Weed Management - The Basics

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Over-arching Weed Science Principles

- Weed ecology and biology basic to all systems
- Weed species cross over cropping boundaries
- Perennial, biennial, or annual - disturbed or undisturbed - the same underlying principles apply

Weed Management- the basics

- No free lunch concept
- Weed management options:
  - Hand Labor (pulling, cutting)
  - Physical (Tillage/Mowing/Burning)
  - Chemical (Herbicides)

Is there anything else?

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Weed Management- the basics

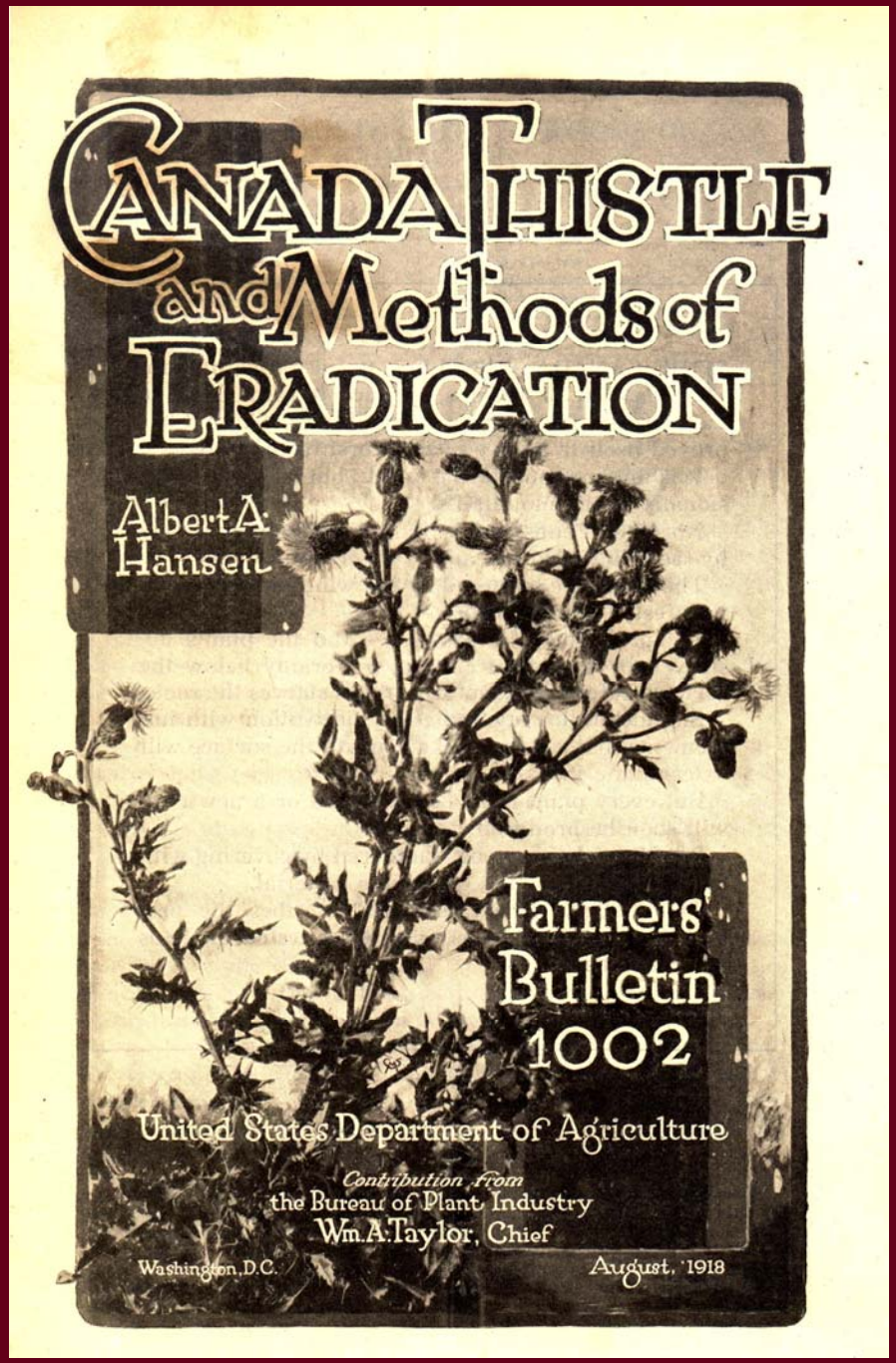
- There is a weed for every occasion
- There is a weed species that is adapted to your management, no matter what it is

Weed Management- the basics

- Therefore, repeated use of the same management will result in a few species that are out of control
- Goal should be to get as many species as possible, but few of any one species
  - Means you are using diversified weed management

The Elusive Holy Grail of Weed Management

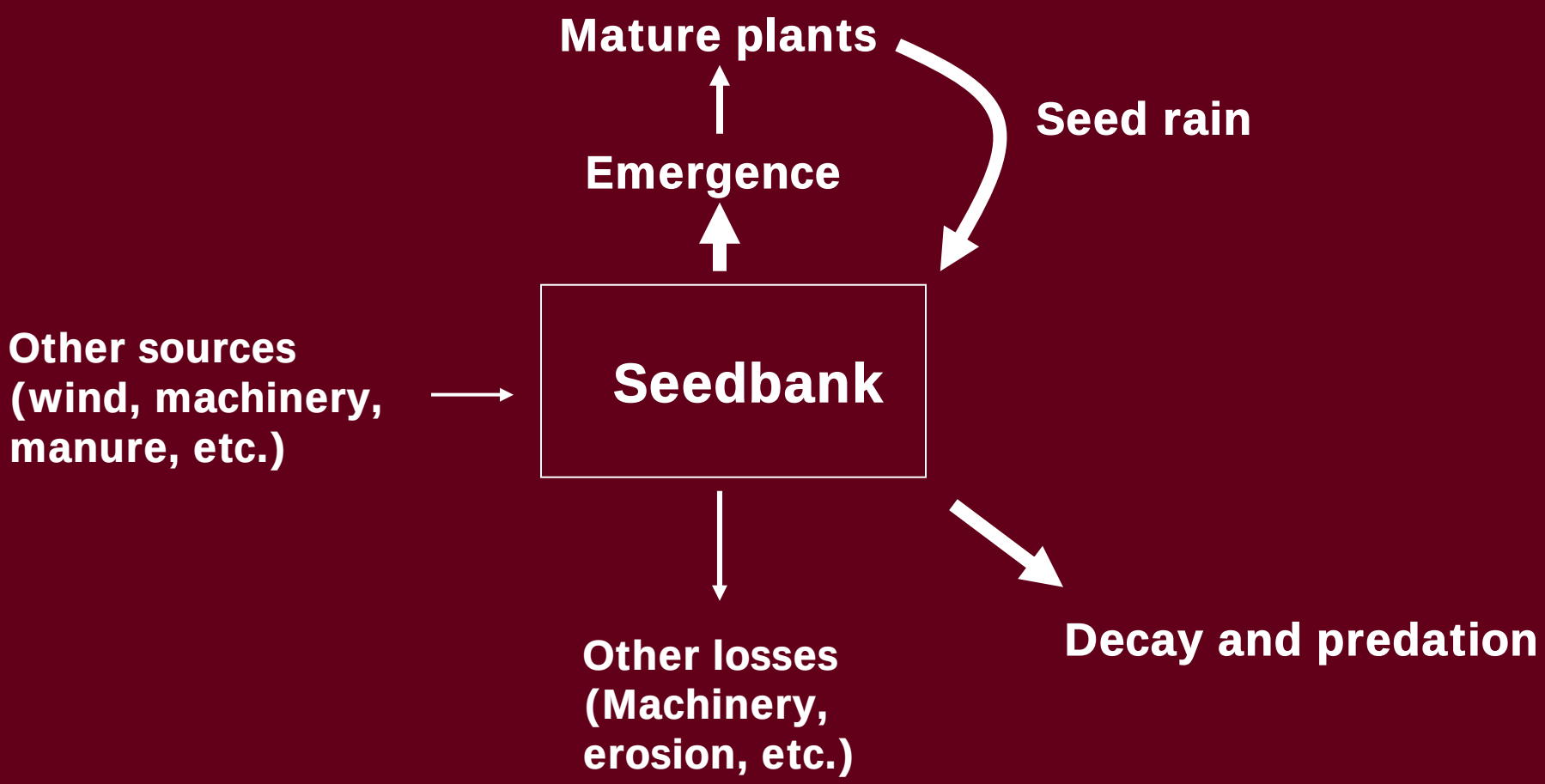
- Eradication!



Annuals - the dilemma

- **Prominent in disturbed soil**
- **Colonizers (voted most likely to succeed)**
- **Seedbanks (long-term memory)**

The Seed Cycle



***In* Risk Management Guide for Organic Producers**

Photos Steve Hurst USDA ARS

Weed seed come in many shapes and sizes with many different mechanisms to cause us headaches.

Breaking Dormancy

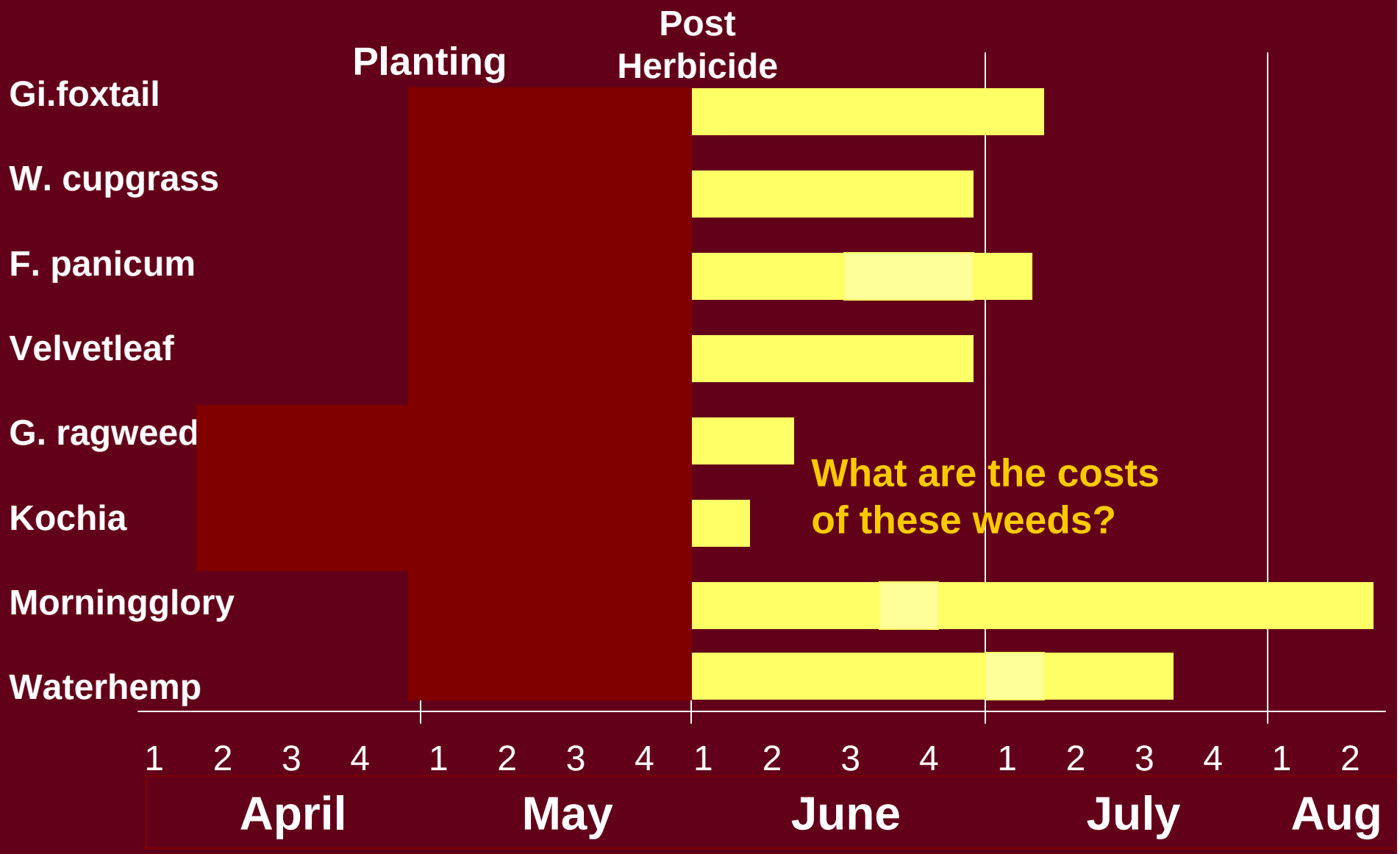
- Light
- Temperature
- Moisture
- Gases
- Aging
- Chemical

Weed Emergence Periods

- **Different species have different optimal emergence periods**

- **Time production practices to minimize impacts of weeds you have**

Weed Emergence Patterns



Sandell, Hartzler and Buhler. Iowa State University.

Weed Seed Production

- Few weeds achieve genetic potential
- Cocklebur – Arkansas
  - 7000 seeds without competition
  - 1100 seeds with competition
- Pigweed in corn
  - 24,000 seeds with even emergence
  - 3,000 seeds with four week delay

via Hartzler, ISU

Table 5-7. Percent reduction of weed seed production *when weeds emerge after crop emergence as compared to when weeds emerge with crop. The amount of seed is dramatically reduced when weeds emerge after the crop. Adapted from Sprague, MSU Extension, 2008.*

WEED	CROP	WEED EMERGENCE (# WEEKS AFTER CROP)	% WEED SEED REDUCTION
Waterhemp	Corn	3	95
Waterhemp	Soybean	3	81
Giant ragweed	Corn	6	99
Giant ragweed	Soybean	6	78
Velvetleaf	Corn	3	60

In Risk Management Guide for Organic Producers. Adapted from Sprague. 2008. MSU Ext. Bull. E-3065

Seed Longevity

- Potential to survive in the soil for long periods of time
  - Most seeds die within 2 to 3 years
  - Est. 2/3 of the seedbank turns over annually

William Beal Buried Seed Study

- **Botanist at Michigan State University**
  (Then Michigan Agricultural College)

- **Buried seeds in 1879**
  - **20 glass bottles**
  - **50 seeds of each of 20 species mixed in sand**
  - **buried 20 inches deep with the mouths pointing downward to avoid water accumulation**

Frank Telewske, curator of the Beal Botanical Garden, inspects the most recent germination results in an experiment initiated by botanist William J. Beal 120 years ago.

William Beal Buried Seed Study

Originally, bottles dug every 5 years

- **1929 switched to every 10 years**
- **1980 switched to every 20 years**

One species, Moth Mullein (*Verbascum blattaria*) still germinated at the 120 year mark

Five bottles remain on MSU campus to be recovered in 2020, 140 years after burial

Photo: Andrew Medichini. Associated Press.

A hardy palm tree seed from ancient Judea, found at the Masada excavation site, above, is thriving, so far.

New York Times, June 12, 2005.

Date palm seed recovered from the Masada fortress site, radio carbon dated at 1990 yrs old (35 BC to 65 AD)

Dr. Sarah Sallon, Louis L. Borick Natural Medicine Research Center

Dr. Elaine Solowey, Arava Institute for Environmental Studies

The 1990 yr old palm seed germinated and is growing. Old seed occasionally can be coaxed to germinate, but usually die as seedlings. This one seemed to gain strength after the 3rd leaf emerged.

Photo: Guy Eisner.

At eight weeks, the persistent seed nicknamed Methuselah was still going strong. Most ancient seeds produce plants that soon die.

New York Times, June 12, 2005.

Lotus seeds in China est. at 1200 yrs sprouted. Seeds in London's Natural History Museum est. to be 500 yrs old germinated after the Germans bombed the museum in WWII and water was applied to extinguish the flames.

Photo: Associated Press.

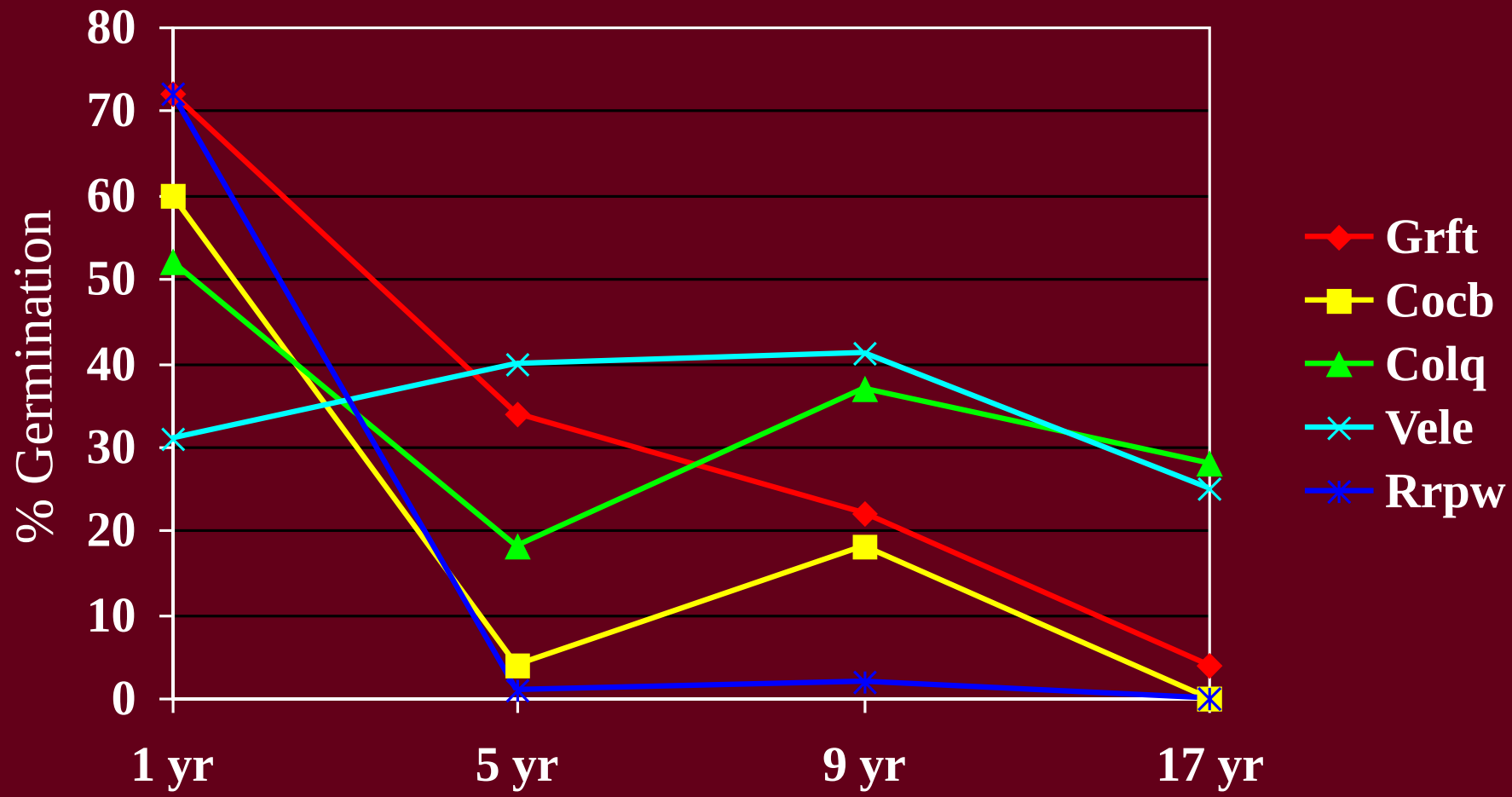
SFGate, Feb. 21, 2012..

http://www.sfgate.com/cgi-in/object/article?f=/c/a/2012/02/21/MNKU1NA41R.DTL&object=/n/p/2012/02/20/9c6f3bcd-3a5b-4e59-a0bd-1db7b7f24dfb.jpg&type=science

Sylene stenophylla **plant regenerated from tissue recovered from a squirrel's chamber in buried sediments in Siberia est. to be over 30,000 yrs. old**

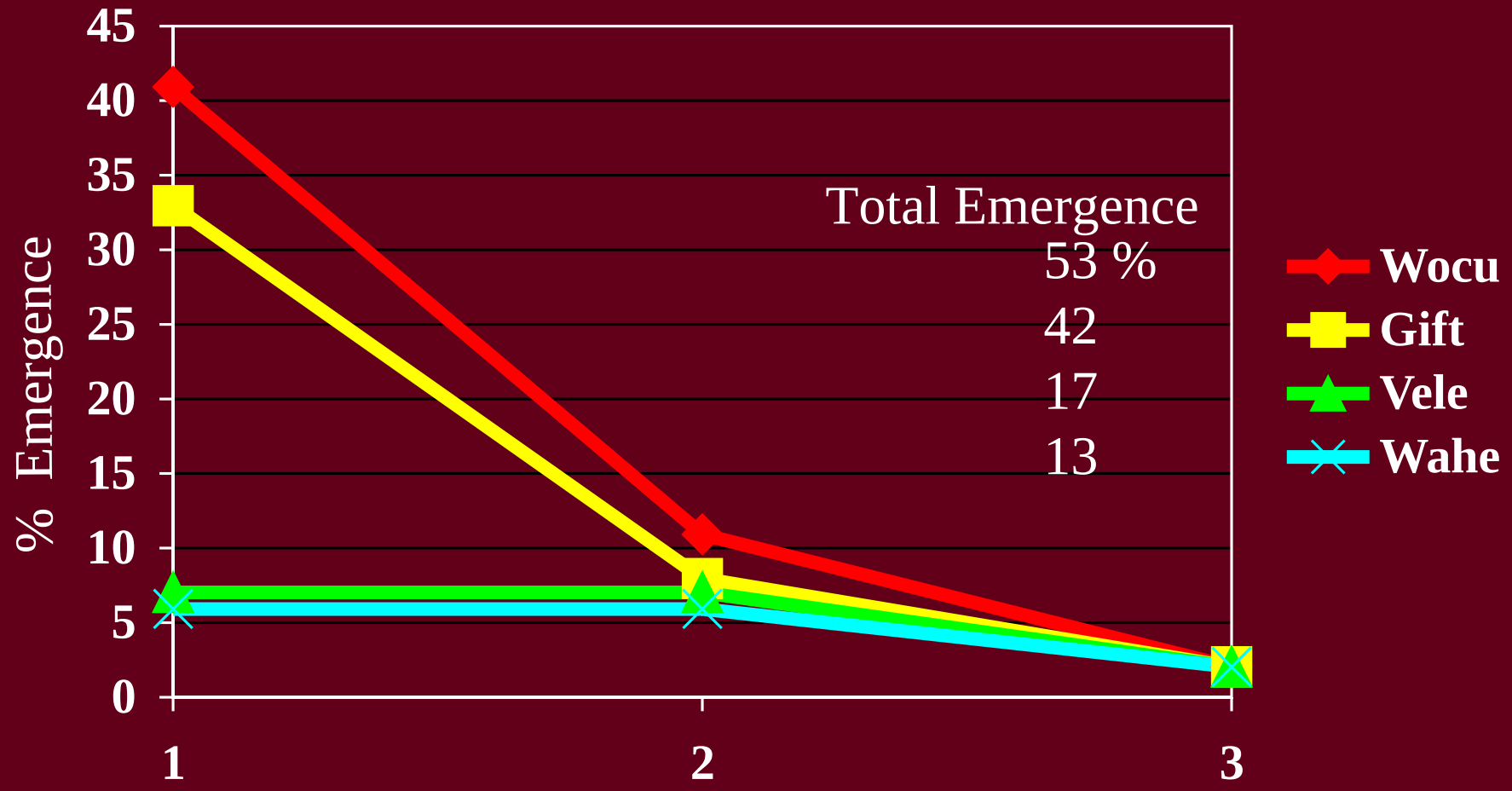
Institute of Cell Biophysics of the Russian Academy of Sciences

Longevity of Weed Seed at 20-cm Depth, NE



Burnside et al. Weed Sci. 1996.

Annual Weed Seedling Emergence
Years After Seed Rain



Hartzler and Buhler. ISU. 1997.

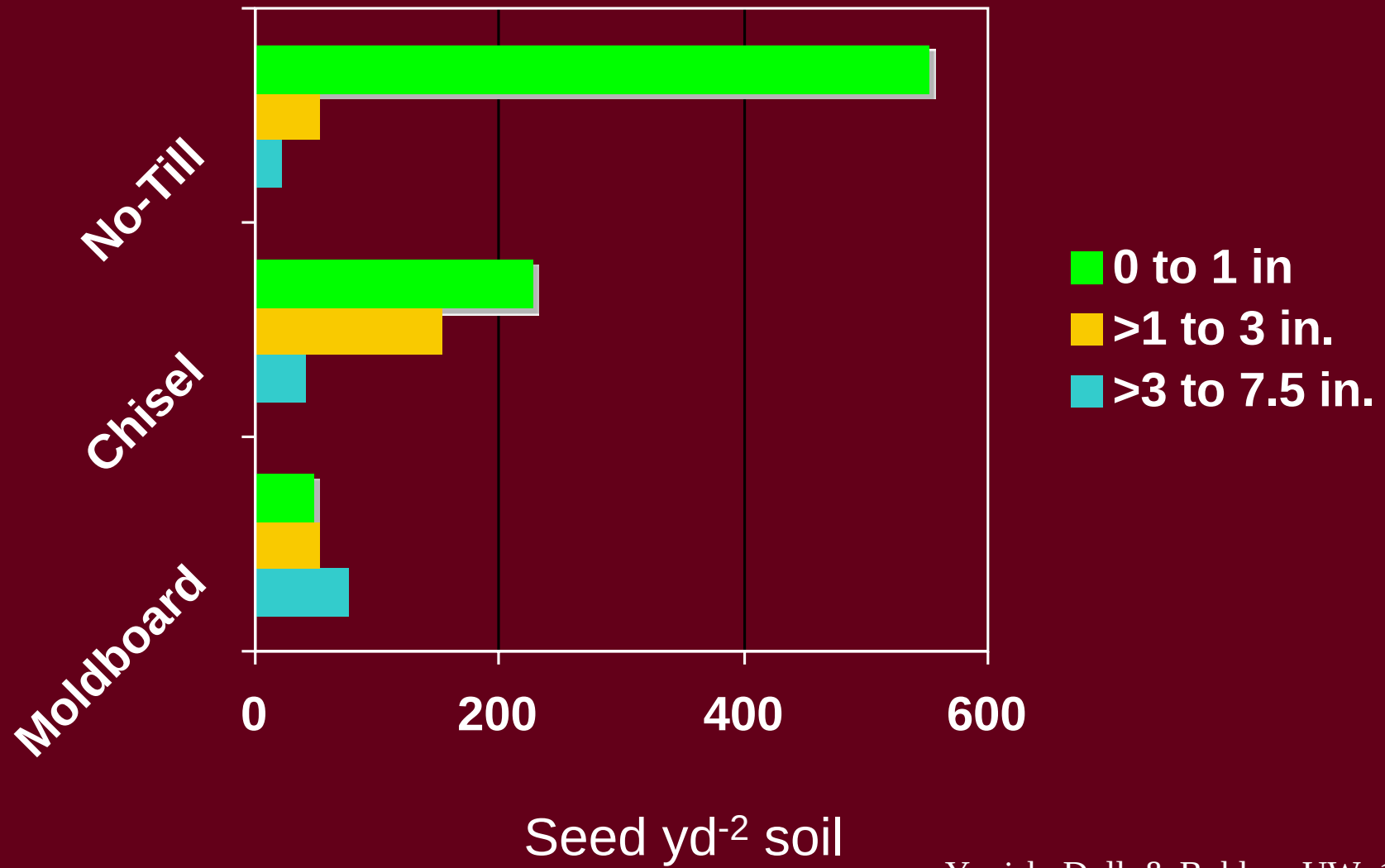
Table 5-9. Weed and crop seed persistence in soil. The approximate number of years it takes to reduce weed seed populations by 50 and 99 percent.

Adapted from Michigan State University, 2005.

		50% REDUCTION	99% REDUCTION
	SPECIES	----------YEARS----------	
Broadleaves	Lambsquarters	12	78
	Velvetleaf	8	56
	Cocklebur	6	37
	Pennsylvania smartweed	4	26
	Redroot pigweed	3	20
	Shepardspurse	3	19
	Curly dock	3	17
	Waterhemp	2	16
	Common ragweed	1.5	10
	Wild mustard	1	7
	Common sunflower	0.5	2
	Hemp dogbane	0.5	2
	Giant ragweed	0.5	2
	Kochia	0.5	2
Grasses	Yellow foxtail	5	30
	Barnyardgrass	2	10
	Large crabgrass	1.5	8
	Giant foxtail	1	5
Crops	Wheat	1	2
	Canola	2	4
	Soybean	1	2
	Corn	2	4

***In* Risk Management Guide for Organic Producers.**
Adapted from MSU Ext. Bull. E-2931. Integrated Weed Management: One year's seeding. Feb. 2005.

Influence of Tillage on Weed Seed Distribution in the Soil Profile



Yenish, Doll, & Buhler. UW. 1992.

Seedbank summary

- **Size of seedbank affects efficacy of management efforts**
- **Seedbanks are dynamic**
  - **Pop. density fluctuates widely depending on input, germination, mortality, predation**
  - **Most turn over in 2 to 3 years**
  - **Small % survive for long periods**

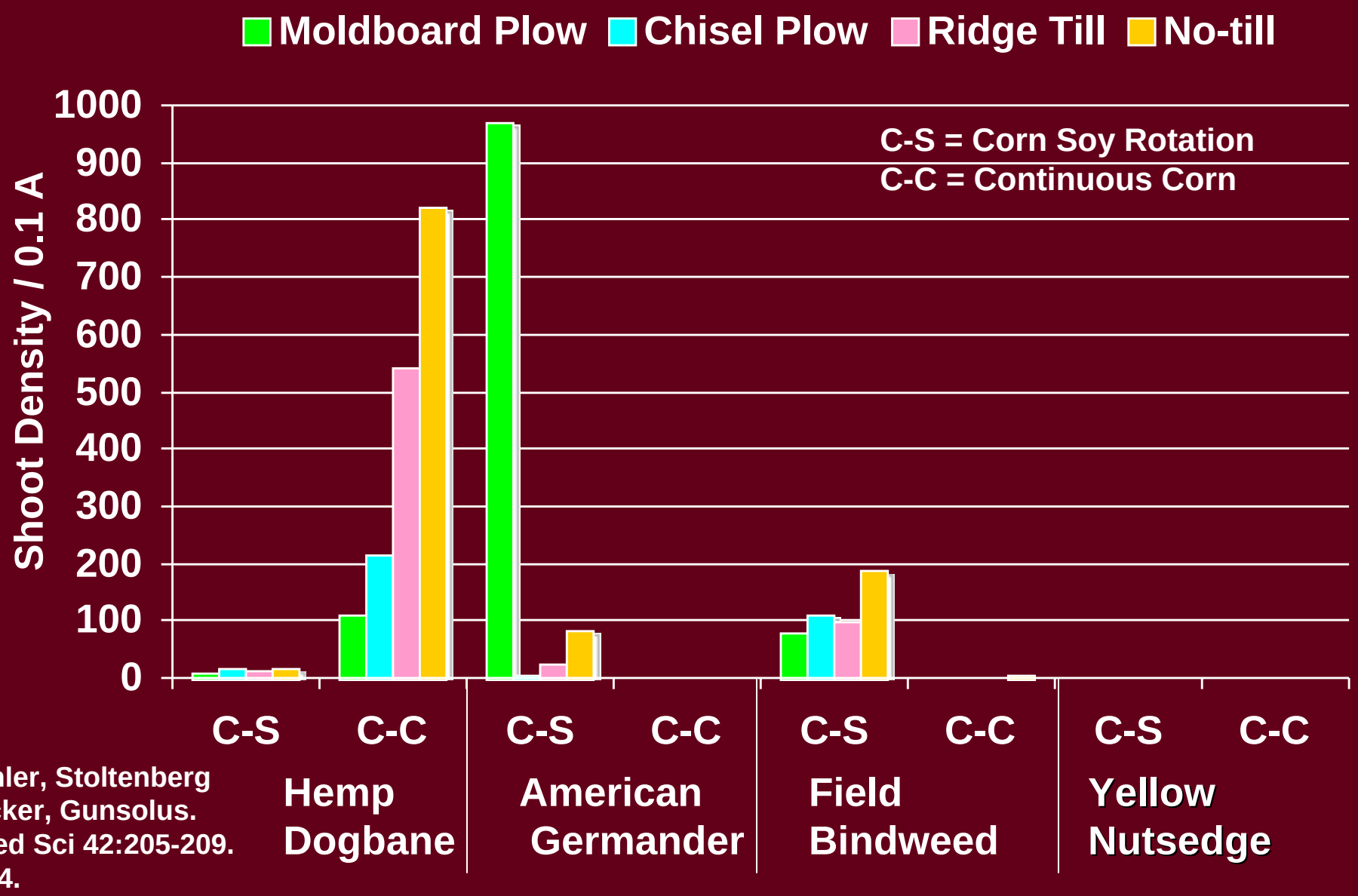
Historically, Species Shift

- Burning
  - Tall grass prairies
- Tilling the prairies
  - Field bindweed
- 2,4-D and N fert
  - Bdlfs to grasses
  - Triazine, acetanilides grasses
- Planting dates
  - Earlier dates to cooler species

Historically, Species Shift

- Rainy or droughty periods
- Reduced or no tillage
  - small seeded species and increased perennials
- Treflan + Sencor t.m. 70's and 80's
  - Eastern Black Nightshade
- Imidazolinones 90's
  - Waterhemp
- Glyphosate 2000's
  - Mares Tail
  - Waterhemp
  - Ragweeds

Perennial Weeds, 14 Year Study, Nashua IA



Buhler, Stoltenberg Becker, Gunsolus. Weed Sci 42:205-209. 1994.

It Takes a Village for Weeds Too!

- **What your neighbors do DOES impact you**

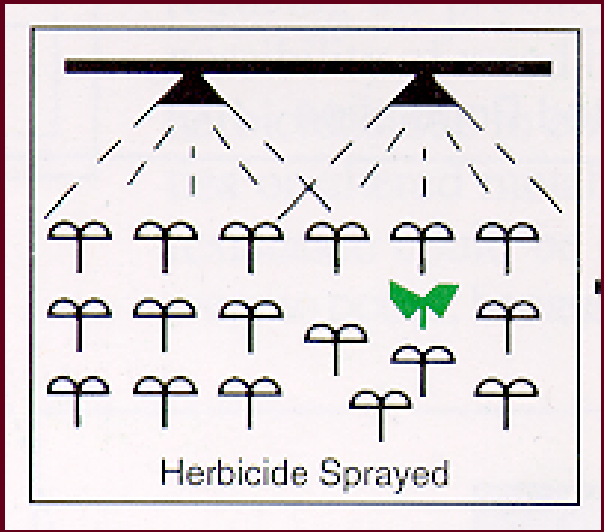
  – **Roundup Ready world will shift the species you face in the non-GMO world**

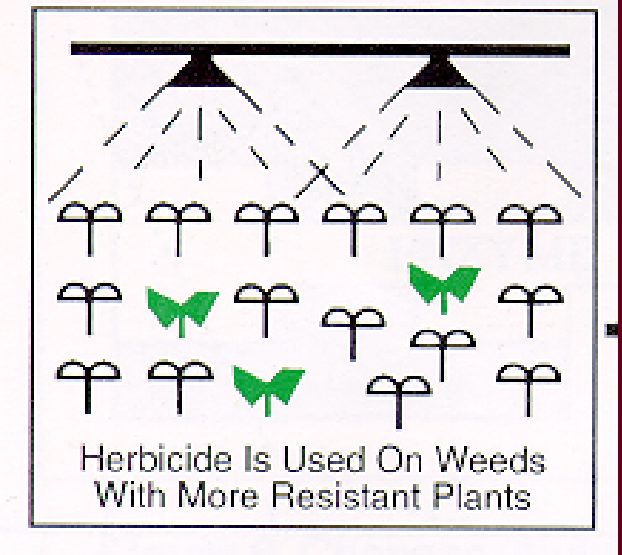
Waterhemp: Rochester, MN

- *Two applications of Roundup Ultra: 34 oz/A and 40 oz/A*
- *Numerous survivors*
- *Initial burndown*
- *Loss of tap root*
- *Prolific re-growth just above and below soil level*

- *Photo: Duane Rathmann*

Selection

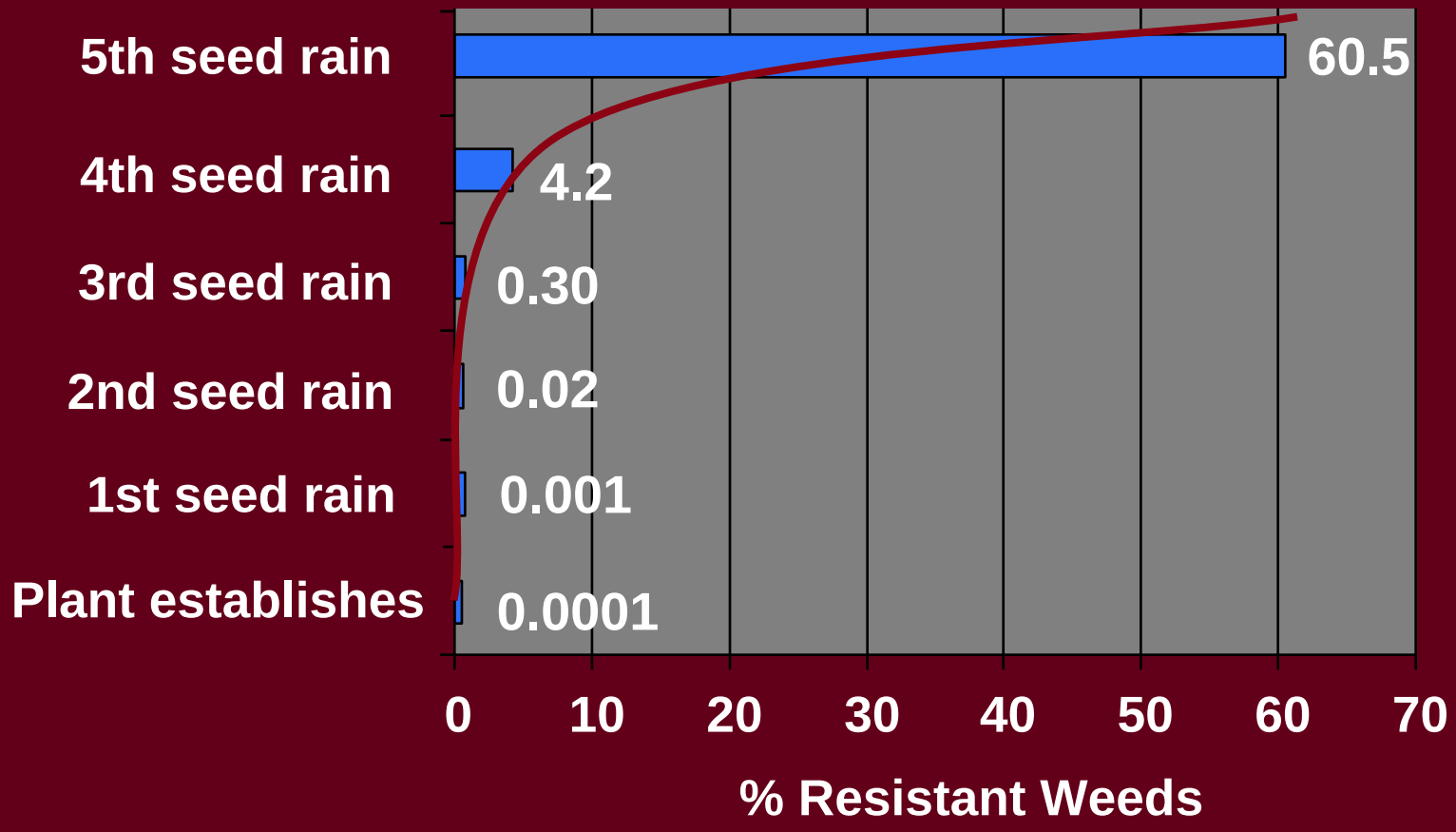




= Resistant Biotype

= Susceptible Or Wild Biotype

Hypothetical Development of Weed Resistant Populations with Repeated Control Methods / Seed Rain



Adapted from resistance development graphic

Weeds To Watch

Weed communities continually shift in response to management practices.

Failure to properly identify new weeds when they first enter a field may result in the plant becoming permanently established and increase weed management costs.

This poster was a six state effort funded by NC Region Pest Mgmt. Center

Effect of Animal Digestive Tract on Weed Seed Viability

- Animals tested:
  - Calves, horses, sheep, hogs & chickens
- Weeds evaluated:
  - Velvetleaf, field bindweed, sweet clover, smooth dock, smartweed, wild rose, and pepperweed.

Jerry Doll, Univ Wisconsin

Effect of Animal Digestive Tract on Weed Seed Viability

- Results:
  - Weeds with soft seed coats had greater mortality than weeds with hard seed coats
  - Calves passed 96 viable seeds/1000 seeds fed
  - Hogs and horses passed 88 viable seeds/1000 seeds fed
  - Sheep passed 64 viable seeds/1000 seeds fed
  - Chickens passed 12 viable seeds/1000 seeds fed

Jerry Doll, Univ Wisconsin

Effect of Animal Digestive Tract on Weed Seed Viability

- In a study of fresh droppings of dairy cow manure in upstate New York; 13 grass and 35 broadleaf weed species were found
- Common weeds found in survey of 20 farms include;
- Common lambsquarters (50% of farms)
- Yellow foxtail (35% of farms)
- Dandelion (30% of farms)
- Wild mustard, pigweed, barnyardgrass (25% of farms)

Jerry Doll, Univ Wisconsin

Effect of Animal Digestive Tract on Weed Seed Viability

- Of the 20 Farms:
  - One farm had 400,000 seeds/ton of manure (mostly common lambsquarters)
  - Four farms had no weed seeds
  - Fifteen farms averaged 75,000 seeds/ton
  - Therefore for 30 tons of manure/acre at 75,000 seeds/ton = 2.25 million seeds/acre
  - The cleaner the field the more noticed the impact. Also, consider addition of new species

Jerry Doll, Univ Wisconsin

Effects of Manure Composting on Weed Seeds

- Study of Manure Pile Temperatures:
  - Horse manure = 201^{o} F
  - Cow manure = 168^{o} F
  - Mixture = 188^{o} F
  - After 60 days all seeds died during the fermentation period in all manure piles

Jerry Doll, Univ Wisconsin

Effects of Manure Composting on Weed Seeds

- Key ingredients appear to be temperature and moisture
- Texas A&M study:
  - barnyardgrass, pigweed, kochia, and bindweed
  - beef cattle at 35% moisture
  - All species (except bindweed) killed after 3 or more days at 160^{o} F. Bindweed needed 7 days at 180^{o} F
  - In dry air at 140^{o} F for 30 days; no effect
  - In dry air at 160^{o} F for 3 days; most all killed

Jerry Doll, Univ Wisconsin

Effects of Manure Composting on Weed Seeds

- Nebraska study:
  - Foxtail, smooth brome, pigweed, common sunflower, and cocklebur and velvetleaf
  - Normal composting facility for one week
  - Dry dairy manure; most seed viable
  - Dry beef manure; most seeds viable
  - Wet beef manure; all seeds dead

  - Dry dairy manure after 4- to 5- months killed all seeds except velvetleaf (max. temp 140^{o} F)

Jerry Doll, Univ Wisconsin

Effects of Manure Composting on Weed Seeds

- Key ingredients to effective composting appear to be temperature and moisture
  - Need temperatures above 140^{o} F (160^{o} - 180^{o} F)
  - Moist compost increases seed kill
  - To reduce viability of hard seed coats such as mustards, field bindweed and velvetleaf both temperature and moisture are necessary

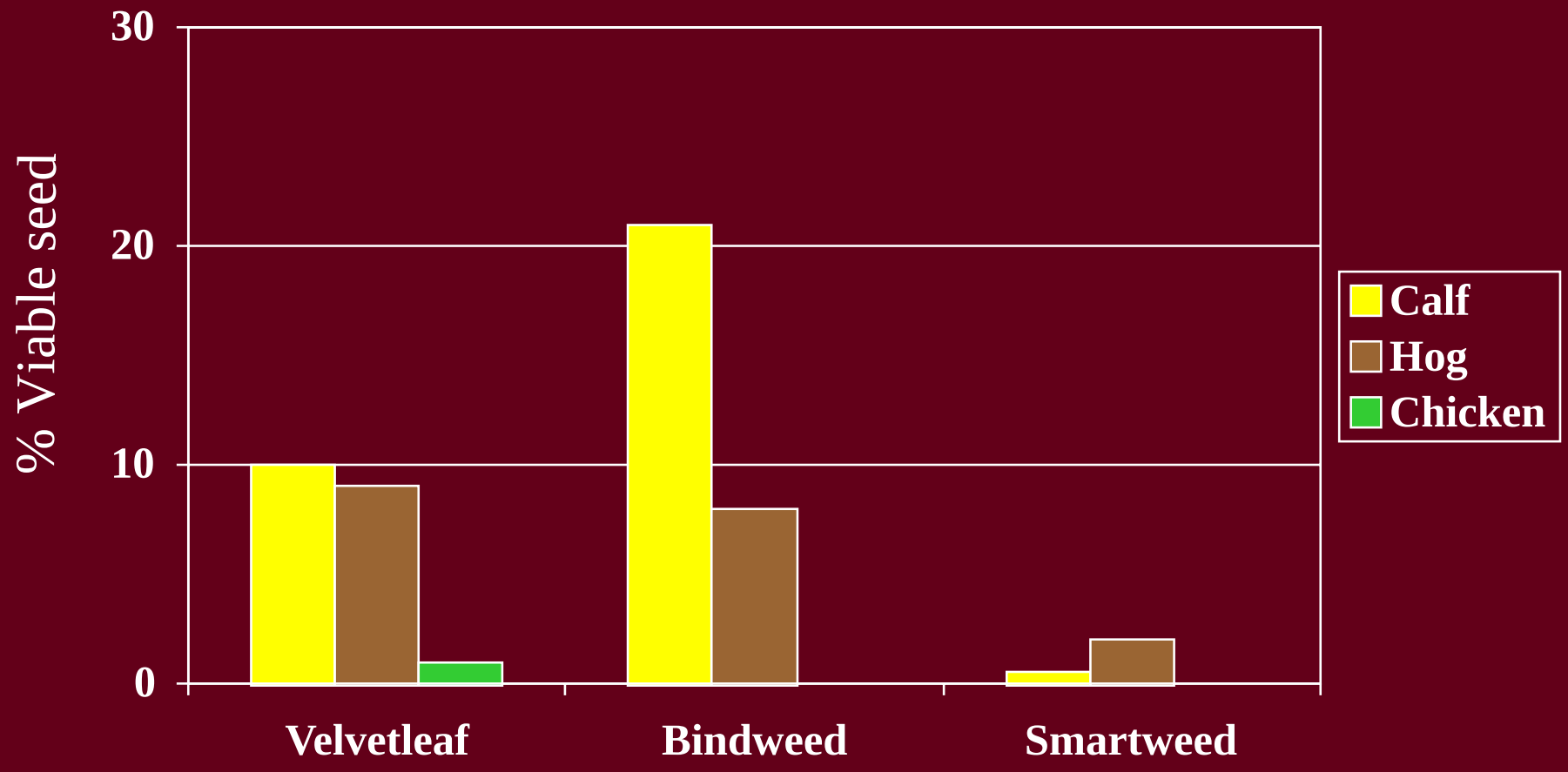
Jerry Doll, Univ Wisconsin

Manure as Seed Source

- Most sees killed by digestion
- Small percentage can survive
  - NY dairy farms, 34 seeds/ft^2 applied to fields in manure
  - Insignificant number compared to existing seedbank
- Site specific issues (chicken or the egg)

via Hartzler, ISU

Digestion Effects on Weed Seeds



Adapted from Harman and Keim. 1934.

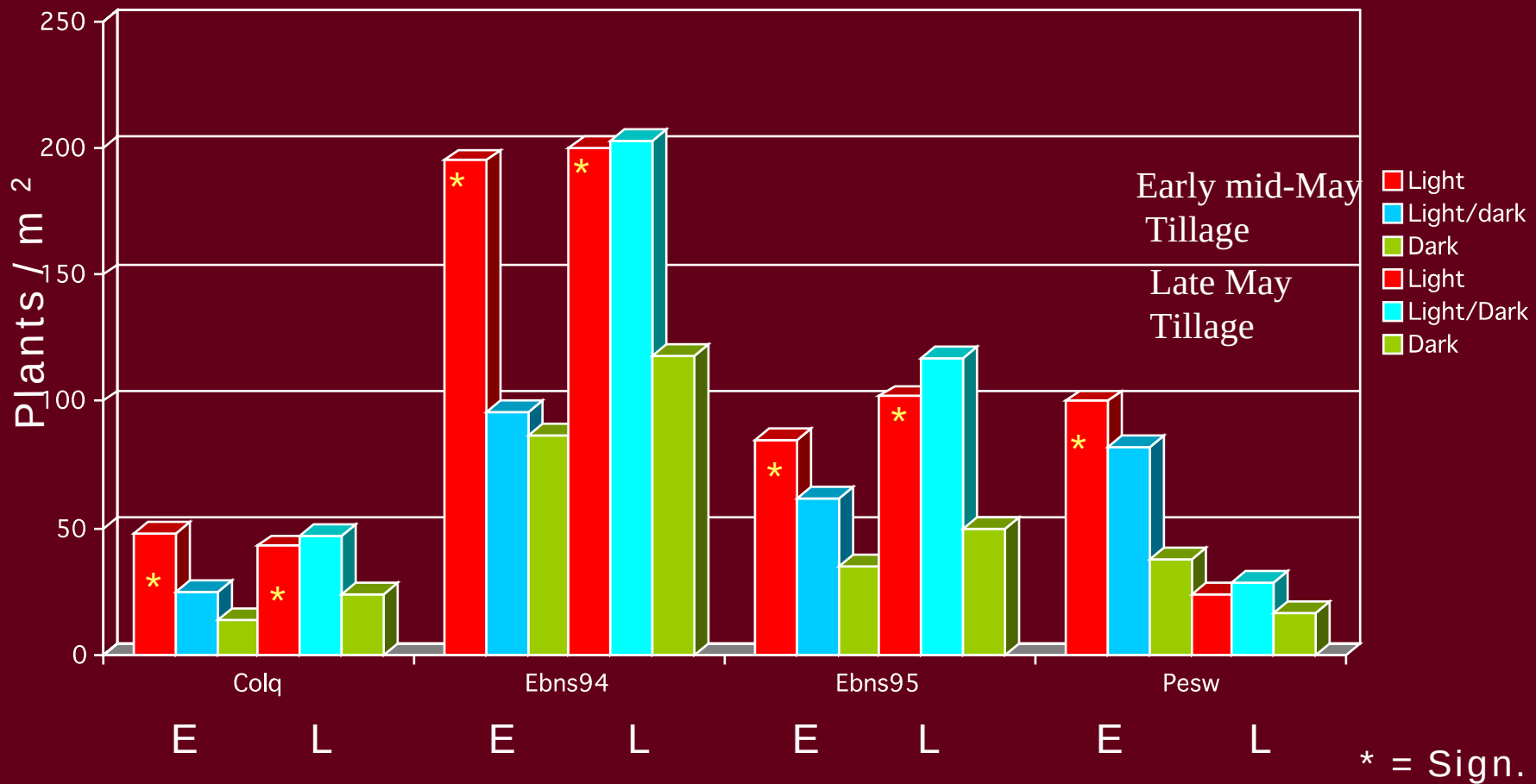
Number of weed seed germinating in a field germination assay for two seasons following 30 days storage in different manure storage systems at Haubenschild Farms

Manure system	Weed species					
	VELE	COLQ	RRPW	LTSW	GIFT	WIPM
Anaerobic digestion	16	12	1	0	0	0
Lagoon storage	12	18	5	0	0	0
Inorganic fertilizer	14	11	4	0	0	0
LSD	NS	NS	NS	NS	NS	NS

VELE = velvetleaf
COLQ = common lambsquarters
RRPW = redroot pigweed
LTSW = Ladysthumb smartweed
GIFT = giant foxtail
WIPM = wild proso millet

Light Effects on Annual Weed Emergence

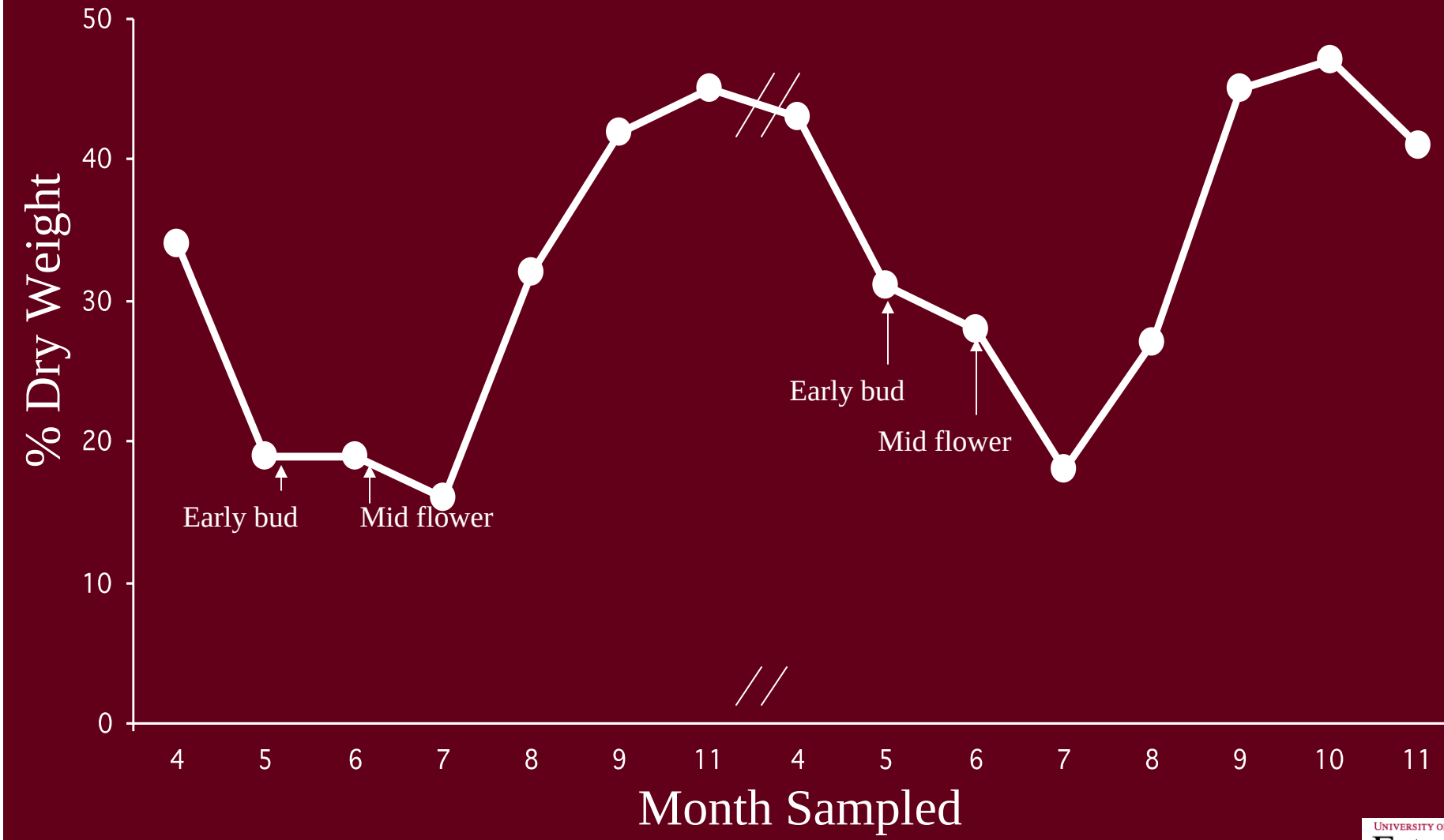
Buhler Weed Technol. 11:496-501. 1997



Perennial Weeds - the challenge

- Very difficult to control
- Repeated treatment is necessary
  - whatever it is
- Survivors
  - regrowth
- Carbohydrate depletion

Seasonal Carbohydrate Levels In Hemp Dogbane Root Crowns



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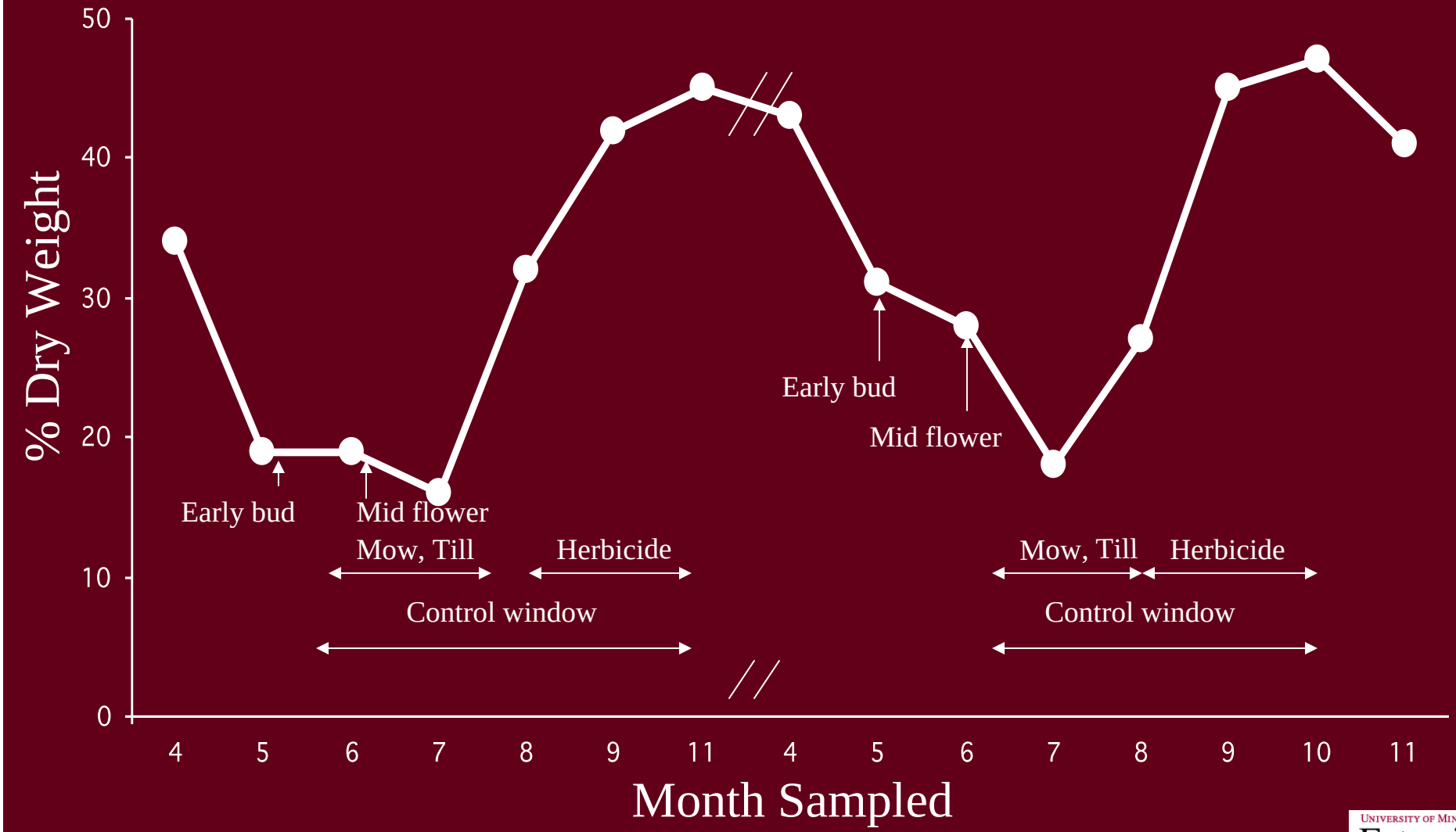

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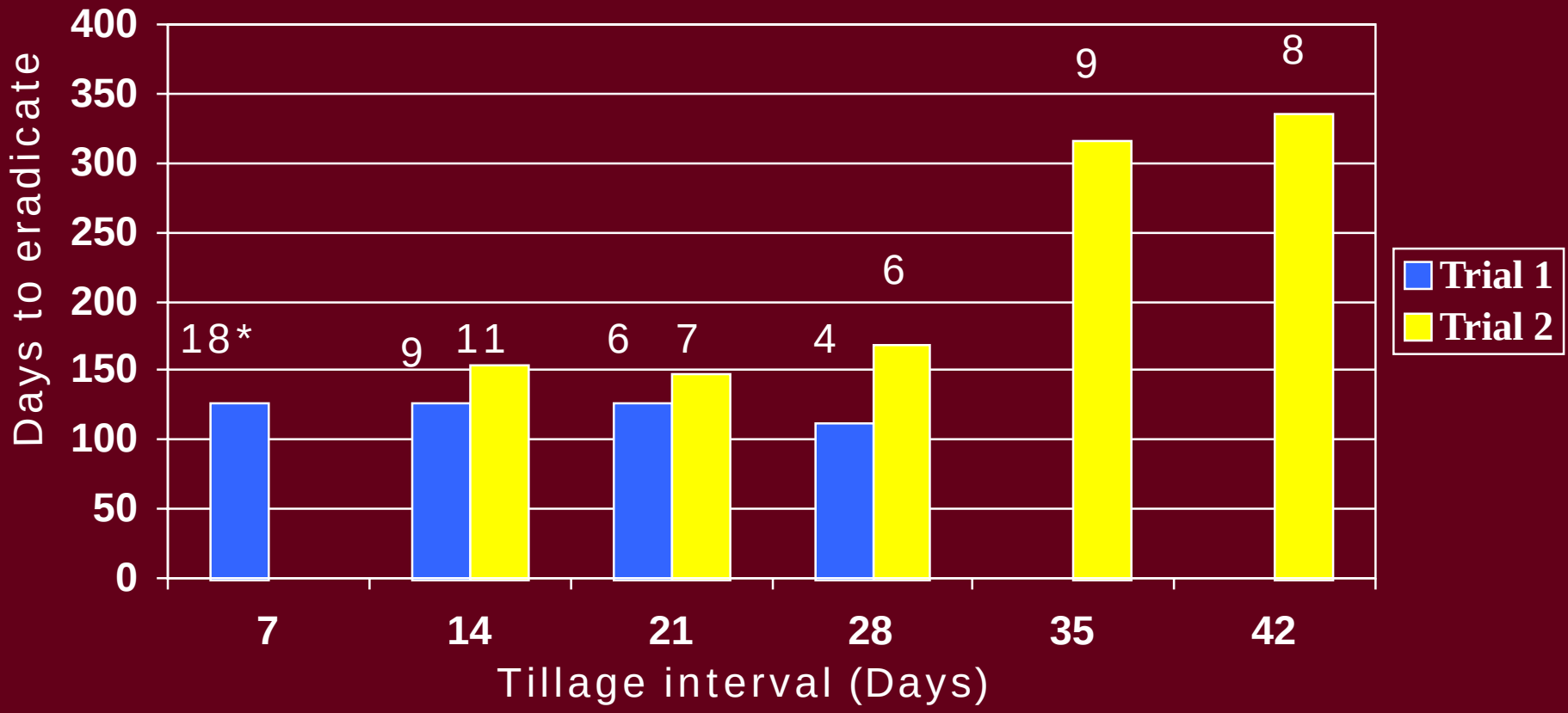
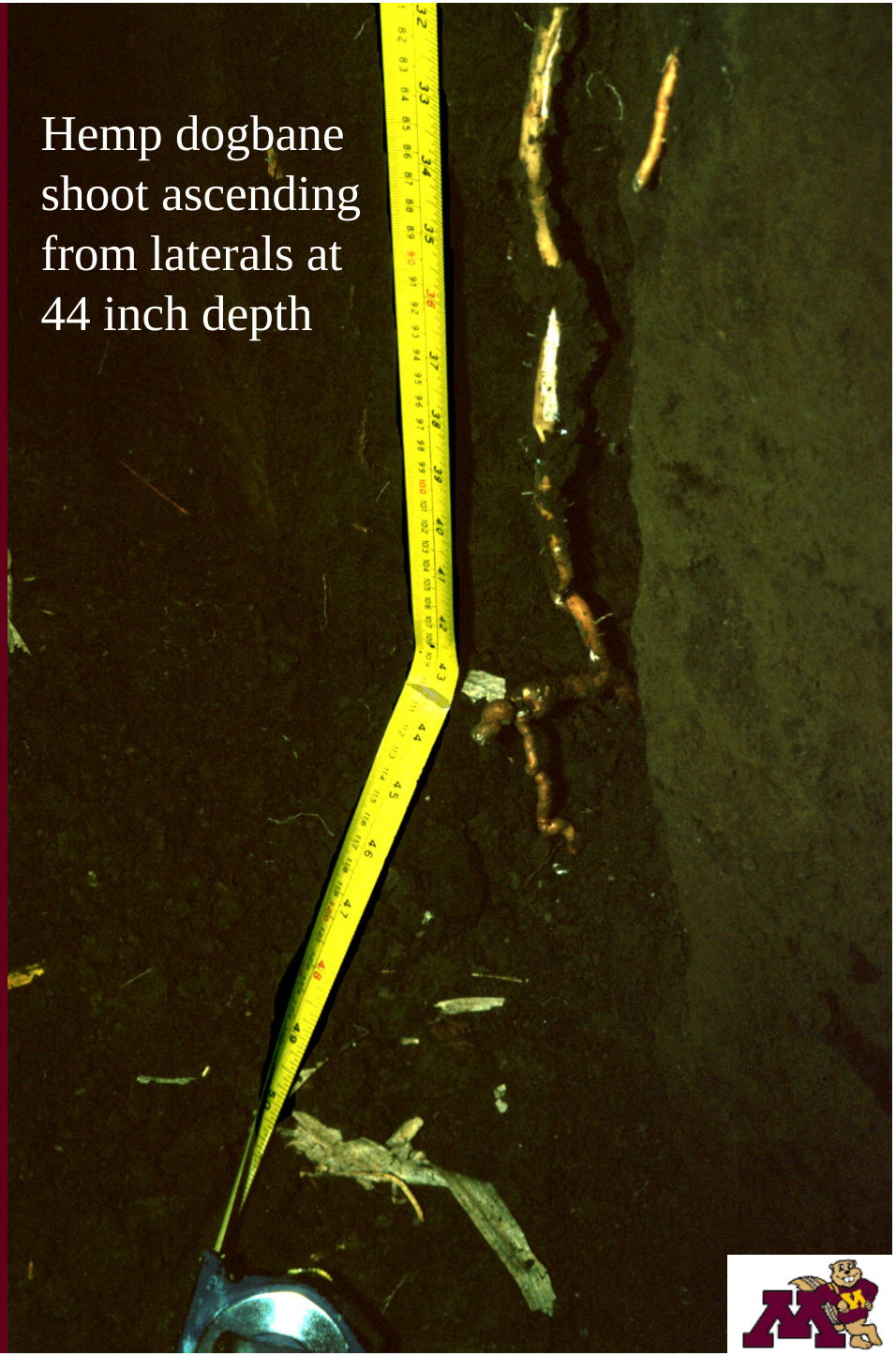
Tillage to Eradicate Canada Thistle



Adapted from Seely, C.I. 1952
Univ. Idaho Exp. Stat. Bull. 288

Plowed 6” deep when 5 ” tall, then duckfoot cult. 5“ deep rest of the tillage operations
* Indicates total no. of tillage events needed to eradicate

Hemp dogbane crowns develop below plow layer



Hemp dogbane shoot ascending from laterals at 44 inch depth

Canada thistle root mass after one season

Phil Westra, Colorado State

Limitations of Bio-Control for Canada Thistle

- Significant weed problem in native range
- Several native *Cirsium* spp.
  - Specificity concerns

Bugs for Biocontrol??

Agents:

Seed-heed weevil	(*Rhinocyllus conicus*)
Rosette weevil	(*Trichosirocalus horridus*)
Defoliating beetle	(*Cassida rubiginosa*)
Gall fly	(*Urophora cardui*)

Thistles:

Musk	(*Carduus nutans*)
Plumless	(*Carduus acanthoides*)
Bull	(*Cirsium vulgare*)
Canada	(*Cirsium arvense*)

Major issues with native thistle susceptibility such as Flodman thistle (*Cirsium flodmani*) - to use or not??

Other Biocontrol??

Mycoherbicides

Thistle rust (*Puccinia punctiformis)*

- as early as 1923
- stunted, chlorotic
- symptoms resemble growth regulator herbicide

White mold (*Sclerotinia sclerotiorum* (Lib.))

Pseudomonas syringae pv. *Tagetis*

- tagetitoxin, inhibits RNA polymerase III

ALL have major consistency issues

Rusts for biocontrol?

Thistle rust (*Puccinia punctiformis)*

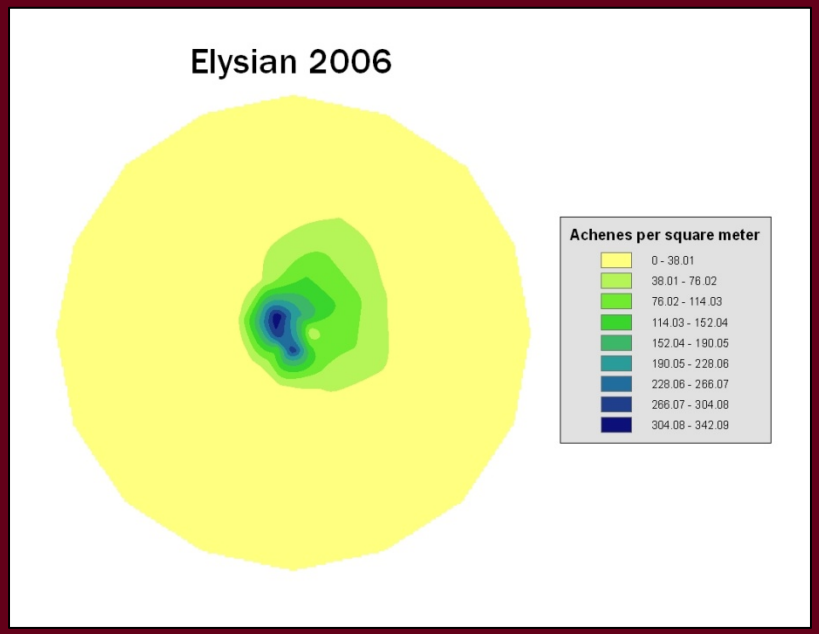
Bacteria for biocontrol?

Pseudomonas syringae

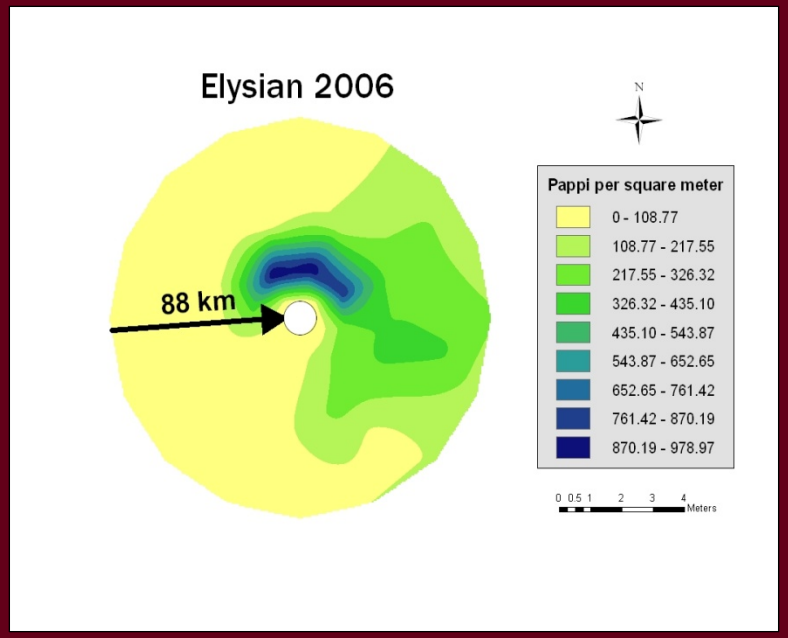
Herbicides for Canada Thistle

- Picloram (Tordon, Grazon)
- Clopyralid (Stinger, Transline, Curtail)
- Aminopyralid (Milestone, Forefront)

Effect of Wind of direction and distance of Canada thistle dispersal



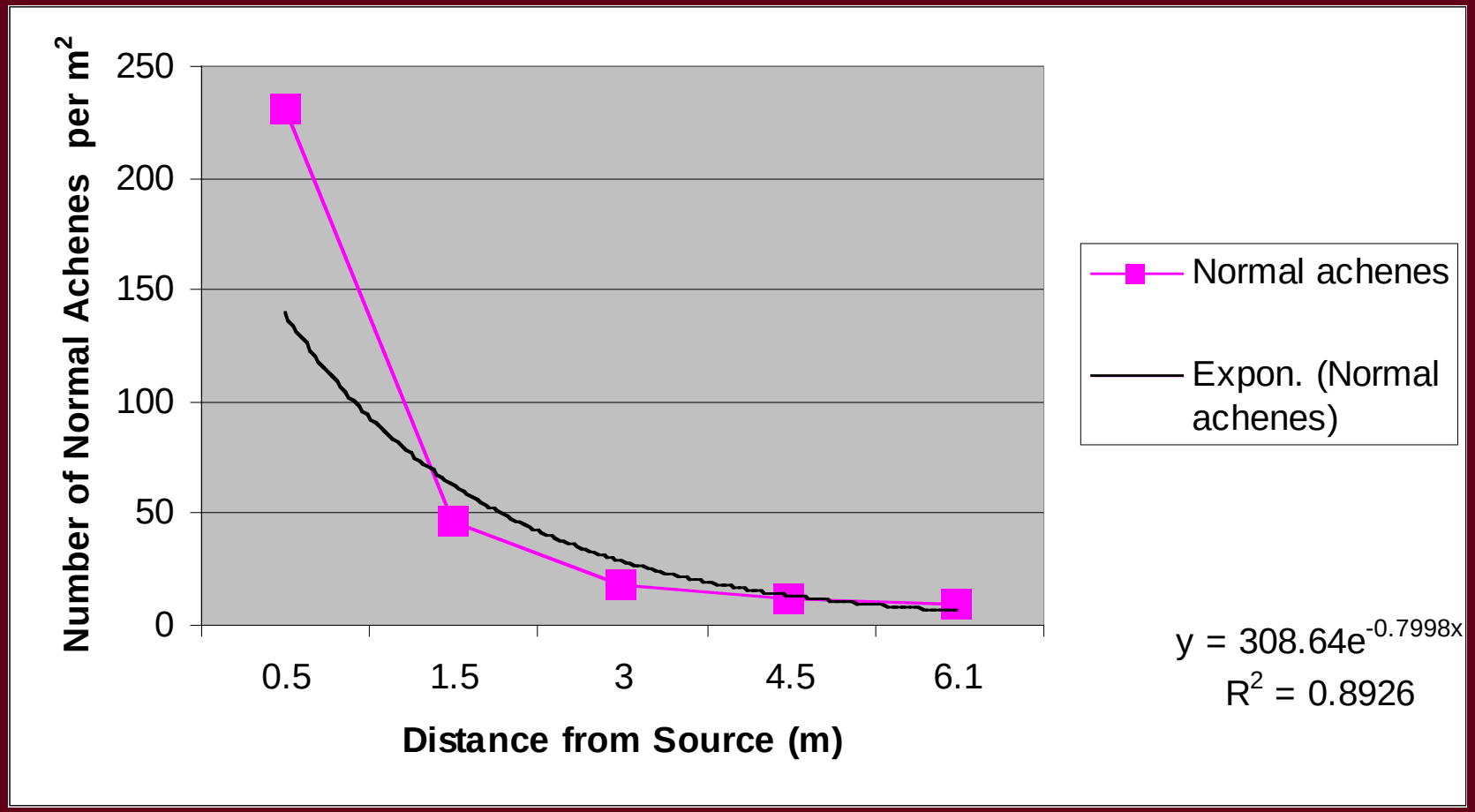
Seeds



Pappi

88 km average daily wind run

Dilution of seed and pappi as area expands



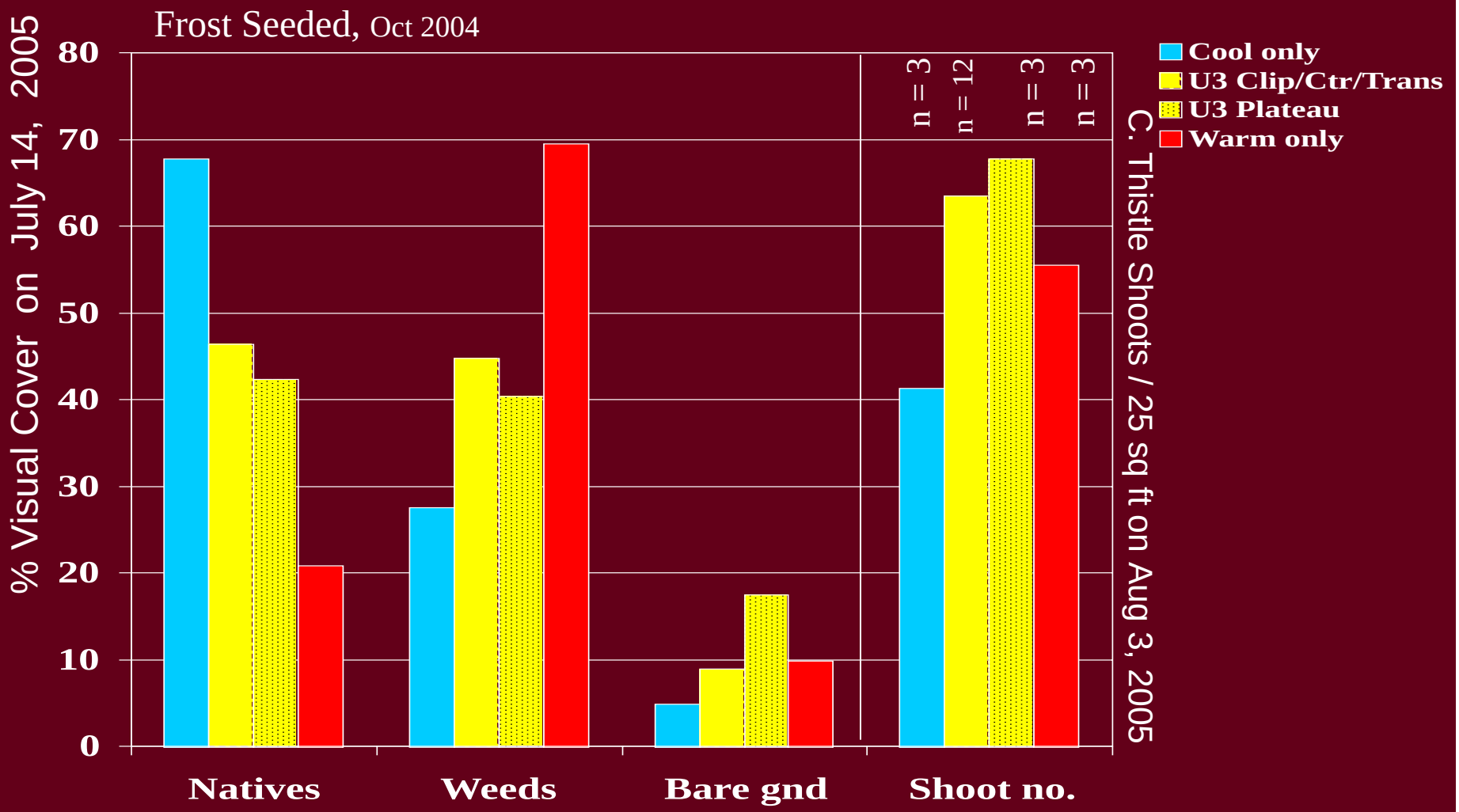
Varied biotypes

Functional Groups Research

University of Minnesota Extension SERVICE

Seeds to Seedlings

Native Seedings to Resist Canada Thistle Invasion
Small Plot Establishment Study, Lamberton MN



U3 Clip, Control, and Transline trts. did not differ at this time so combined, n = 12. For the remainder n = 4.

Reflects effects of 1st round of treatment, 2004 - 2005.

Native Seedings to Resist Canada Thistle Invasion
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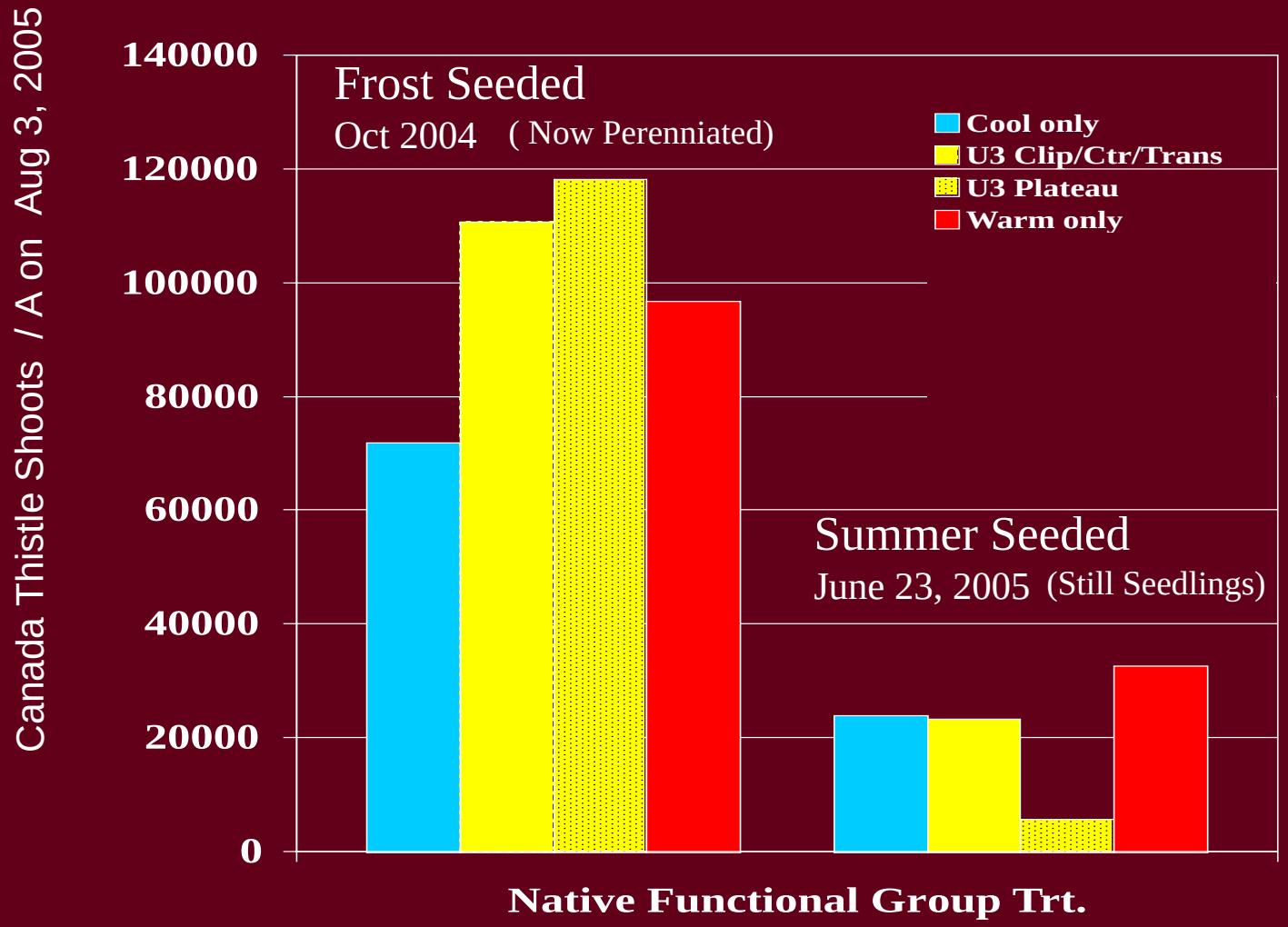

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