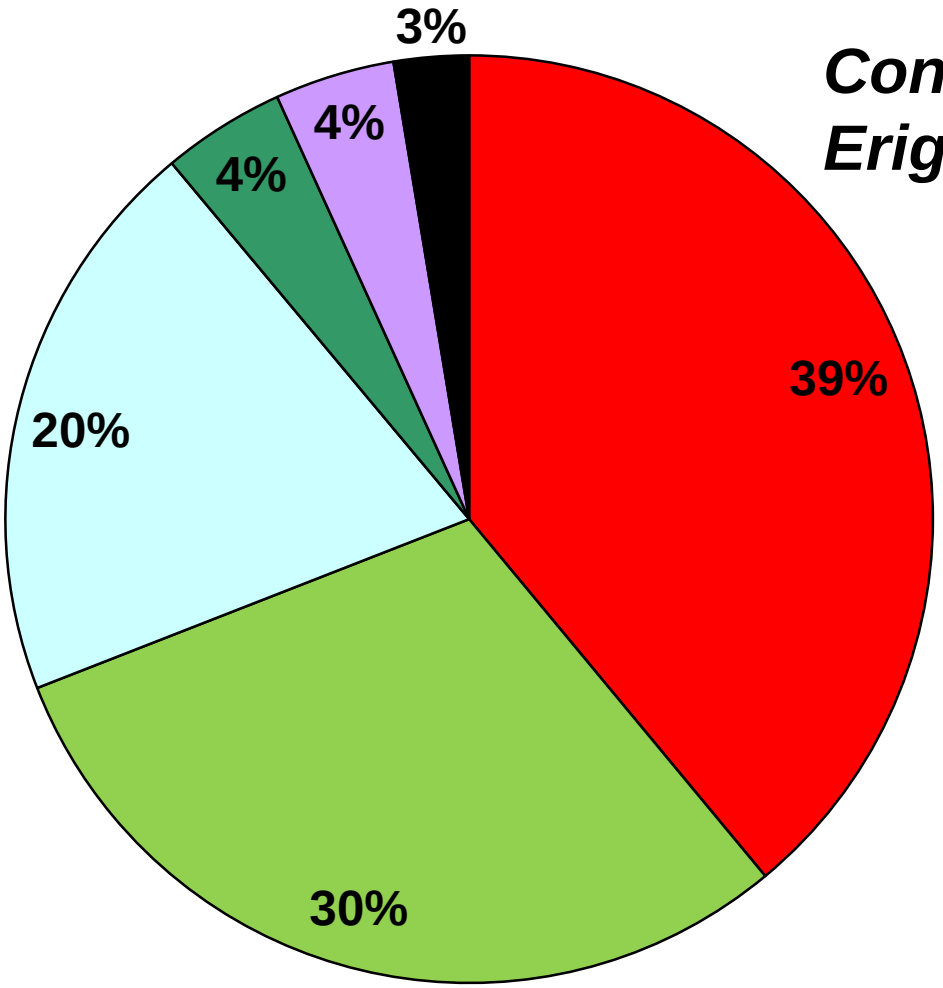


Hits on Web of Science

Species	1900 to 2000	Since 2000	+control (since 2000)
Conyza canadensis*	**95**	**681**	**274**
Chenopodium album	805	1554	567
*Bassia scoparia**	170	315	111
Amaranthus retroflexus	389	842	370
Amaranthus palmeri	66	533	337
Setarai faberi	143	191	82
Digitaria sanguinalis	177	414	182
Cyperus esculentus	242	496	263

*also used alternate name
Search 1/16.2020

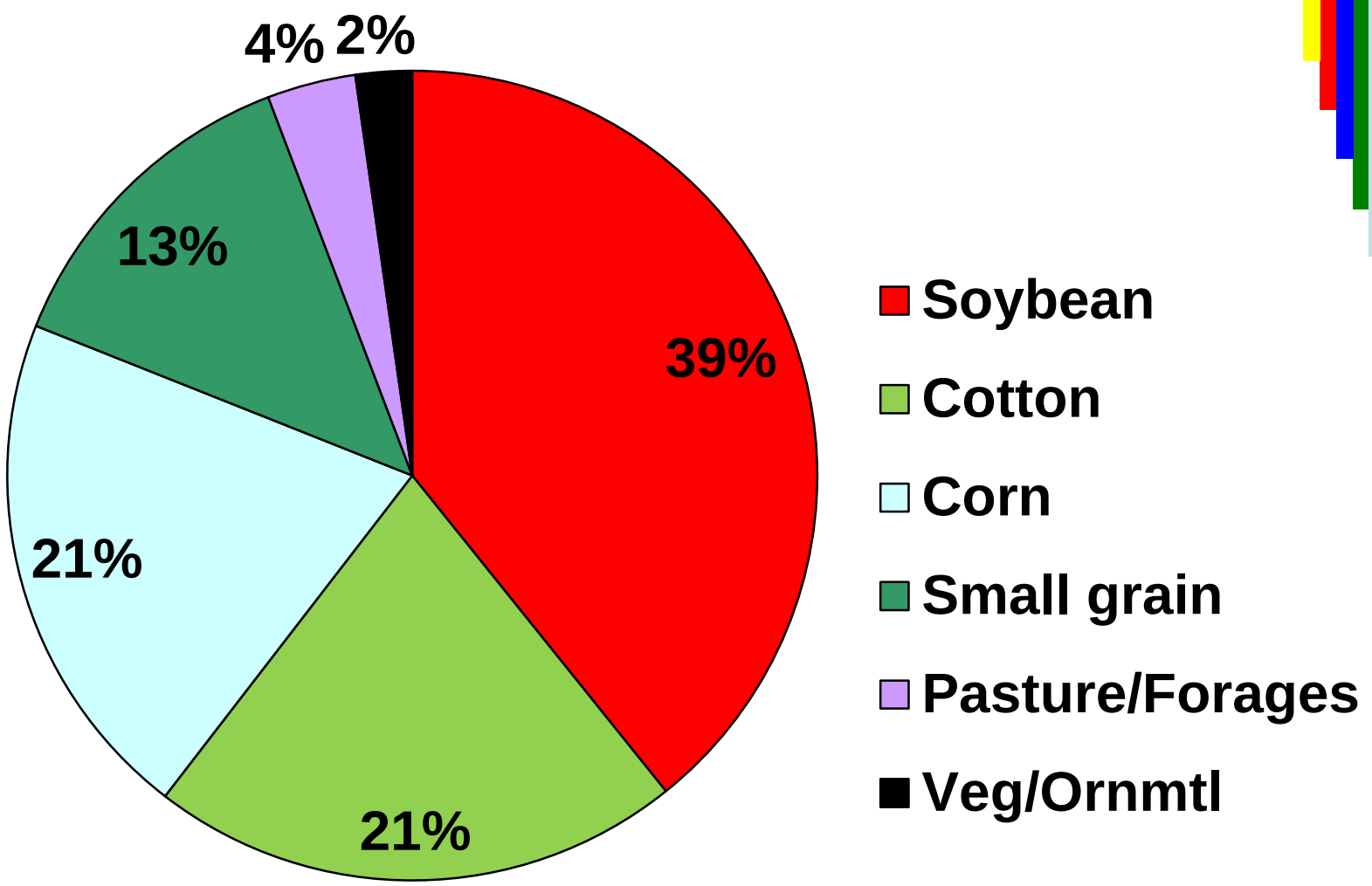
Types of Research
based on Web of Science



***Conyza canadensis* or *Erigeron canadensis* PLUS**

- Resistance
- Control
- Seed
- Rotation or Cultural
- Oils
- Ecology

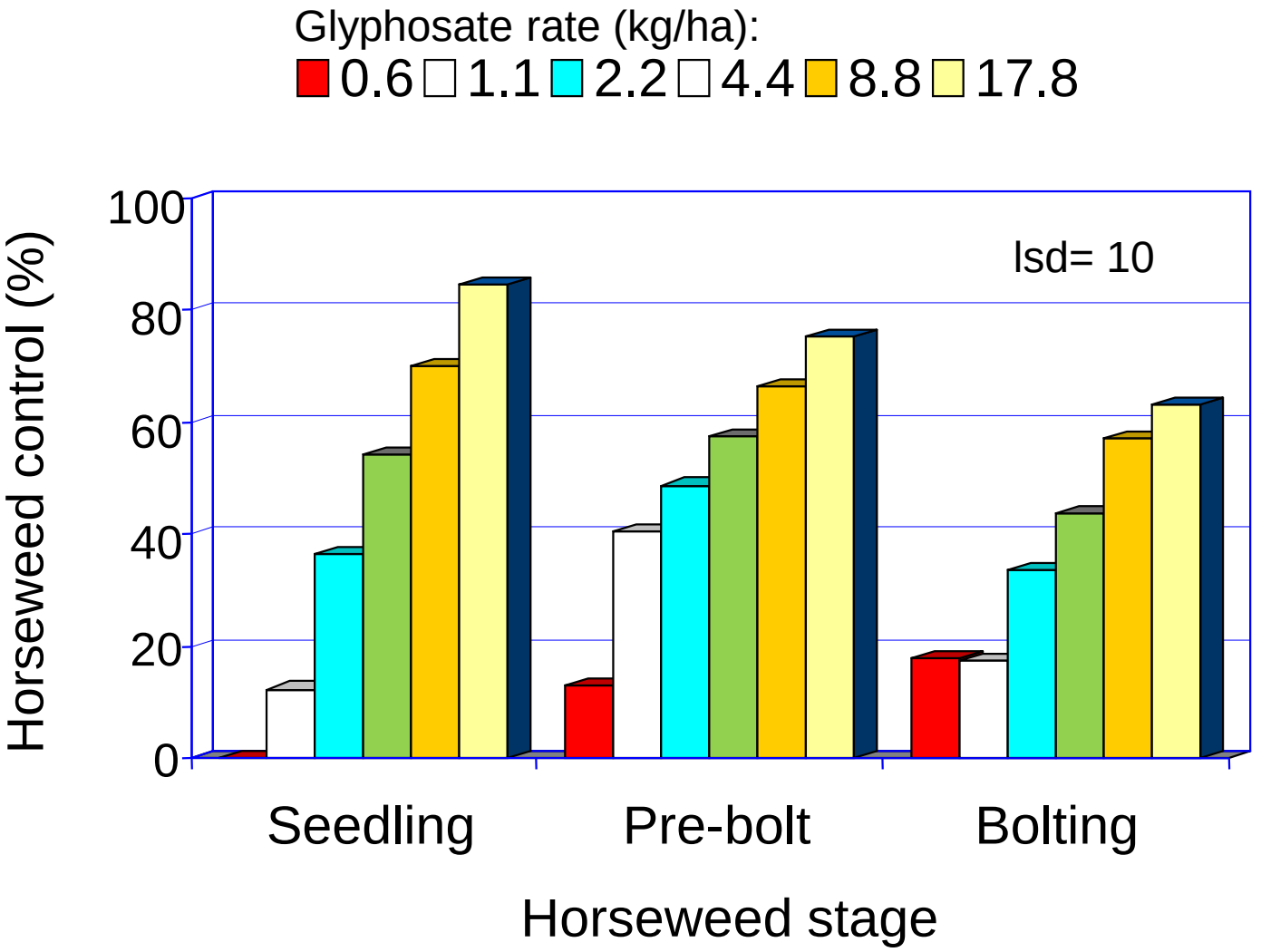
Crops
based on Web of Science



Influence of growth stage on level of resistance

Rationale: Research to confirm resistance was done with seedling horseweed plants, treated 3 weeks after planting. This research demonstrated an 8- to13-fold level of resistance. However, it is unclear how horseweed plants will respond to glyphosate applied at various stages.

Resistant population

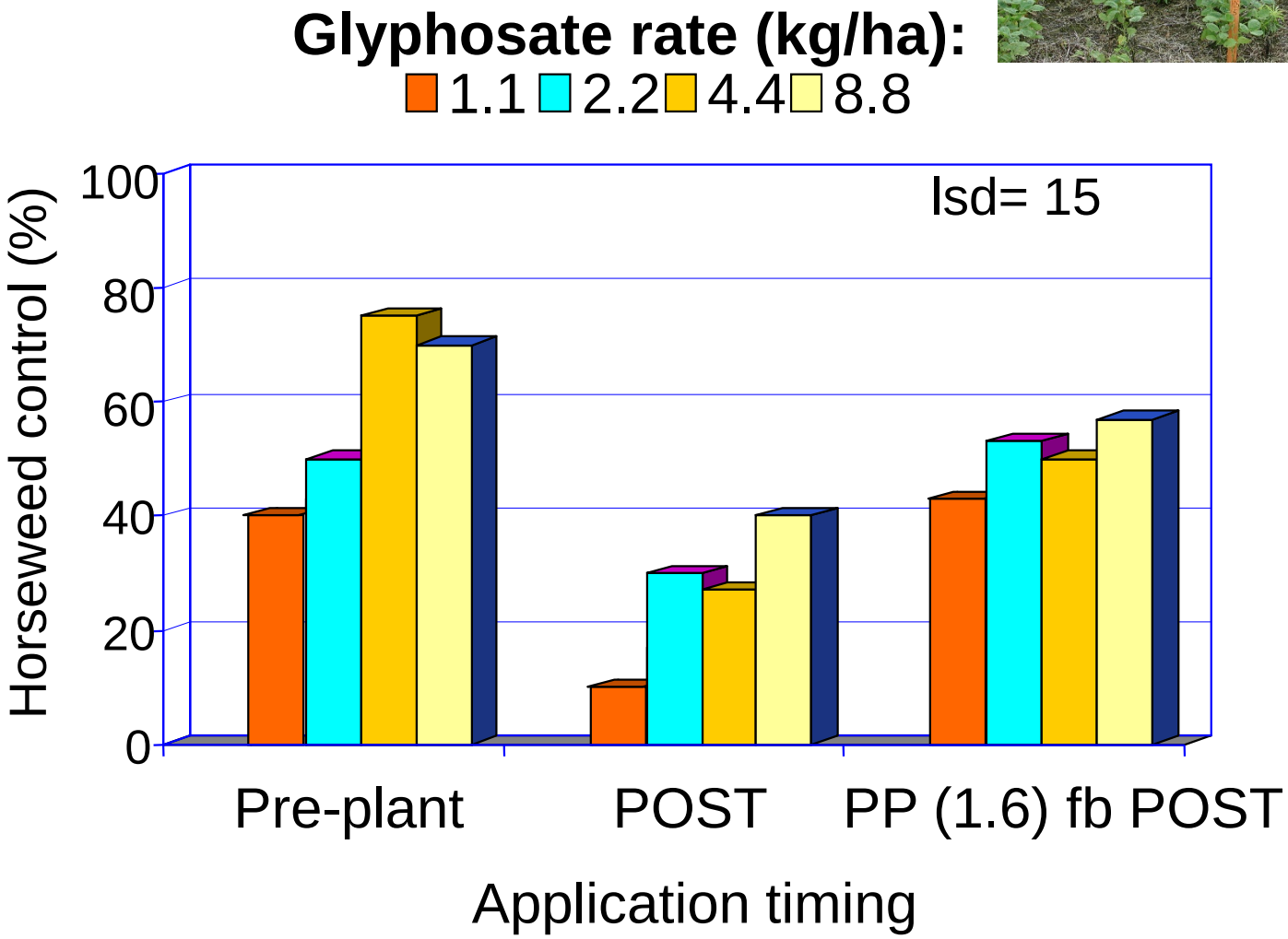


Effect of Multiple Glyphosate Applications on GR-ERICA

Effect of Glyphosate on GR-ERICA

- Two factor factorial
  - timing and rate
- Glyphosate applied at planting (BD), POST, or 1.6 kg ae at planting fb POST (BD fb POST)
- Glyphosate rates 1.1, 2.2, 4.4, or 8.8 kg ae/ha

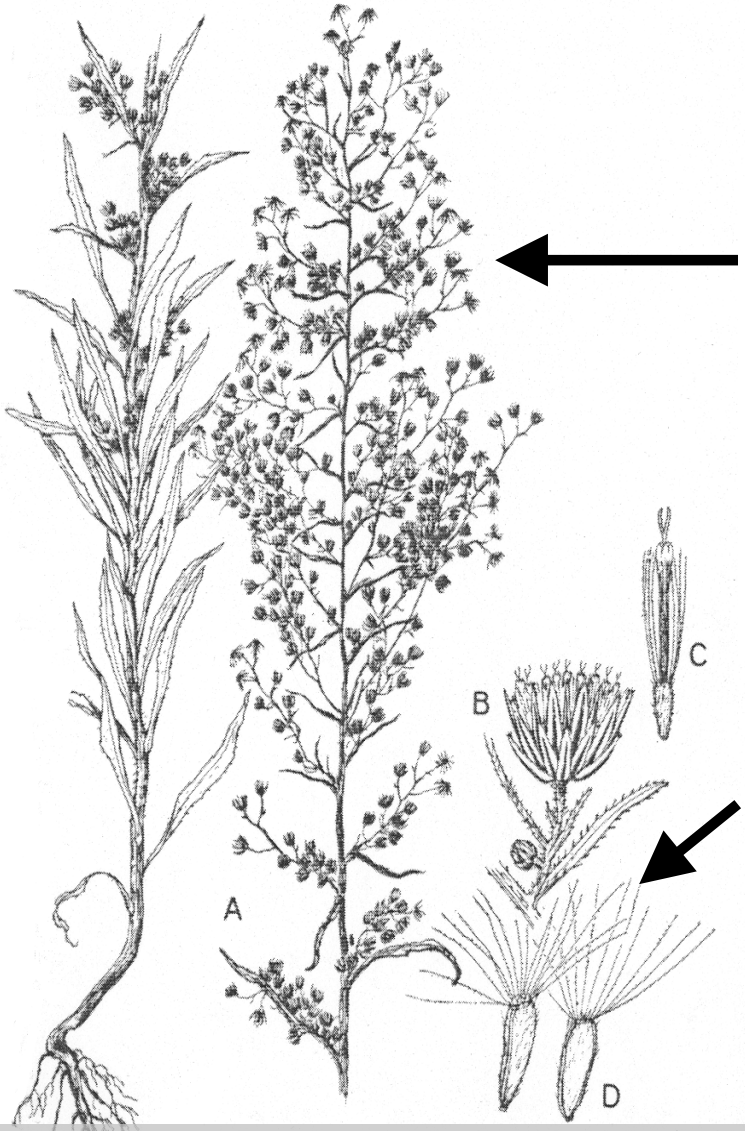
Sequential Glyphosate Applications



Field trial
Soy9-02


Harmony Extra
1.5 oz/A


untreated



High number of seeds produced

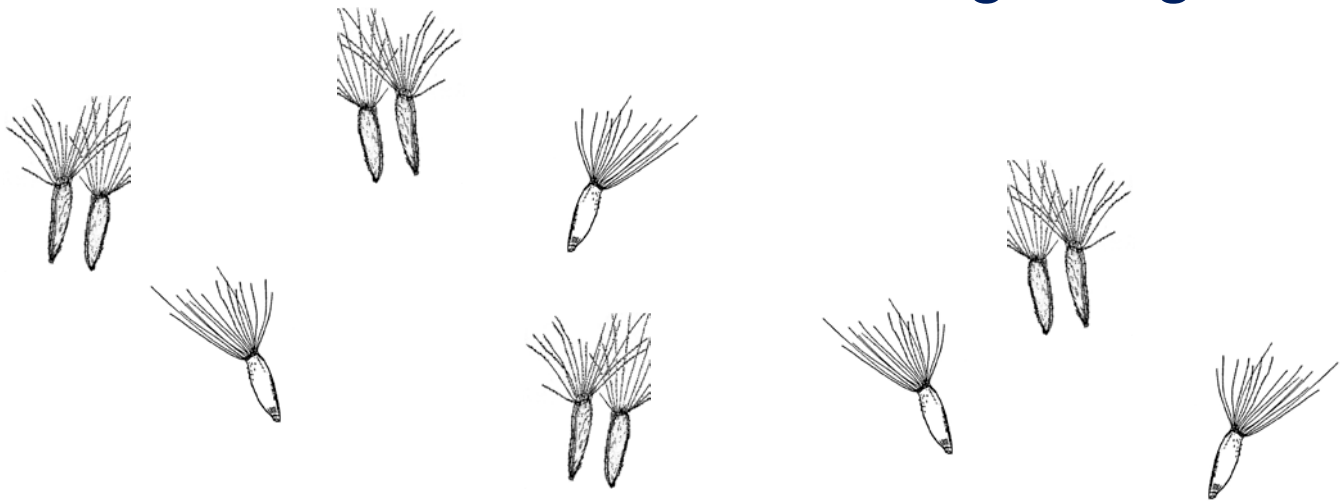
Small wind-blown seed

Important To Consider the Ecology and Biology of the Plant


3
4
5

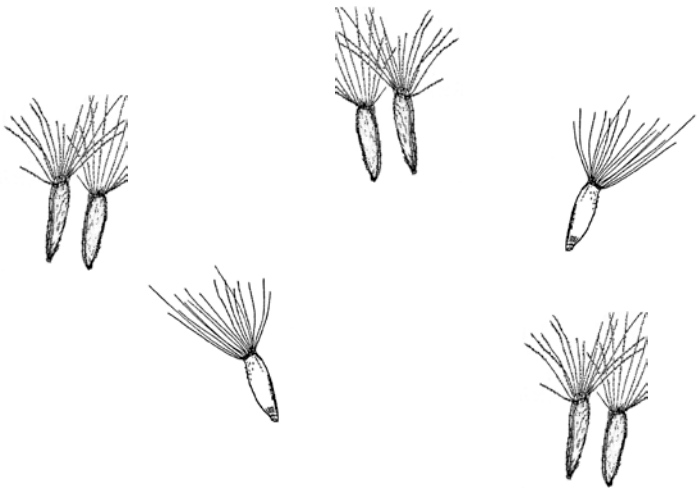
Dispersal

- Seed is capable of moving in the atmosphere for 500 km
- Are seeds able to move secondary movement?
  - Move with wind after reaching the ground



Seed Movement

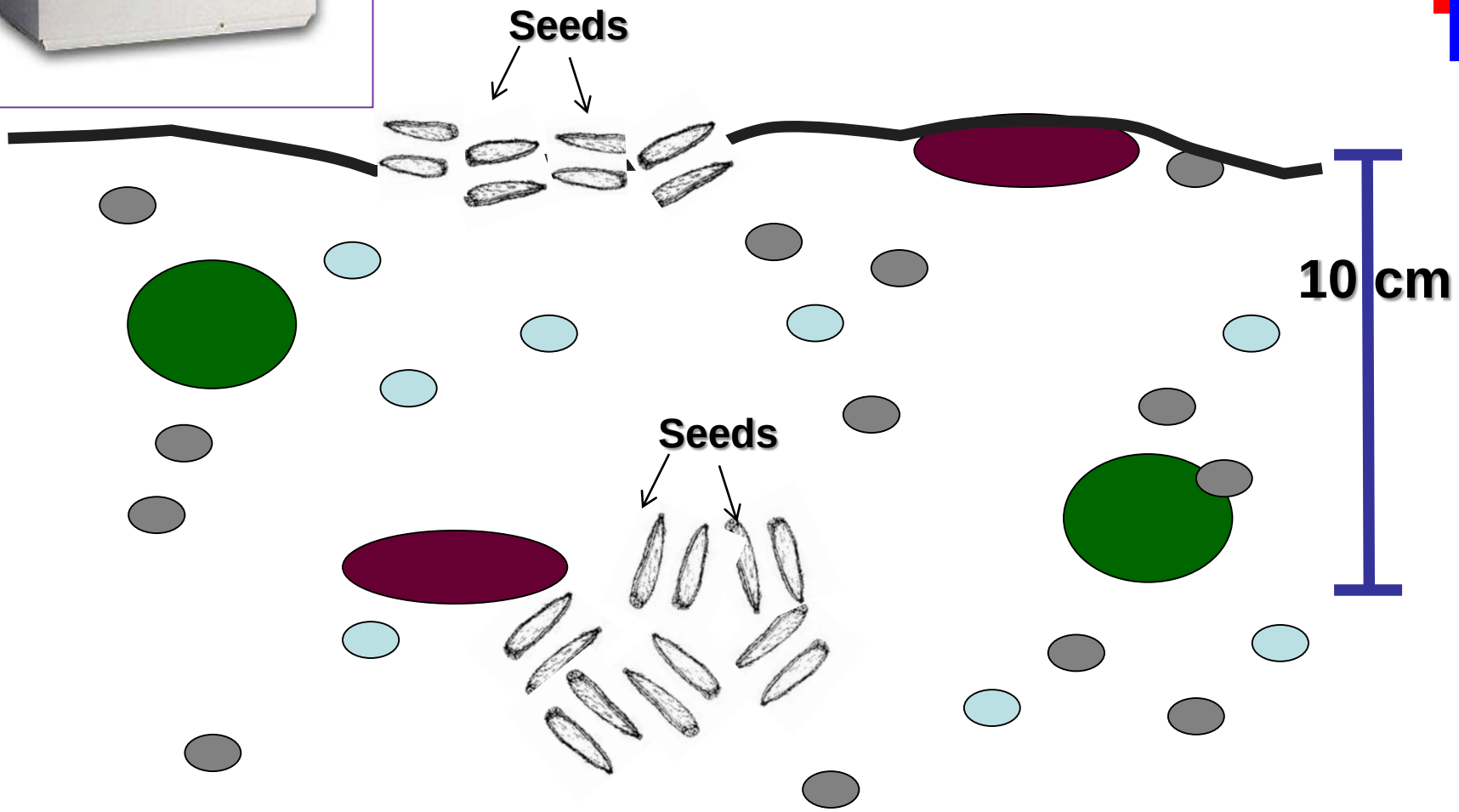
- Reports of ~200,000 seeds per plant
- Dauer found ~130,000 seeds/plant
  - at modest density of 10 plants/m^2 there are 1.3 M seeds/m^2

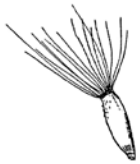


Implications

- A stringent management plan can be negated by neighboring fields
- Is an area-wide management plan practical?

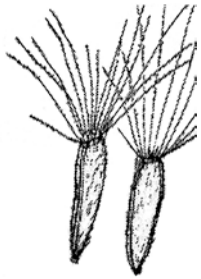
Evaluating Seed Longevity





Seed Longevity

- Seeds maintained in freezer had almost 100% viability at 36 mos
- Seeds buried 10 cm 30% viability at 18 mos and 15% at 36 mos
- Seeds on soil surface had 5% viability at 12 mos and continued to decline to 36 mos



Used germination as indicator of viability

Seed Biology

- *C. canadensis* germinates readily without light
- Seed is capable of germinating as soon as it's mature
  - appears that large percentage will germinate shortly after falling to the soil
- Seeds can only germinate and emerge at soil surface
  - presumably due to tiny seeds


MM
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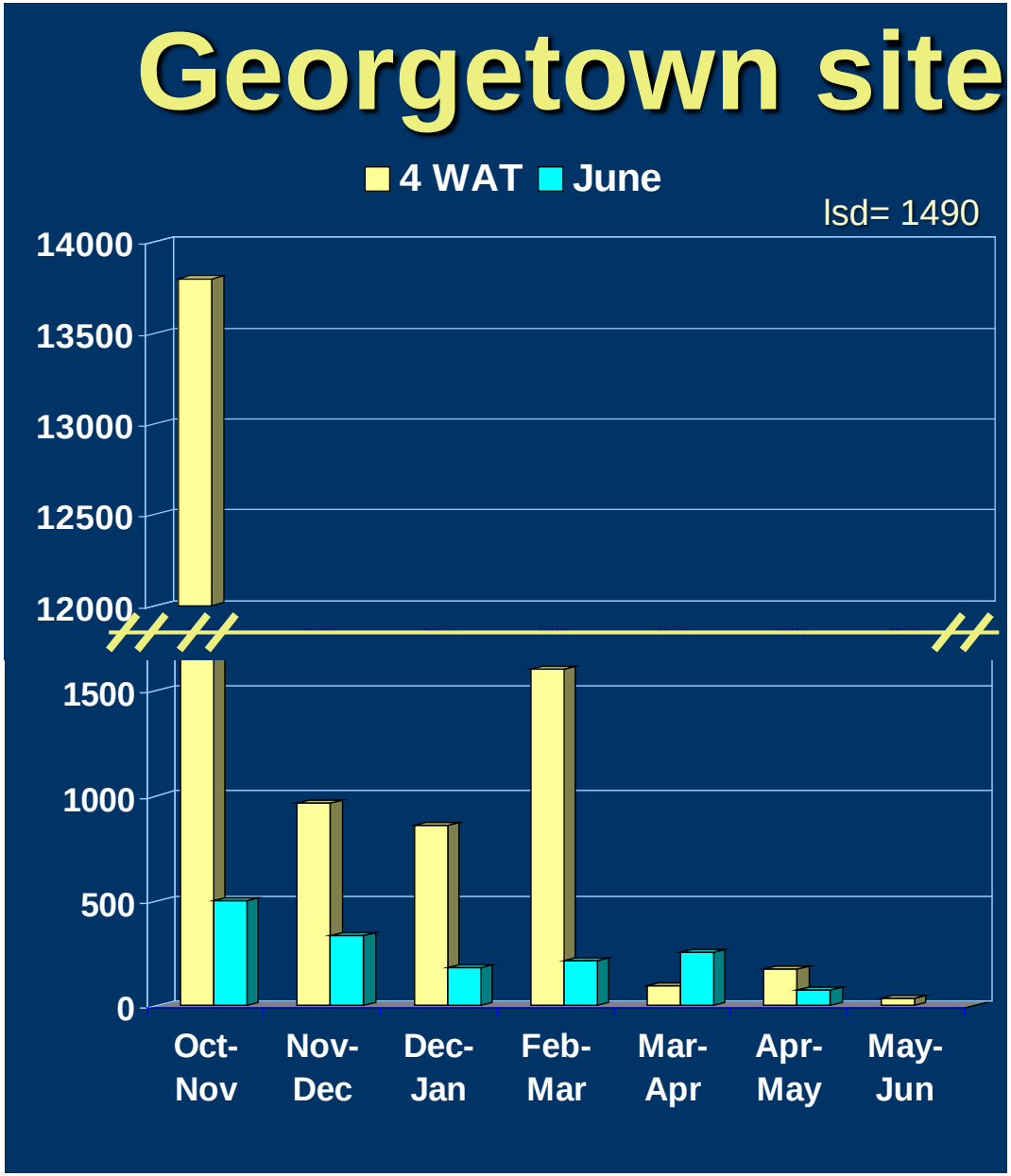
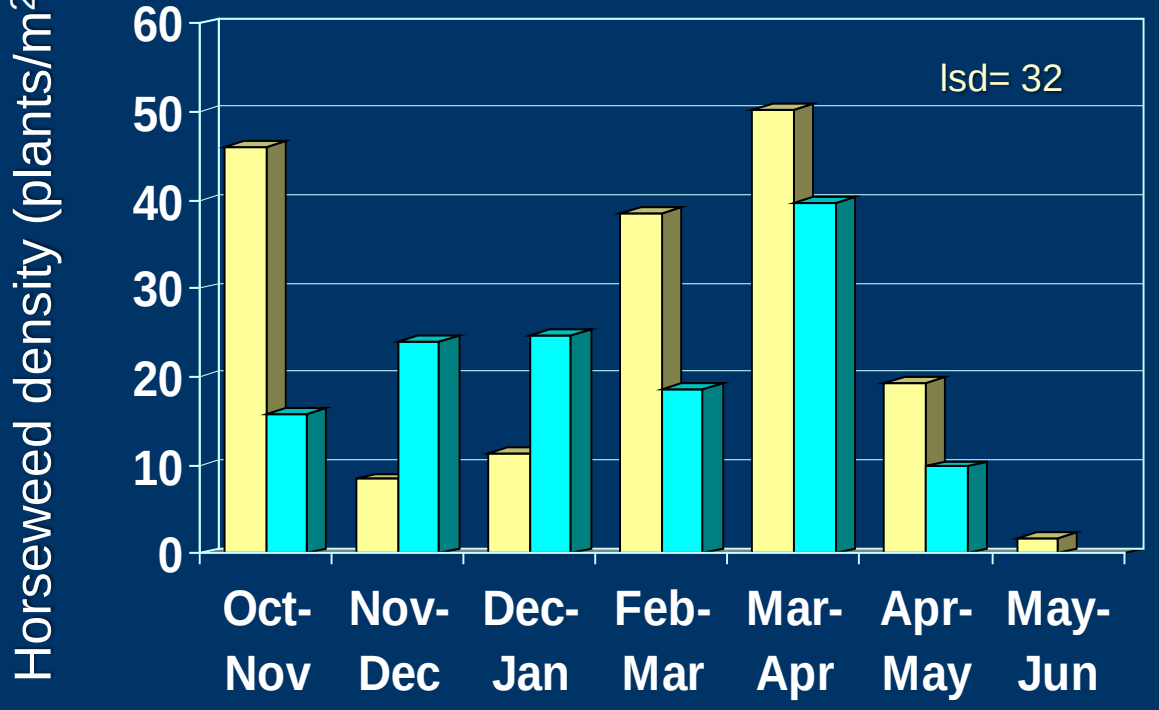
Georgetown site



2002/2003 data

Seaford site

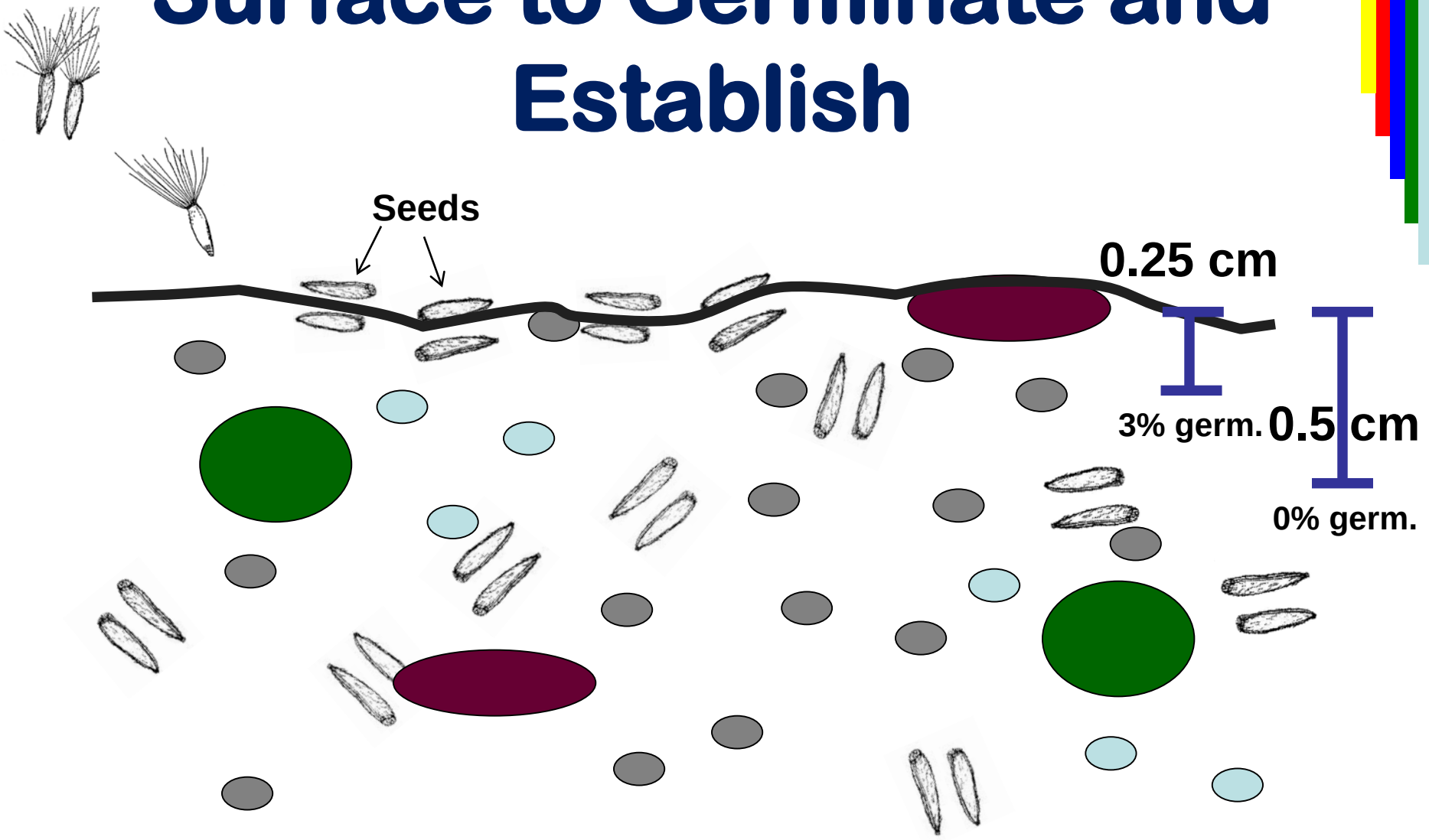


2002/2003 data

Emergence

- Two distinct emergence periods
  - Fall and spring
  - Recently more comments about emergence after soybean planting
- What is driving fall versus spring emergence??

Seeds Must be at Soil Surface to Germinate and Establish



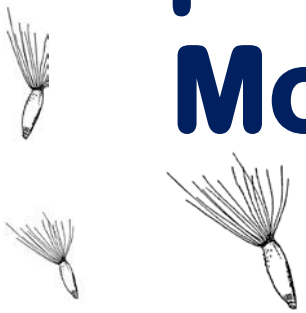
Nandula, et al., Weed Sci. 2006

Safe-Sites for Development

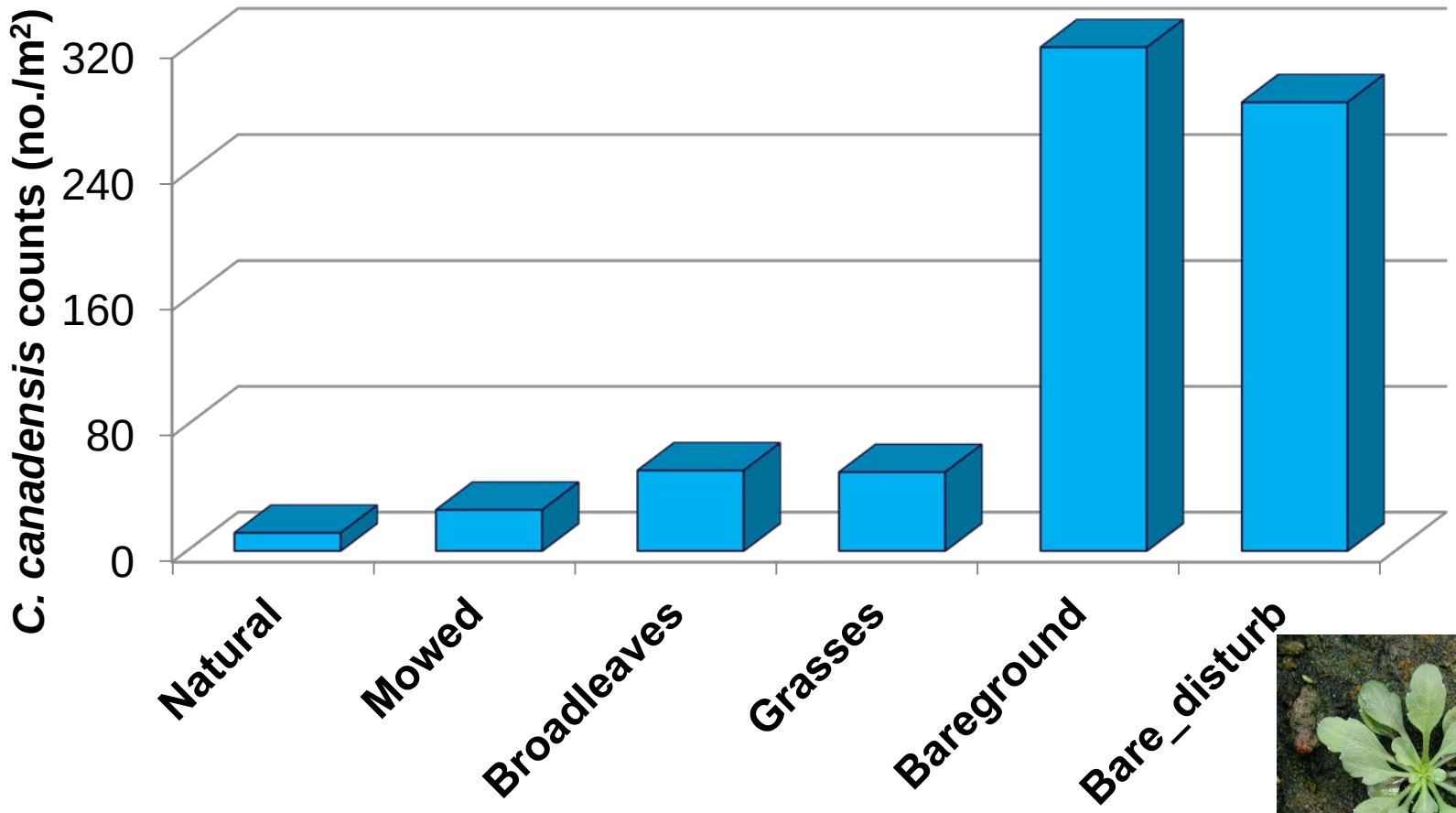
Looked at number of plants to develop in:

- Natural vegetation
- Natural vegetation - mowed
- Perennial grasses only
- Broadleaves only
- Bare ground
- Bare ground - disturbed

Spread Seeds in the Fall and Monitored for Emergence



Seedling Establishment



Average of 4 sites
Counts made in late November

Effect of Crop Residue on ERICA Establishment

Effect of Crop Residue on ERICA Establishment

- Interaction with crop residue
  - Higher horseweed densities with less residues and/or “more fragile” residue
  - Quick establishment of other weed species may prevent horseweed from establishing

Effect of Winter Cover Crop

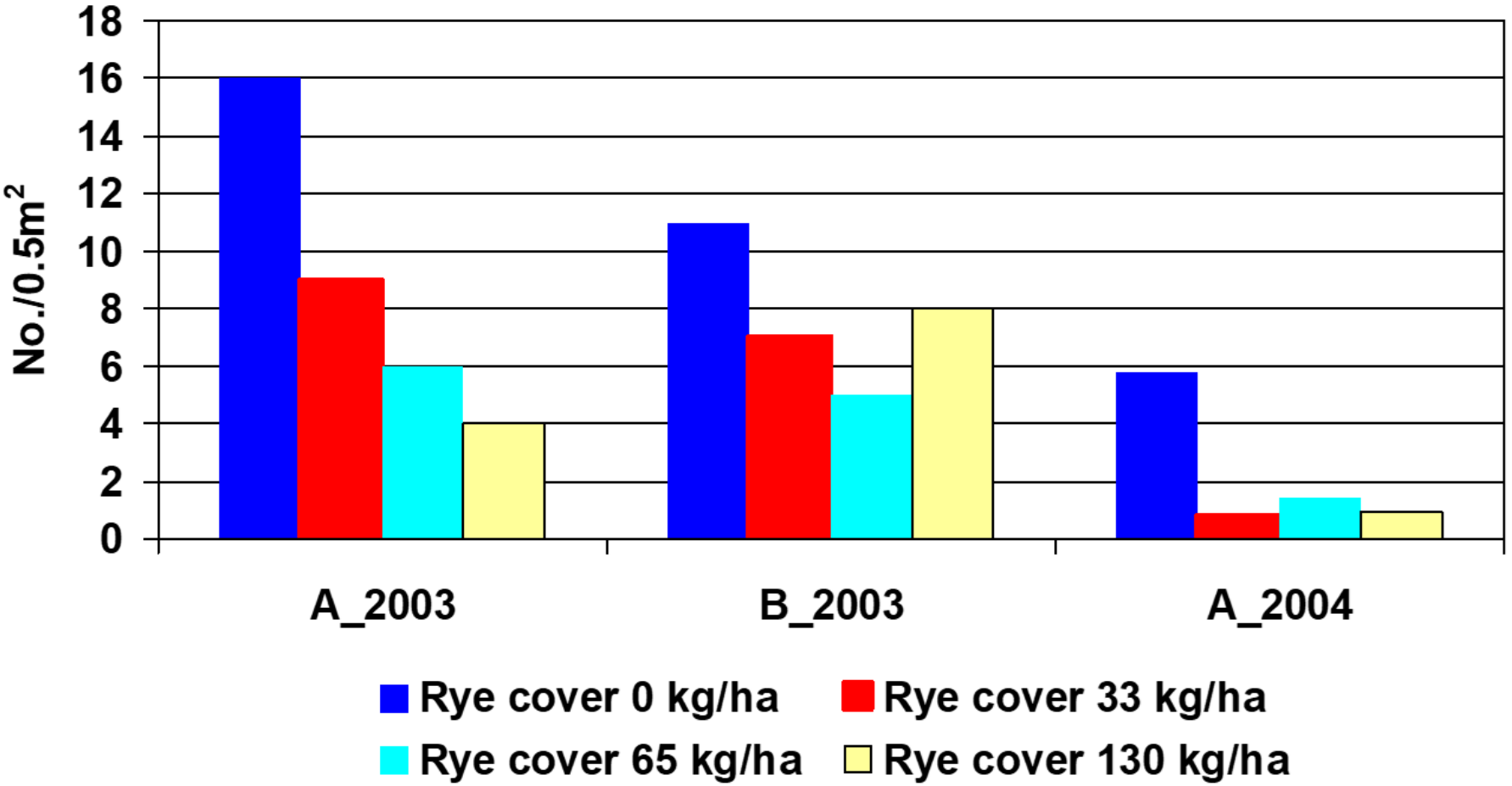
- Popularity of cover crops for nutrient management in Mid-Atlantic region
- Can they be managed to improve horseweed control

Effect of Rye on ERICA Establishment

- Rye seedling rates
  - 0
  - 0.5 bu/A = 33 kg/ha
  - 1 bu/A = 65 kg/ha
  - 2 bu/A = 130 kg/ha

- Spring nitrogen applications
  - 0 or 33 kg/ha

Effect of Rye on ERICA Establishment



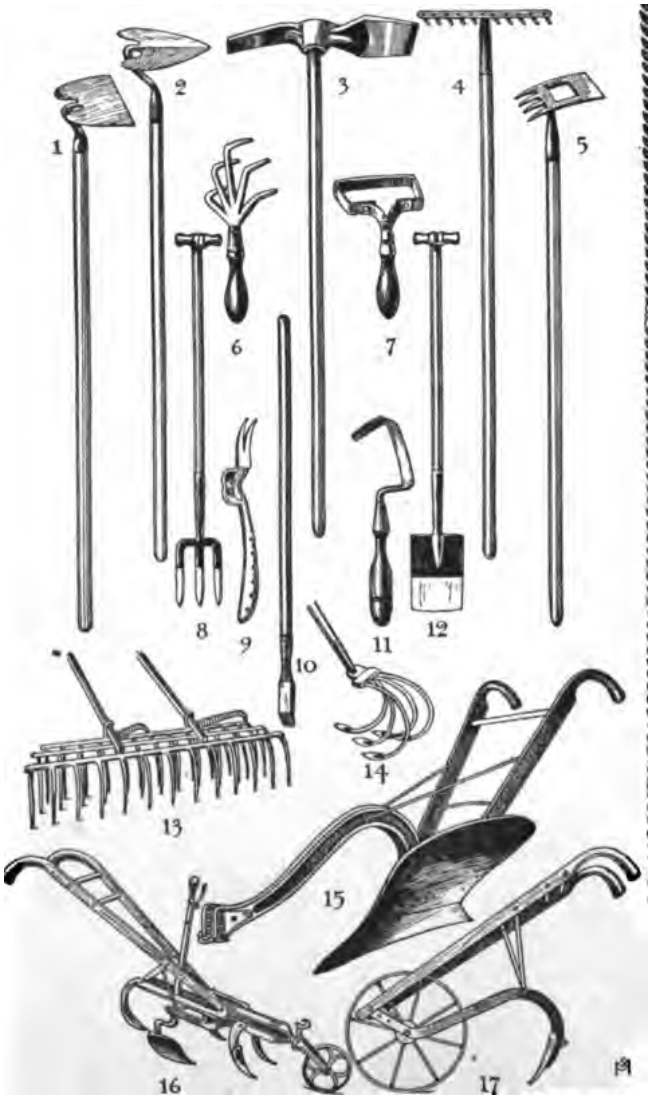
Nitrogen at 33 kg/ha had no impact

Cereal Rye for ERICA management

Cereal rye does not eliminate horseweed, so need tools that allow planting veggies in a timely fashion

Manual of Weeds
A. Georgia

- Means of Control
  - Hand-pull
  - Burn stubble to destroy weed seeds
  - “fields run to horseweed” should be put to a well-tilled hoed crop



GR *Conyza canadensis* Management in DE

- Not an issue to control in corn
  - No-till corn is treated early with paraquat + atrazine; while horseweed plants are in rosette stage
  - ATRAZINE
  - HPPD herbicides very effective (with atrazine)

GR *Conyza canadensis* Management in DE

- Soybeans
- Need a “two-hit approach”
  - Fall fb spring
  - Early spring fb at planting
- Cereal rye (with a knockdown herbicide for termination)
- The key is to “start clean” and not have to treat it POST

Treat while in seedling stage

GR *Conyza canadensis* Management in DE Soys

- Use of 2,4-D has been inconsistent
  - Rate and timing
- Dicamba pre-plant is looking promising (HT-soybeans) pre-plant
  - Re-plant restrictions / more management
- Saflufenacil

GR *Conyza canadensis* Management in DE Soys

- Use of residual herbicides with second “hit”
  - Metribuzin, flumioxazin, sulfentrazone
- POST with glufosinate, dicamba, or 2,4-D
  - All require HT-soybeans

- Burndown in double-cropped soybeans
  - Glyphosate plus glufosinate

Options in RR Soybeans Very Limited

Only option in this situation is another application of glyphosate and hope for some stunting and soybeans to improve their competitiveness

Photo: Matt Morris

GR *Conyza canadensis* Management in DE

- Small grains
  - Paraquat or saflufenacil for burndown
  - PGR herbicides POST

- Cover crop for vegetables
  - In need of an option that allows vegetables to be planted in a timely fashion
  - Glyphosate fb paraquat
  - Sequential paraquat applications

What Makes *Conyza* Unique?

- It's ability to disperse locally as well as over great distances
- Prolonged germination period (fall/spring)
- Well adapted to no-till or perennial crop production
- Ability to develop HR biotypes
- Horseweed has become one of our four "driver-species"
  - AMAPA, AMBEL, IPOSS, AMARE (vegetables)


2010. 7. 15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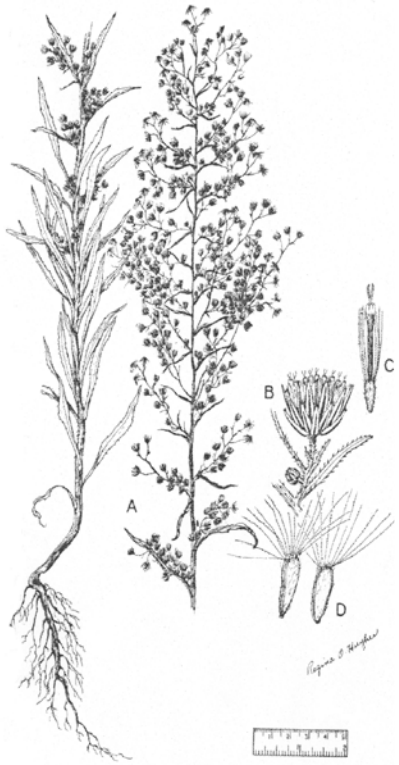
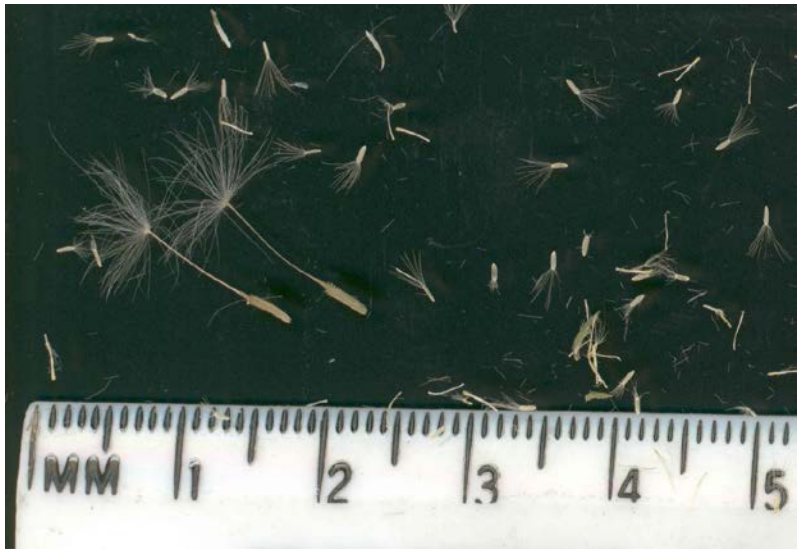
Weed Science


A
B
C
D


MM
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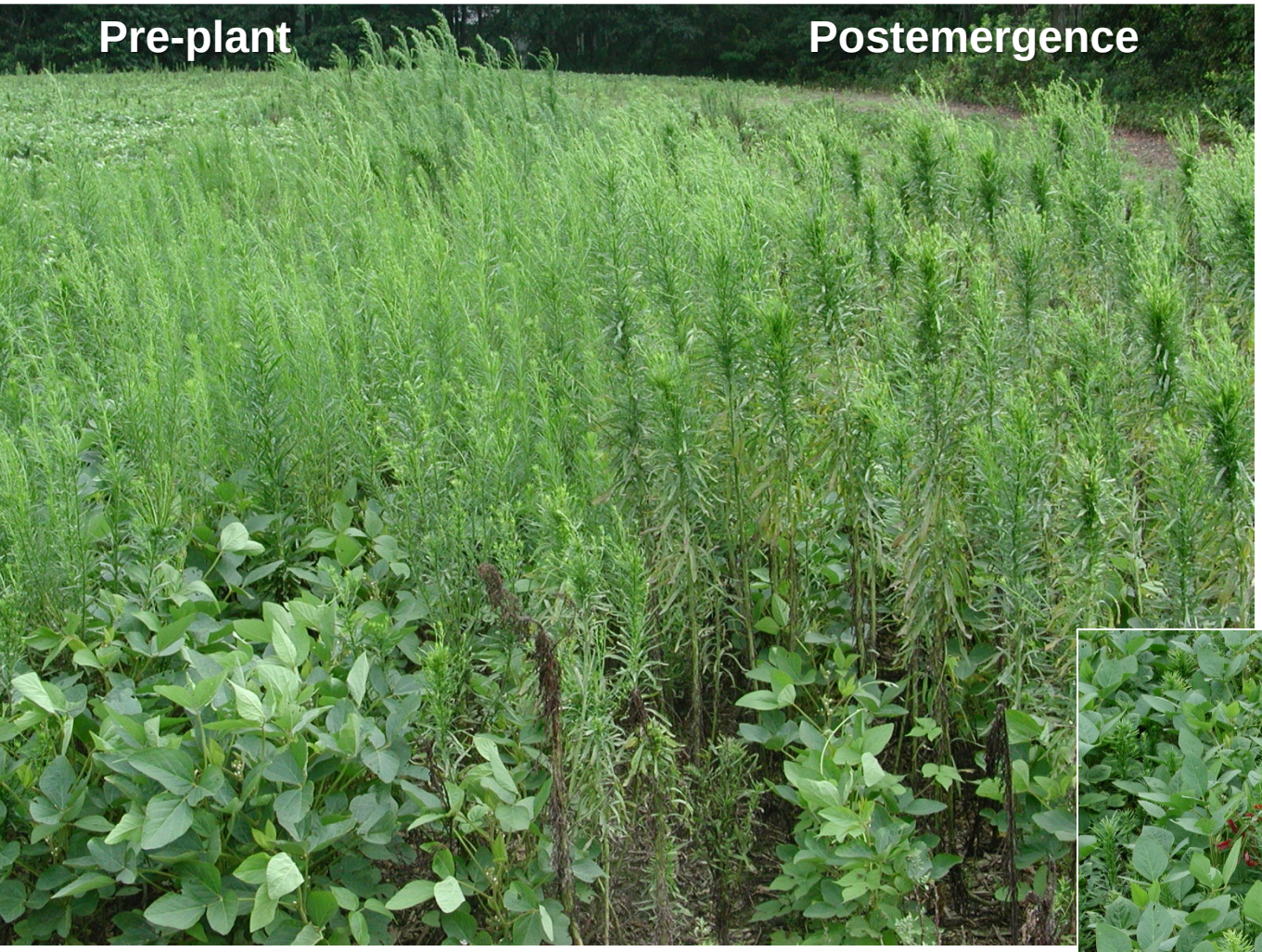
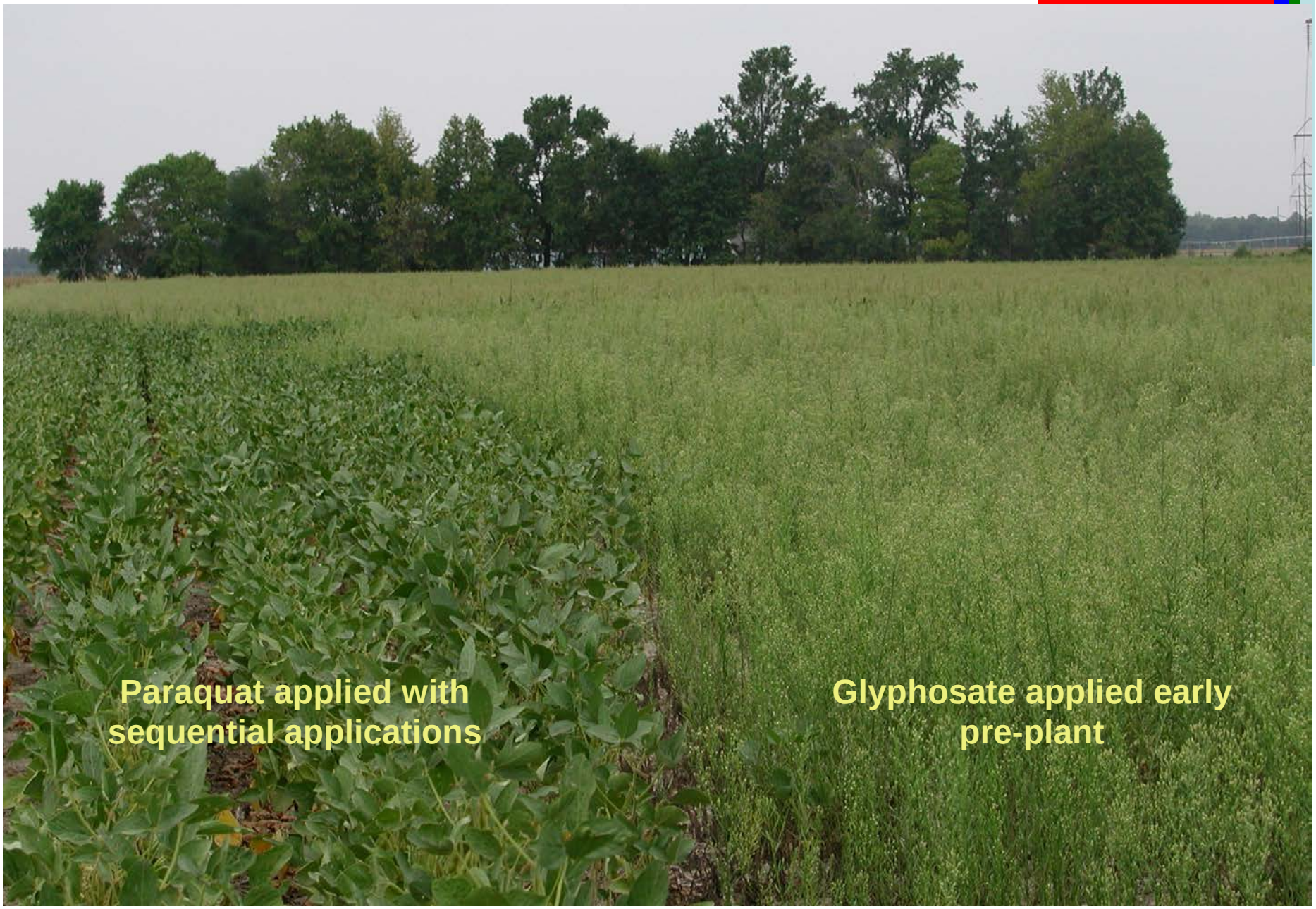
Not restricted to agriculture

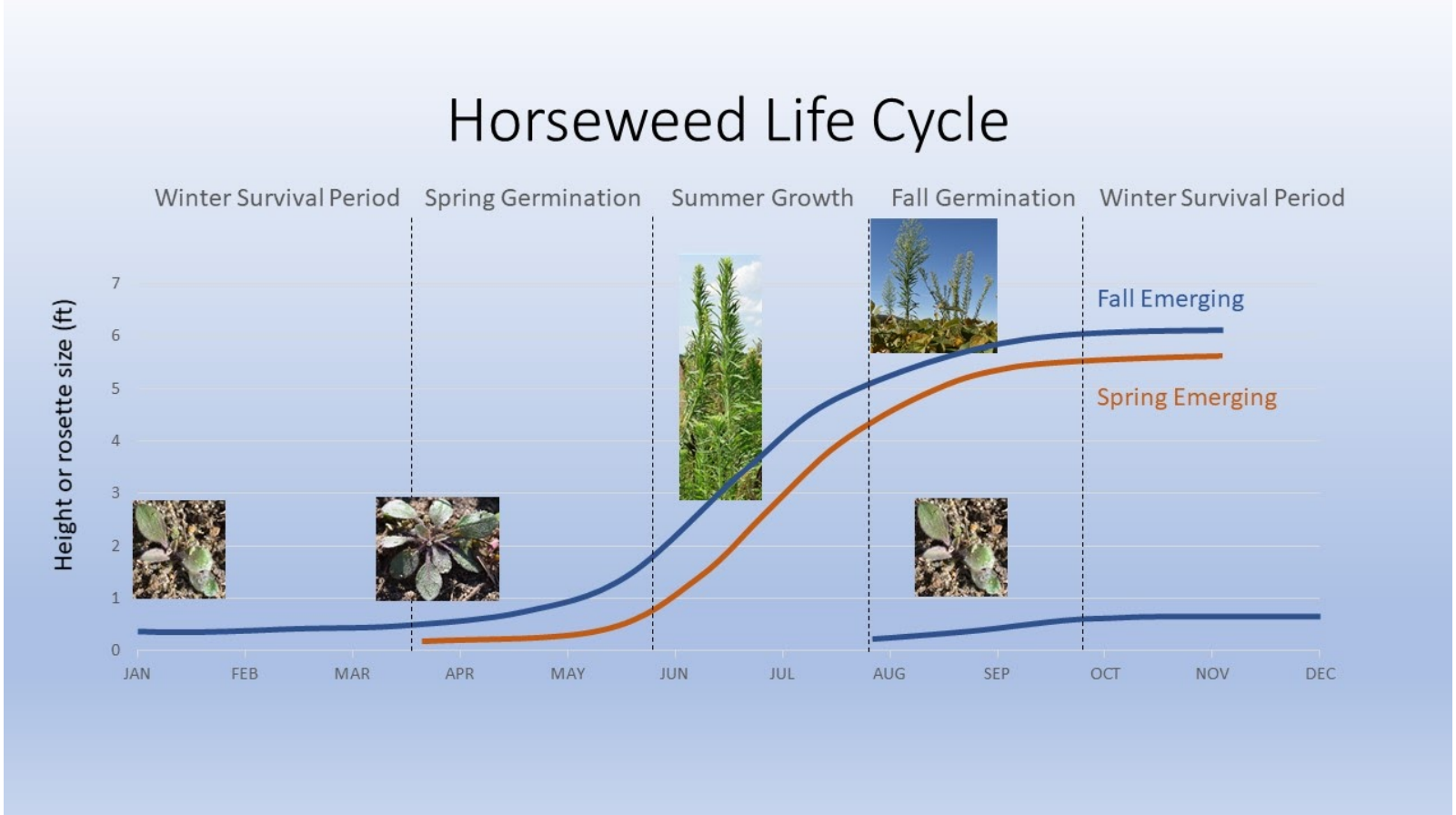
Treated with glyphosate


Glyphosate POST (2.2 kg ae/ha)


Pre-plant
Postemergence

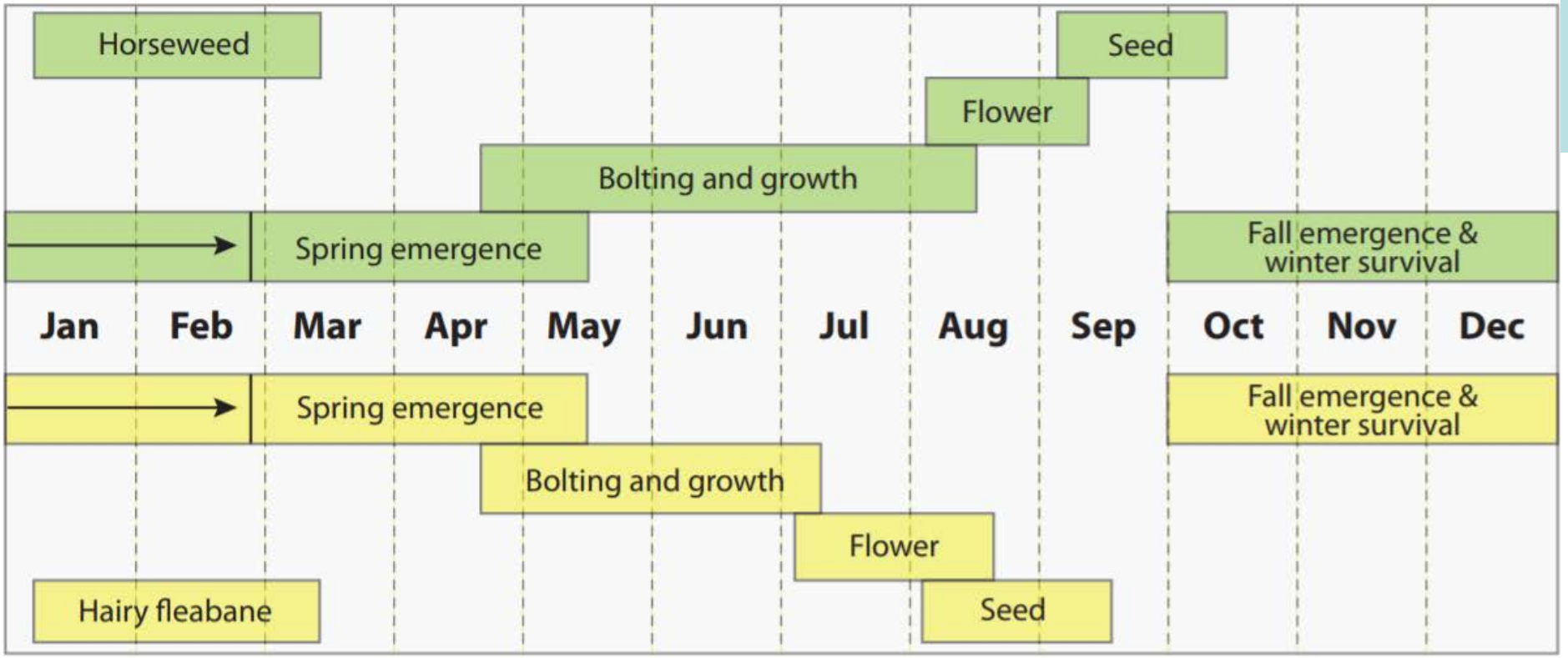

Paraquat applied with sequential applications
Glyphosate applied early pre-plant

Life-cycle of C. canadensis in North America



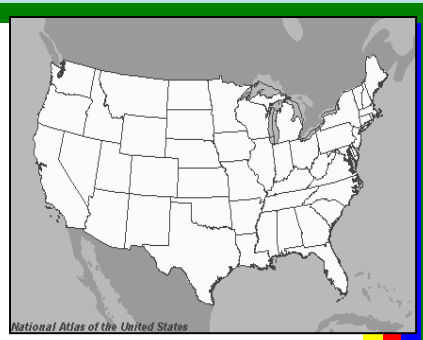
Modified from *Biology and Management of Horseweed*, Purdue University

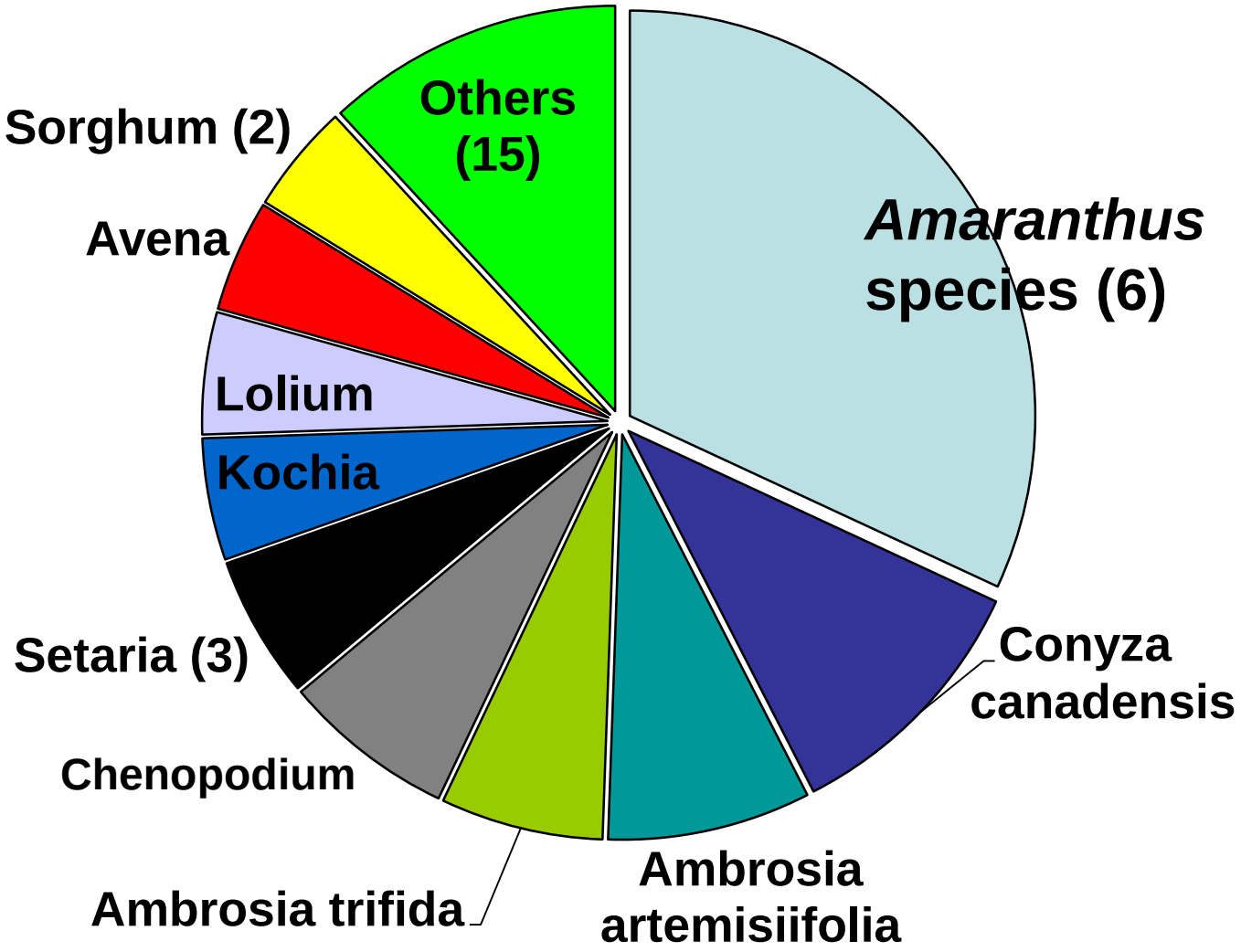
Life cycle of C. canadensis and C. bonariensis



Shrestha etal. 2008, UCDavis Pub 8314

What Species Are Most Troublesome?





US Extension Specialists

NT Soybean Preplant Weed Control

- A non-selective (burndown)
- + 2,4-D or dicamba (if situation permits)
- + residual herbicide

- Fall applications (after first frost to late November
- Early spring (>30 days prior to planting)
- Late spring (<30 days prior to planting)

Fall Applications

- Paraquat or glyphosate
- + 2,4-D or dicamba
- + long residual (i.e. chlorimuron)

- Puts heavy reliance on residual herbicides (no crop)
  - often need additional burndown application before planting
- Need non-selective
- Great time to incorporate paraquat

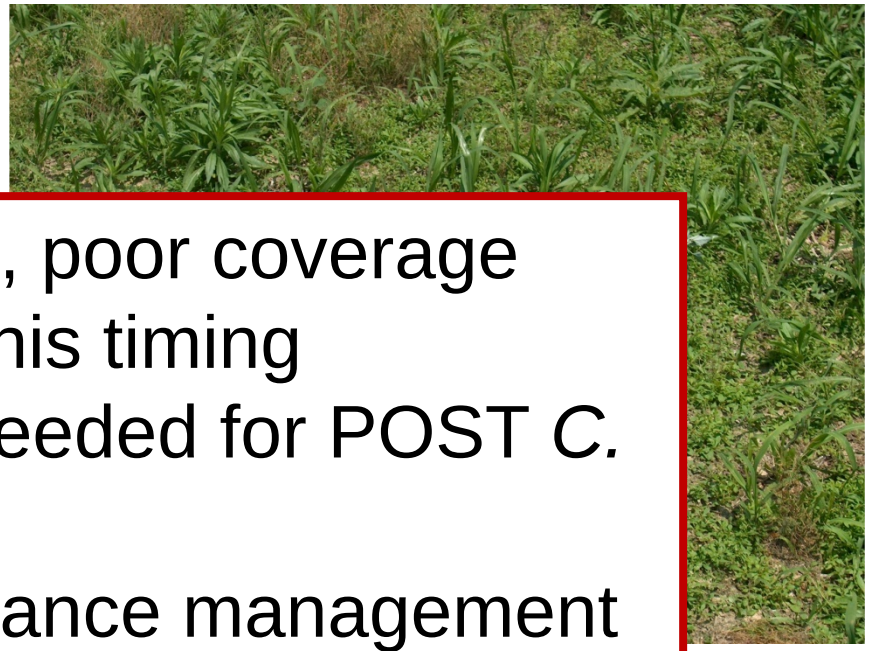
Early Spring Applications

- Paraquat or glyphosate (depends on weed size)
- + 2,4-D or dicamba (if situation permits)
- + full rate residual herbicide

• Need to be sure 2,4-D or dicamba is appropriate
• Winter annual weeds are relatively small

Late Spring Applications

- Glyphosate (rate depends on weed size)
- + full rate residual (need something with chlorimuron if *C. canadensis* is present)
- 2,4-D if possible



- Timing is with large weeds, poor coverage
- 2,4-D rate is restricted at this timing
- First situation residual is needed for POST *C. canadensis* control
- Need to be aware of resistance management

When Should That First Application Be Made??

Can it be made in the fall ??