

*Lives Weeds Lead -
Secrets They Don't
Want You To Know*

With Special Guest Star

Roger Becker

University of Minnesota

Lives Weeds Lead -

Secrets They Don't Want You To Know

- **The Basics - Weed Truths**
- **The Perennials - How Difficult They Are**
- **The Annuals - Show Up at Every Party**
- **Future Shifts - We Shape Our Destiny**
- **The Poop - Messy Business and Survival**
- **Competing - Free Trade of Resources**



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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:**
 - Labor - Pulling/Cutting/**
 - Herbicides/Tillage/**
 - Mowing/Burning**
 - Is there anything else?**

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**

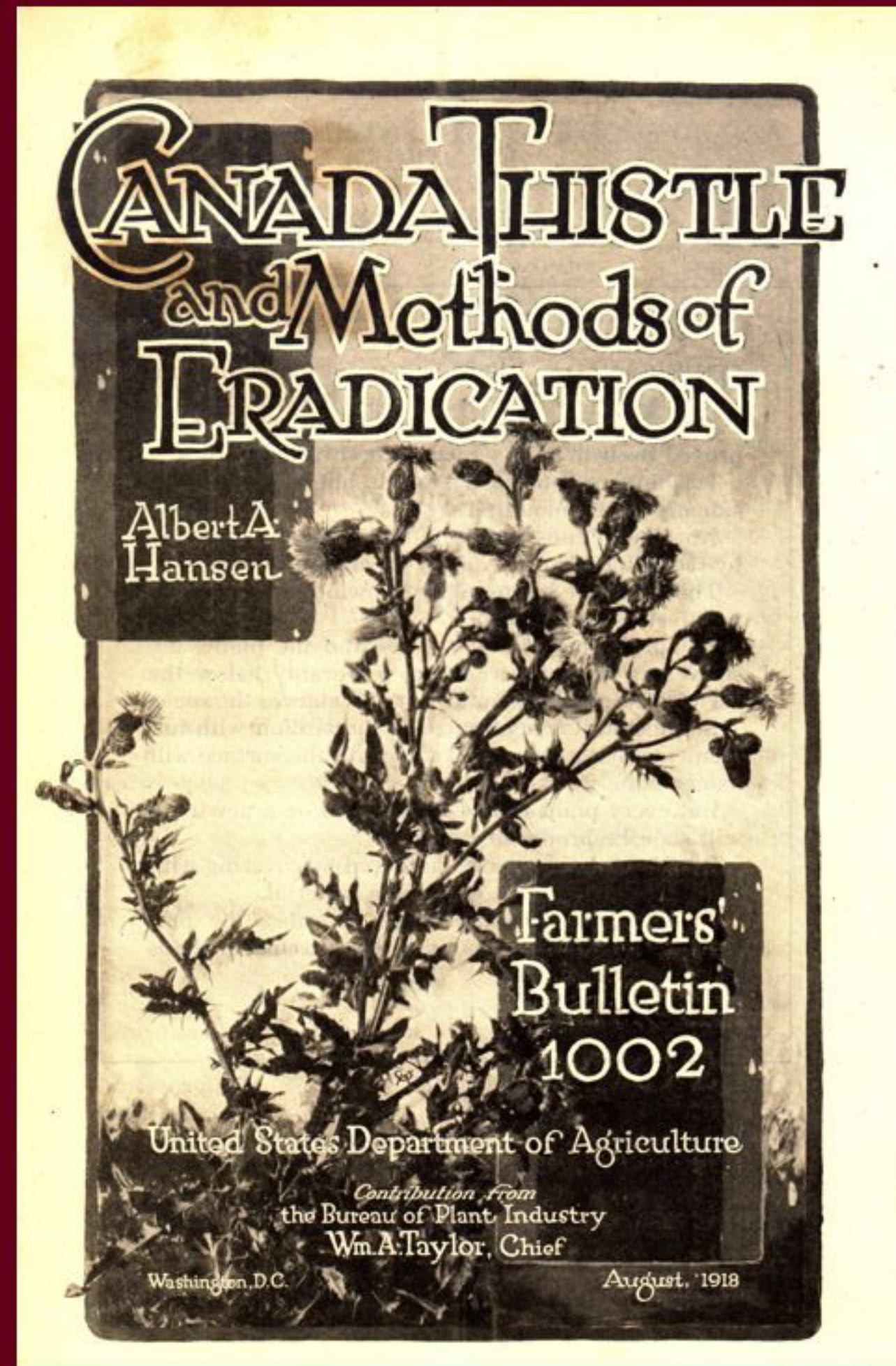
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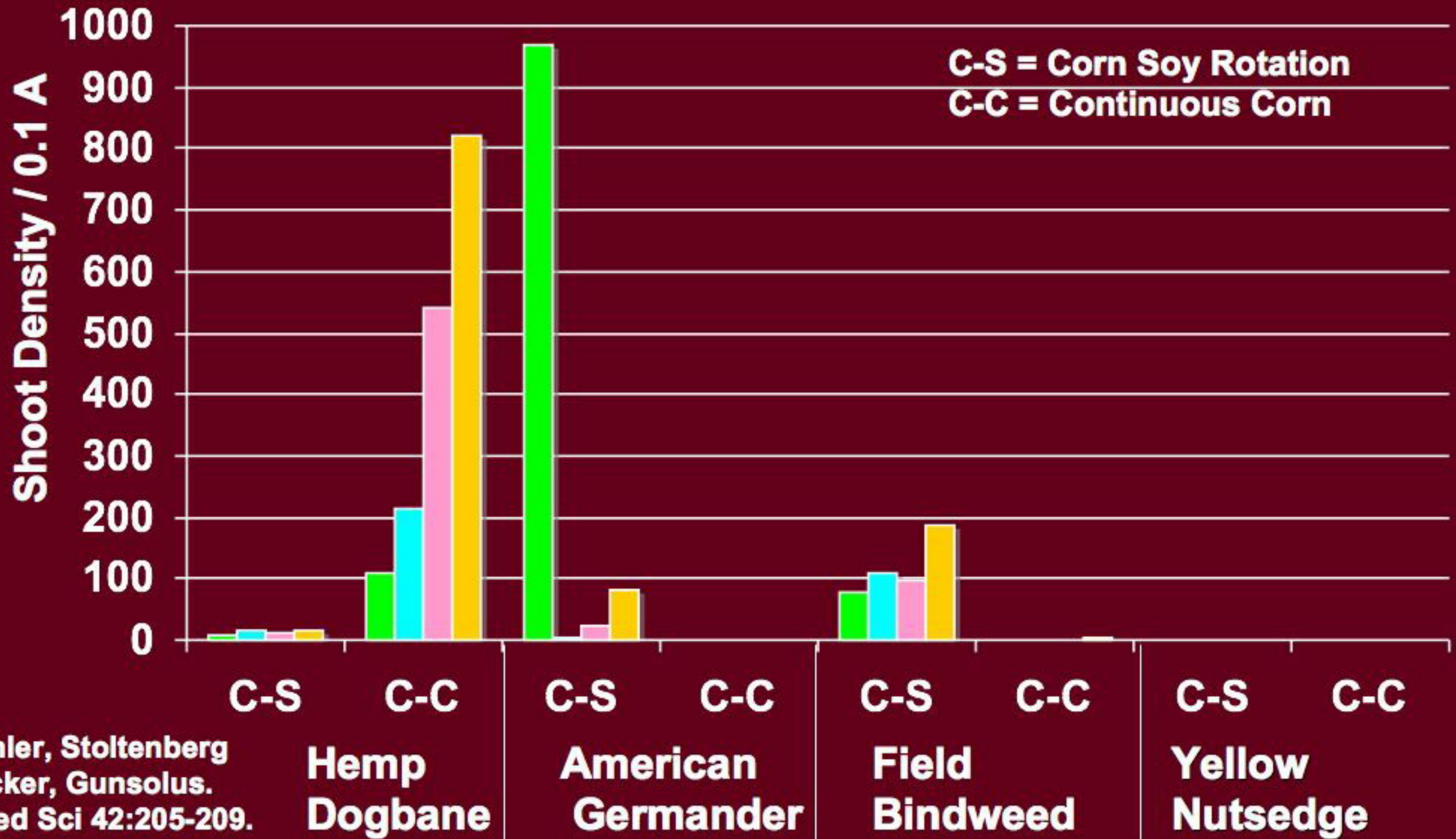
The Elusive Holy Grail of Weed Management

- Eradication!



Perennial Weeds, 14 Year Study, Nashua IA

■ Moldboard Plow
 ■ Chisel Plow
 ■ Ridge Till
 ■ No-till

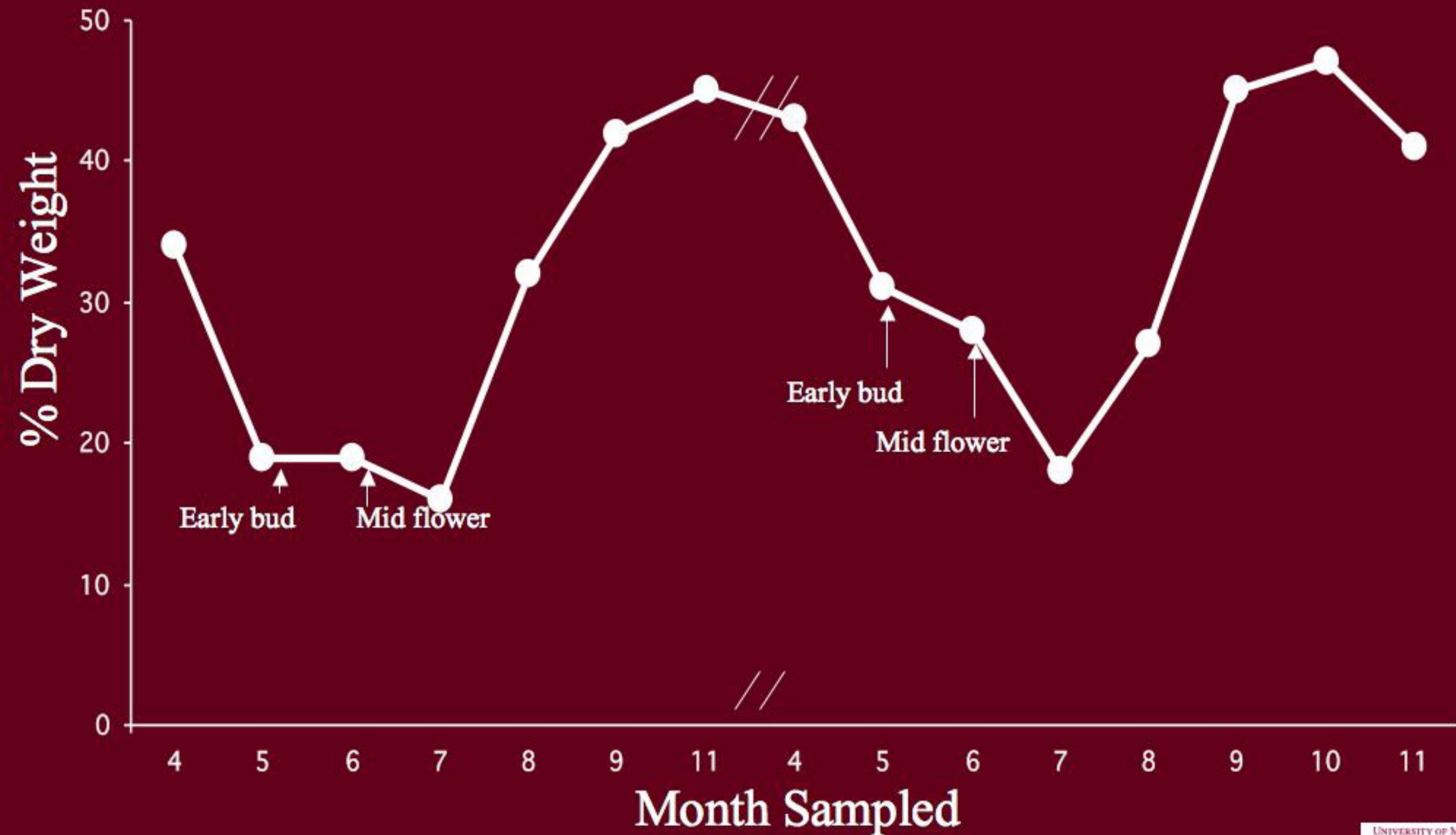


Buhler, Stoltenberg
 Becker, Gunsolus.
 Weed Sci 42:205-209.
 1994.

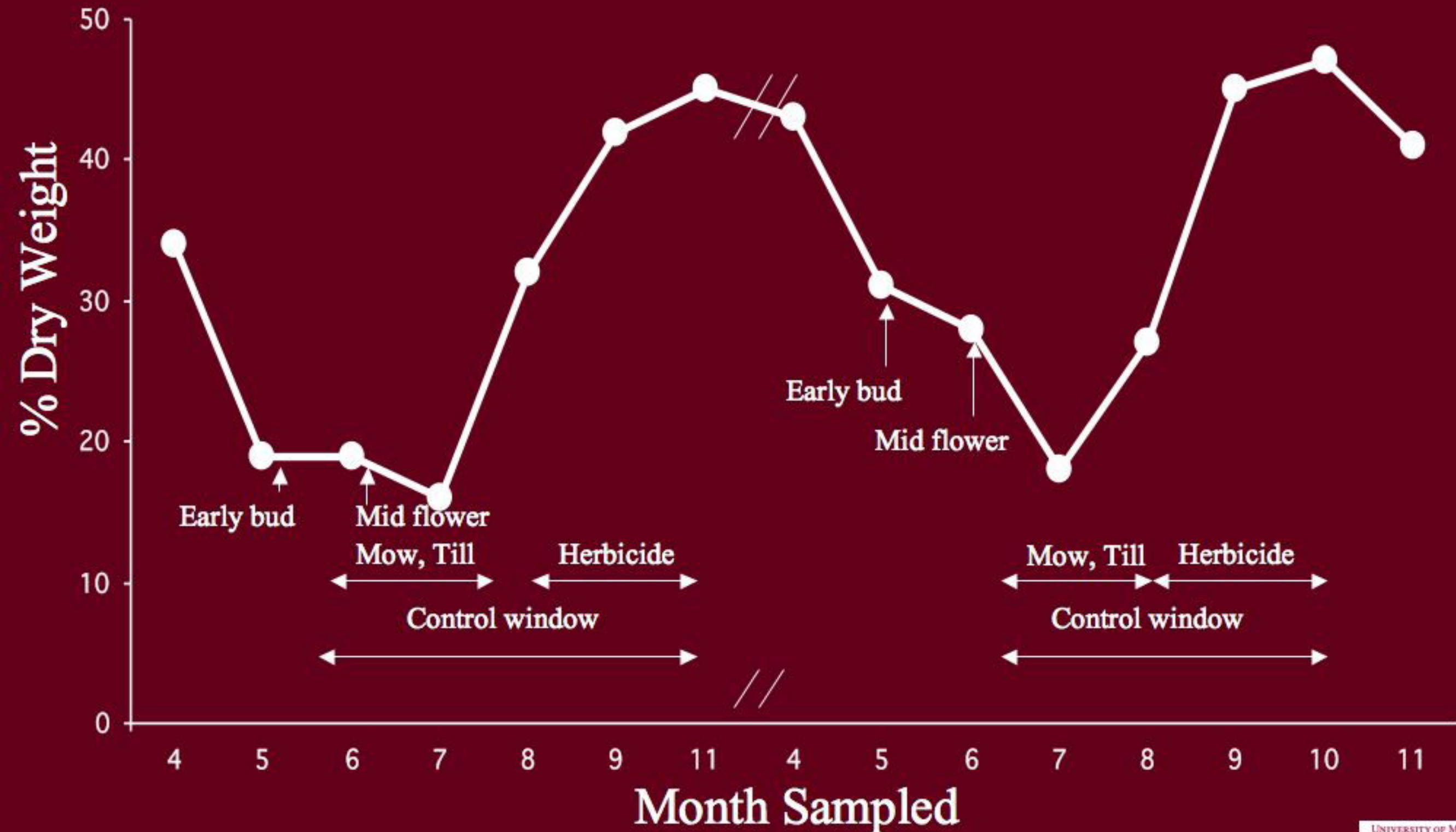
Perennial Weeds - the challenge

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

Seasonal Carbohydrate Levels In Hemp Dogbane Root Crowns



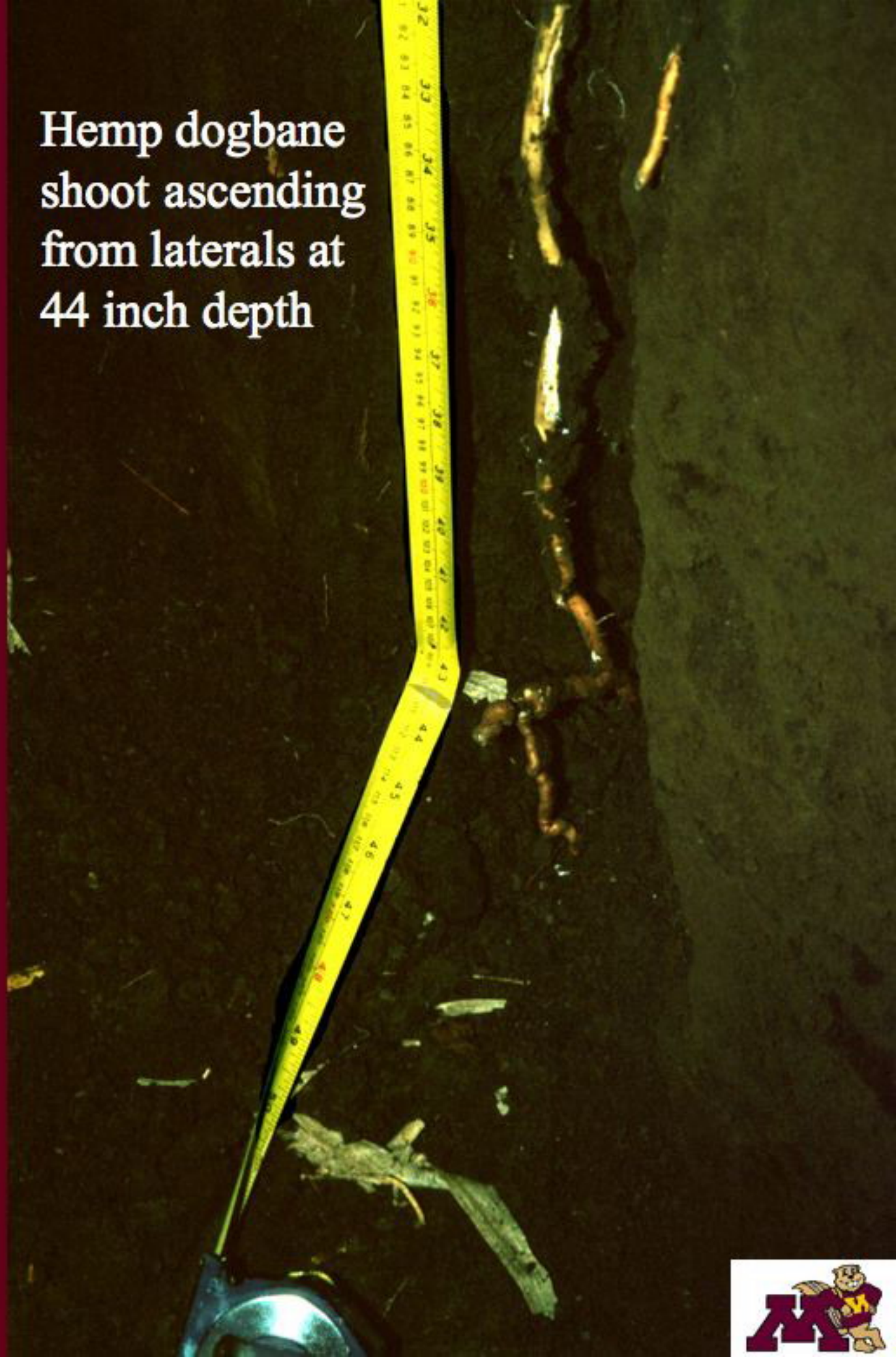
Seasonal Carbohydrate Levels In Hemp Dogbane Root Crowns





Hemp dogbane crowns develop below plow layer

Hemp dogbane shoot ascending from laterals at 44 inch depth



Phil Westra, Colorado State



Bugs for Biocontrol??

Agents:

Seed-head weevil	(<i>Rhinocyllus conicus</i>)
	(<i>Larinus planus</i>)
Gall fly	(<i>Urophora cardui</i>)
Seed-head fly	(<i>Terellia ruficauda</i>)
Stem weevil	(<i>Hadroplontus litura</i>)
Rosette weevil	(<i>Trichosirocalus horridus</i>)
Defoliating beetle	(<i>Cassida rubiginosa</i>)
Root-crown weevil	(<i>Cleonis pigra</i>)

Rusts for biocontrol?

Thistle rust

(*Puccinia punctiformis*)



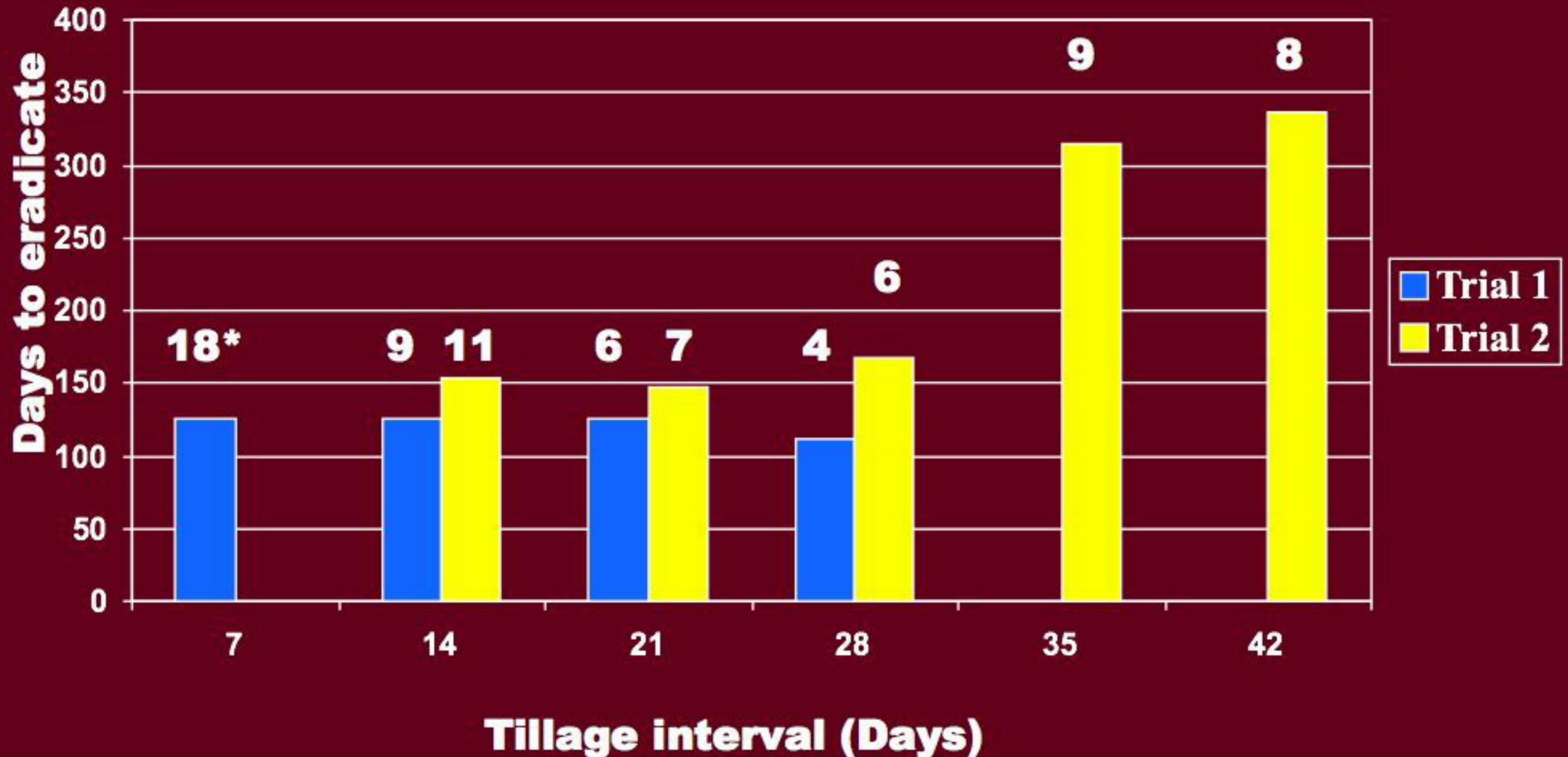
Bacteria for biocontrol?
Pseudomonas syringae



Check (top left)
plus 4 degrees
of control

Jurg Hiltbrunner

Cultivation to Eradicate C.Thistle



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

Plow 6" deep when 5" tall, then duckfoot cult.
5" deep
* Indicates total no. of tillage events needed to eradicate





Male Flower

Female Flower





Becker U of Mn 2006[©]

Canada Thistle Seeds



Normal



Shrunken

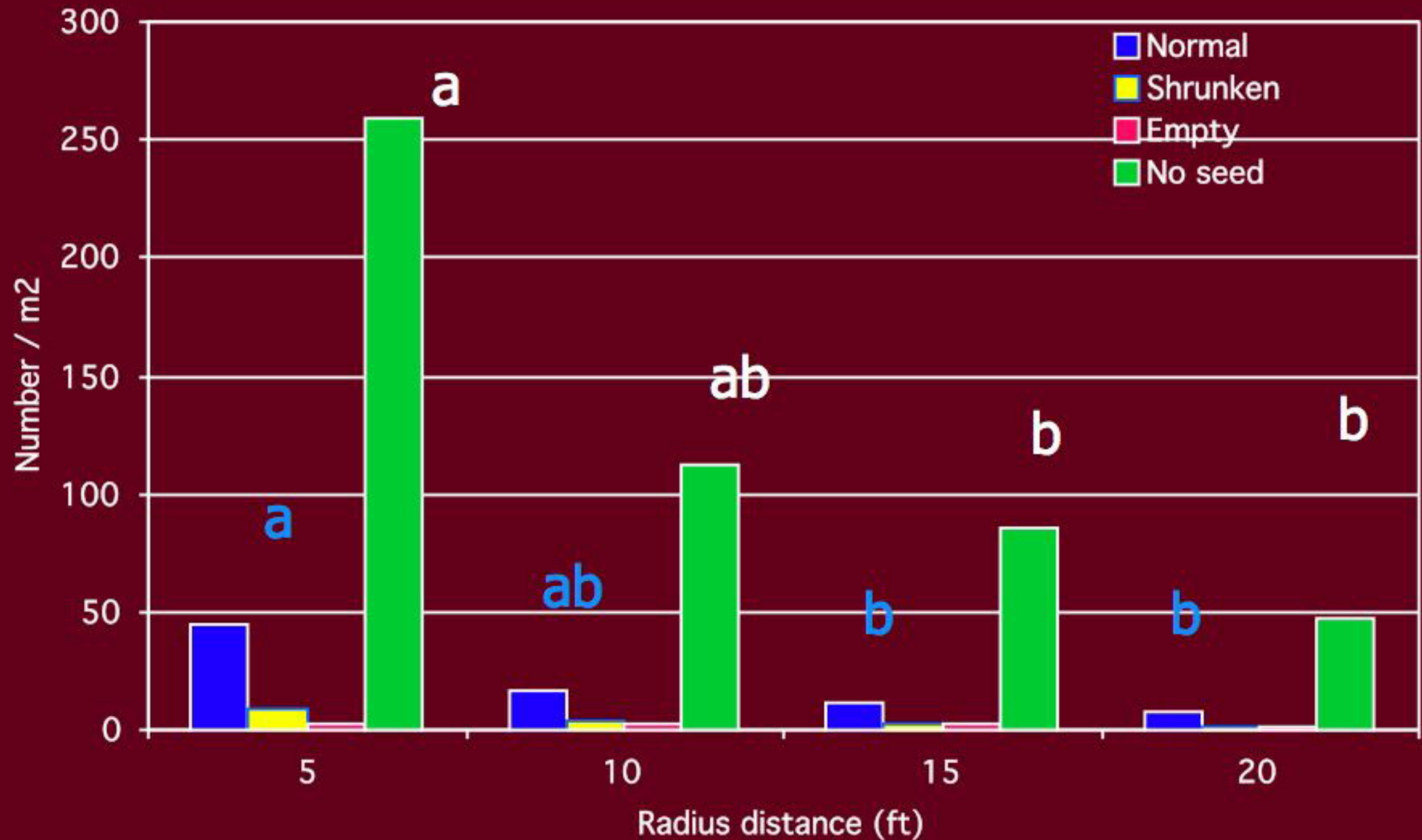


Empty



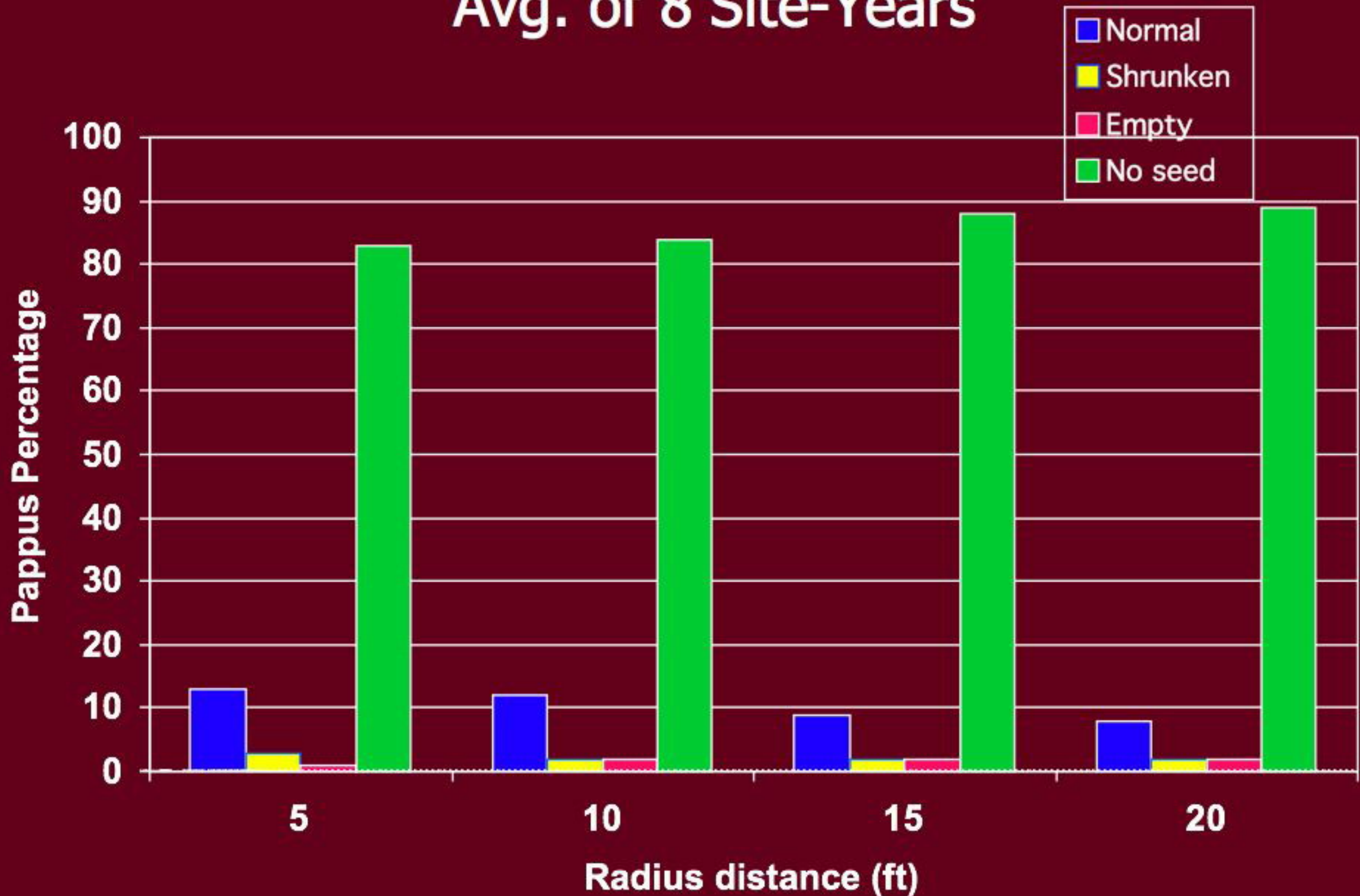
Open (spiral) trapping scheme

Avg. of 8 Site-Years

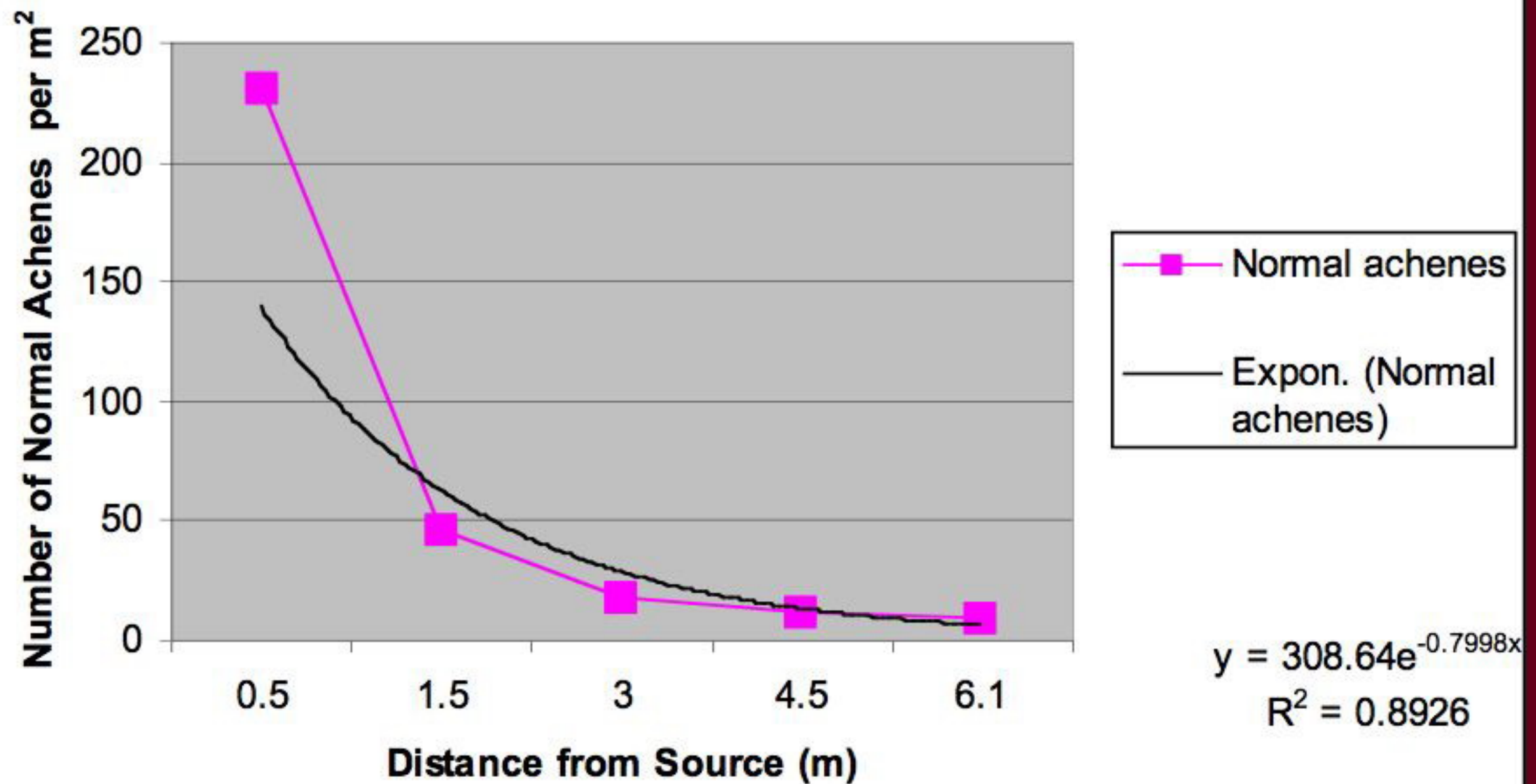


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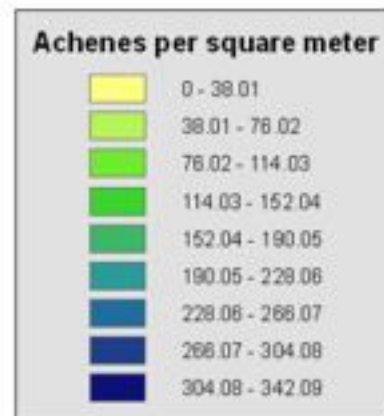
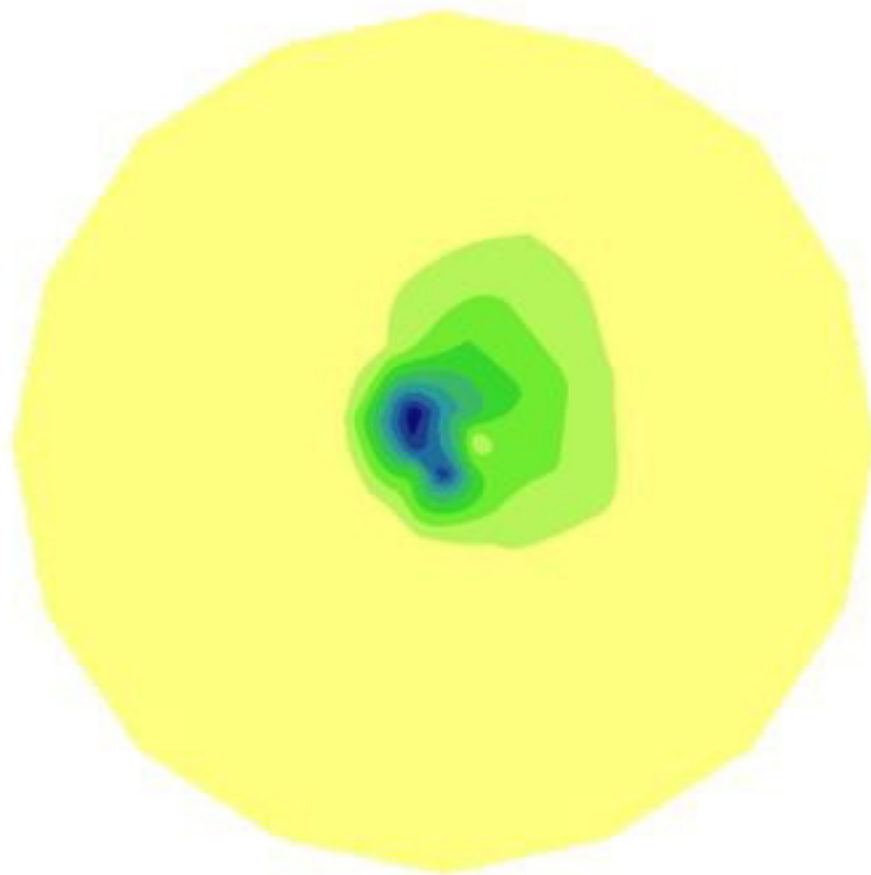


Dilution of seed and pappi as area expands



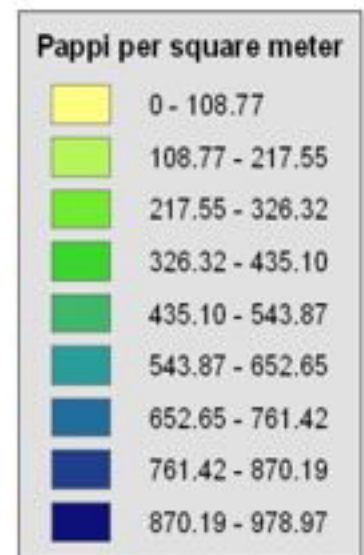
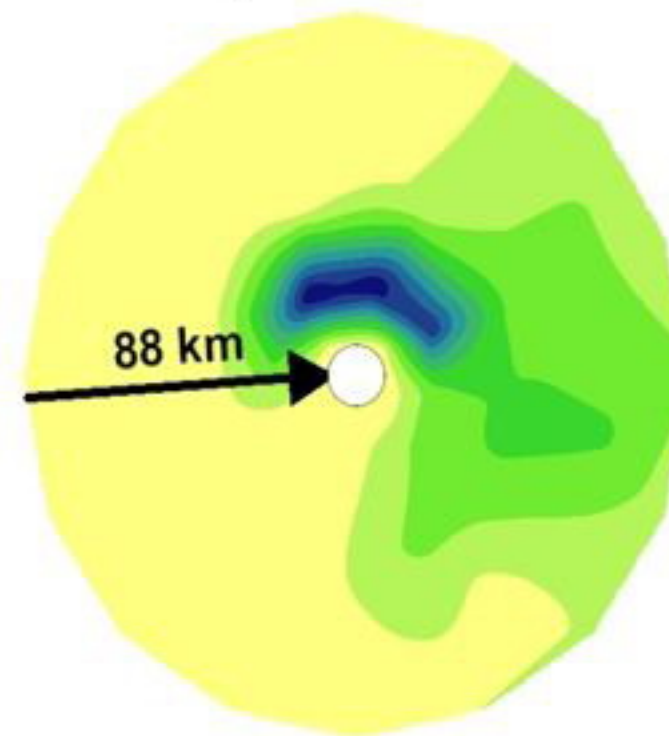
Effect of Wind of direction and distance of Canada thistle dispersal

Elysian 2006



Seeds

Elysian 2006



Pappi

88 km average daily wind run



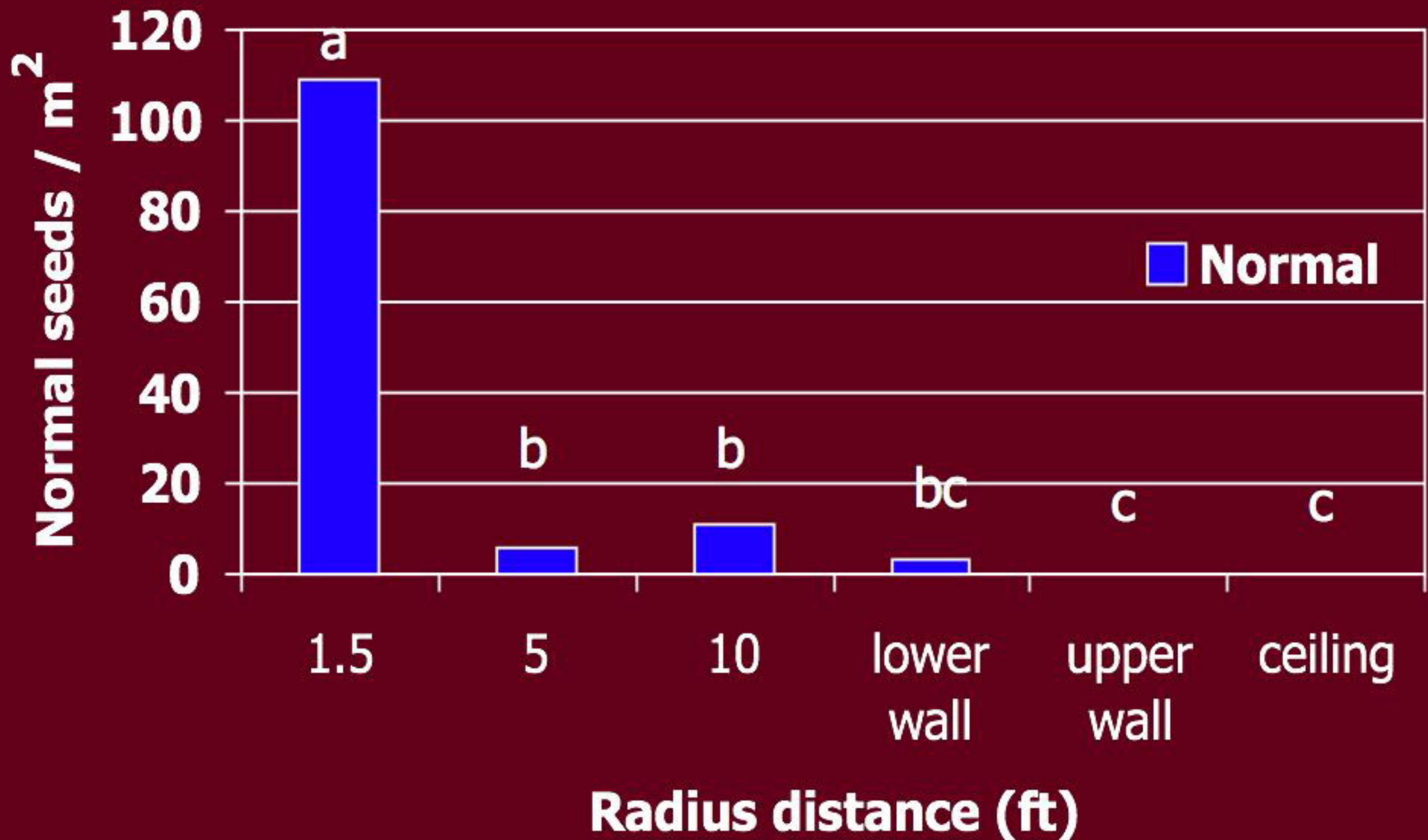
Becker U of Mn 2006[©]



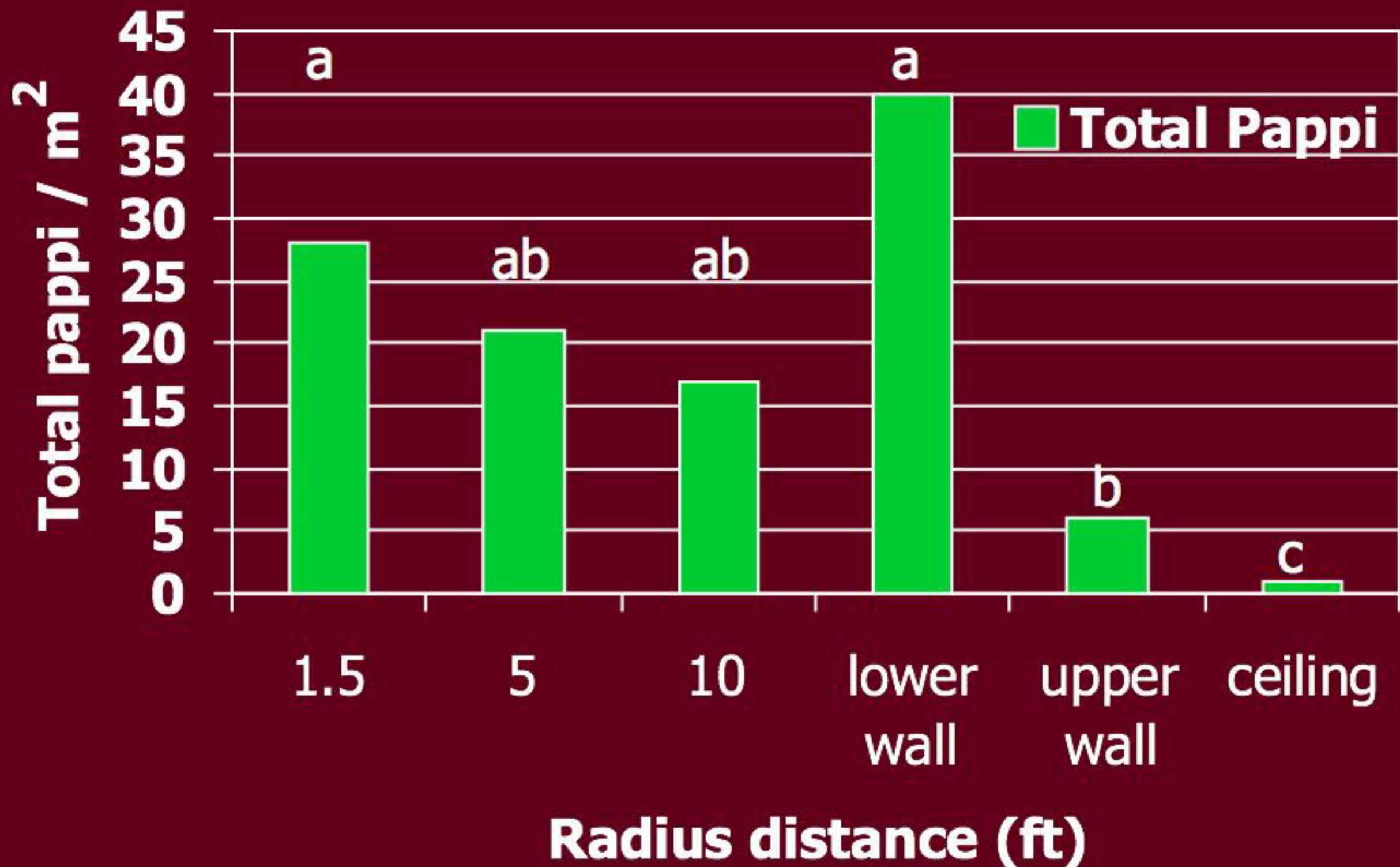
Becker U of Mn 2006[©]



Closed (cage) trapping scheme



Closed (cage) trapping scheme



Conclusions

- **Over 80% (83 to 89%) of wind blown pappi do not have an seed attached at 5 ft distance or greater**
- **Pappi and seed separate easily (deciduous)**
 - **Most seed falls near the parent plant**
- **Wind dispersal close to ground**
- **Movement with prevailing winds**

Conclusions

- The contribution of wind blown pappi to long distance dispersal of Canada thistle appears to be relatively small.**
- **Odds against the small number becoming established as new colonies**
 - **Landscape scale could be significant however**
 - **High priority on use of resources to prevent seed flight may not be productive as directing efforts into best control of the plant itself**

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Weed Life Cycles

- **A few weeds are biennials**
- **Complete life cycle in less than two years**
- **Must start from seed every two years**
 - **In the first year the plants form a rosette of leaves. This is the over-wintering stage.**
 - **The next spring the plants produce a stem with flowers and seeds (bolt from vernalization)**
 - **Many pasture weeds are biennials (e.g. bull, musk and plumeless thistle, wild carrot)**

Annual Weeds

- **Seed viability in soil**
 - **Weed-seed banks contain multiple weed species.**
 - **Weed species differ in their longevity (broadleaf > grass).**
 - **Weed seed buried deeper in the soil stays viable longer.**
 - **Majority of seeds are lost within 2-3 years.**
 - **Recovery of seed bank requires only 1 year of poor weed control.**



Weed Seed Banks

- **Seed viability**
 - **Physiological death**
 - **Predation : rodents, insects, worms**
 - **Dormancy : esp. w/ deeper burial**
 - **Pathogens**
 - **Germinate : may or may not establish**
 - **Physical damage**



Impact of seedbank on weed management

- **Level of inputs required to control weeds directly related to seed bank size**
- **Seed production by weeds needs be considered in management decisions**
- **What is an acceptable level of seed production?**



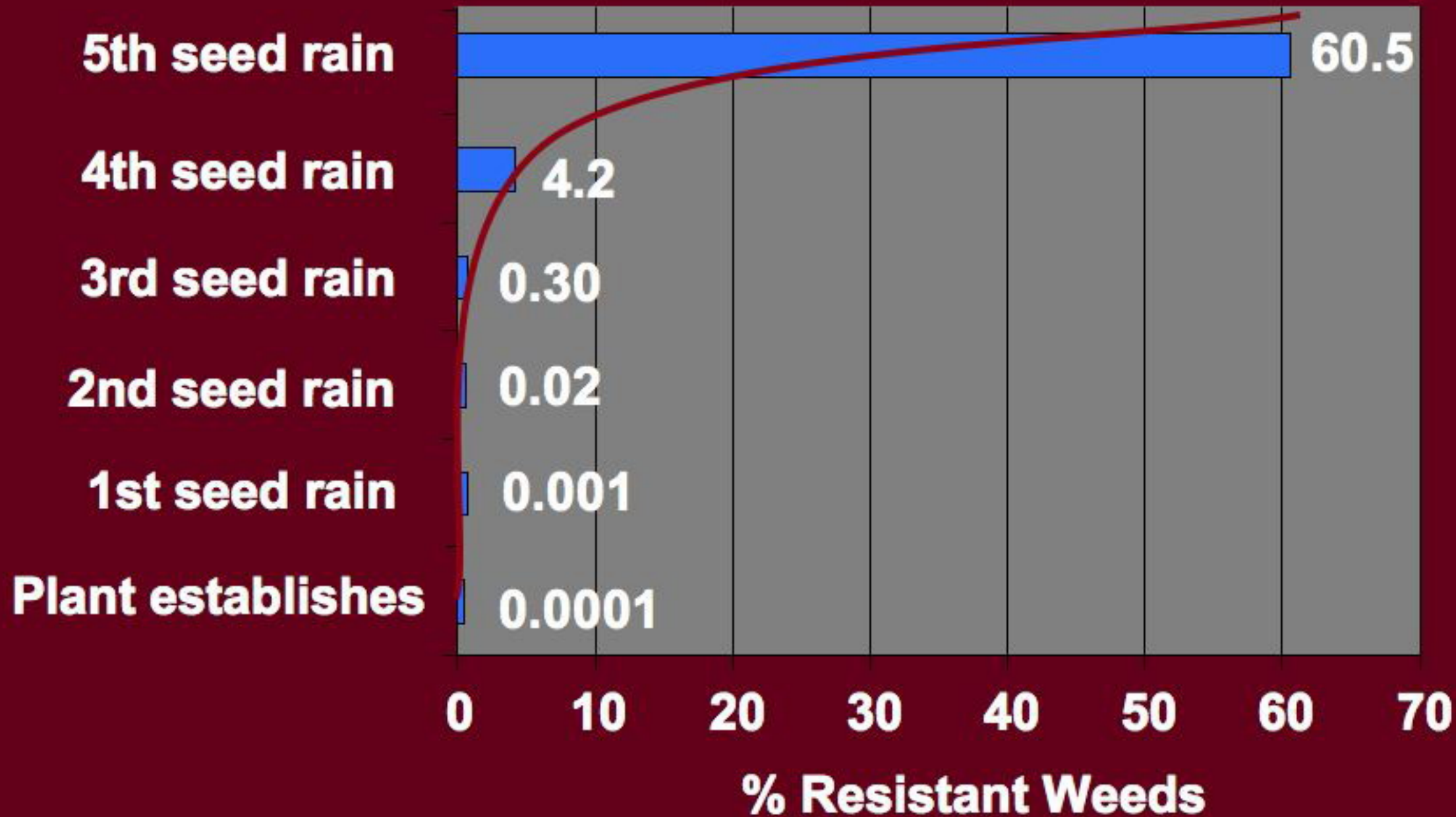
Seed Production Potential

Species	Number/Plant
• Redroot pigweed	230,000
• C. Lambsquarter	38,000
• P. Smartweed	6,500
• B. nightshade	40,000
• Giant foxtail	4,000
• Woolly cupgrass	40,000

Weed Seed Production

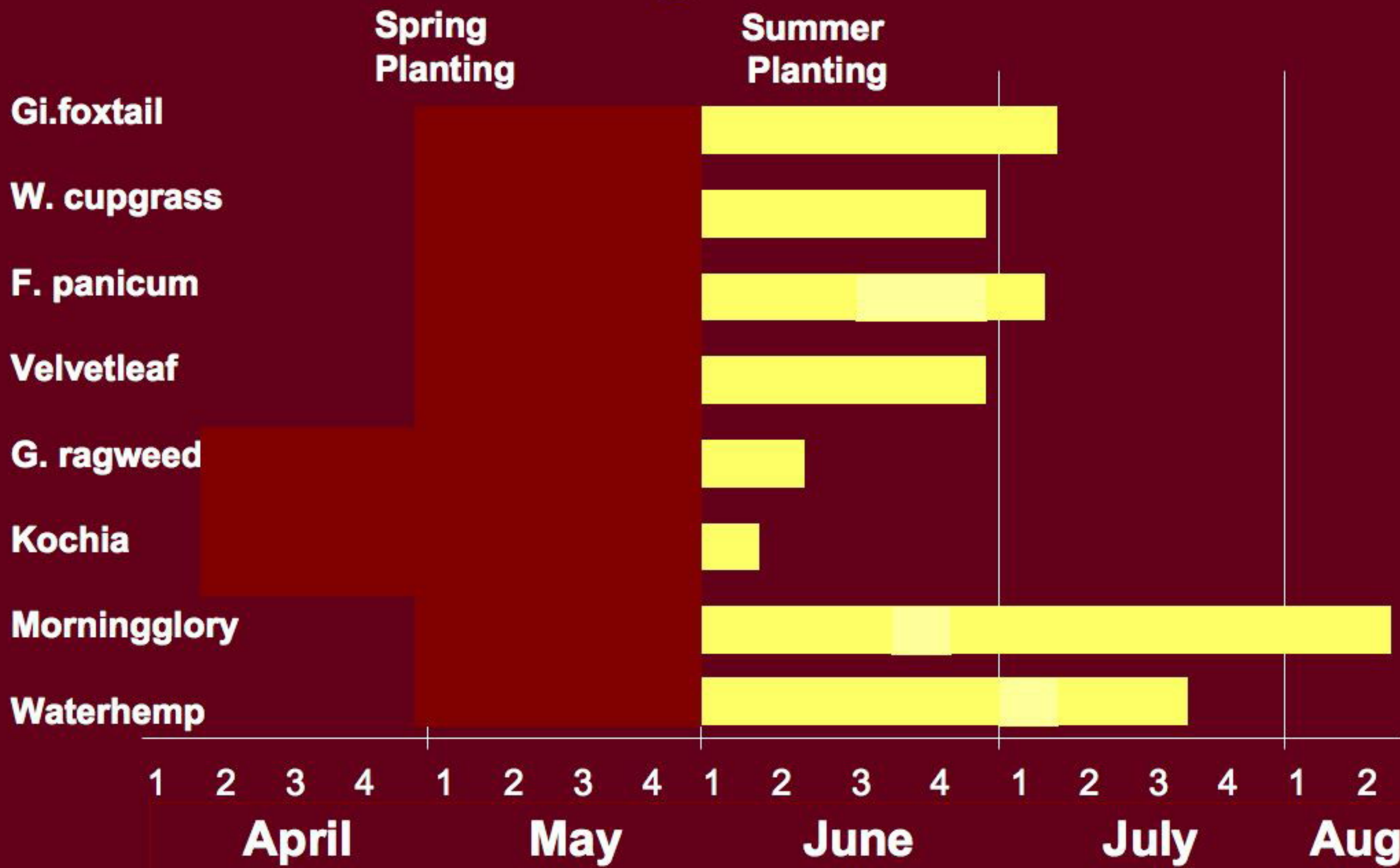
- **Few weeds achieve genetic potential**
- **Cocklebur – Arkansas**
 - **7000 seeds without competition**
 - **1100 seeds with competition**
- **Pigweed in corn**
 - **24,000 seeds with even emergence**
 - **3,000 seeds with four week delay**

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



Adapted from resistance development graphic

Weed Emergence Patterns



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



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.

- **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**

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.

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

Dr. Elaine Solowey, Arava Institute for Environmental Studies

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

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.



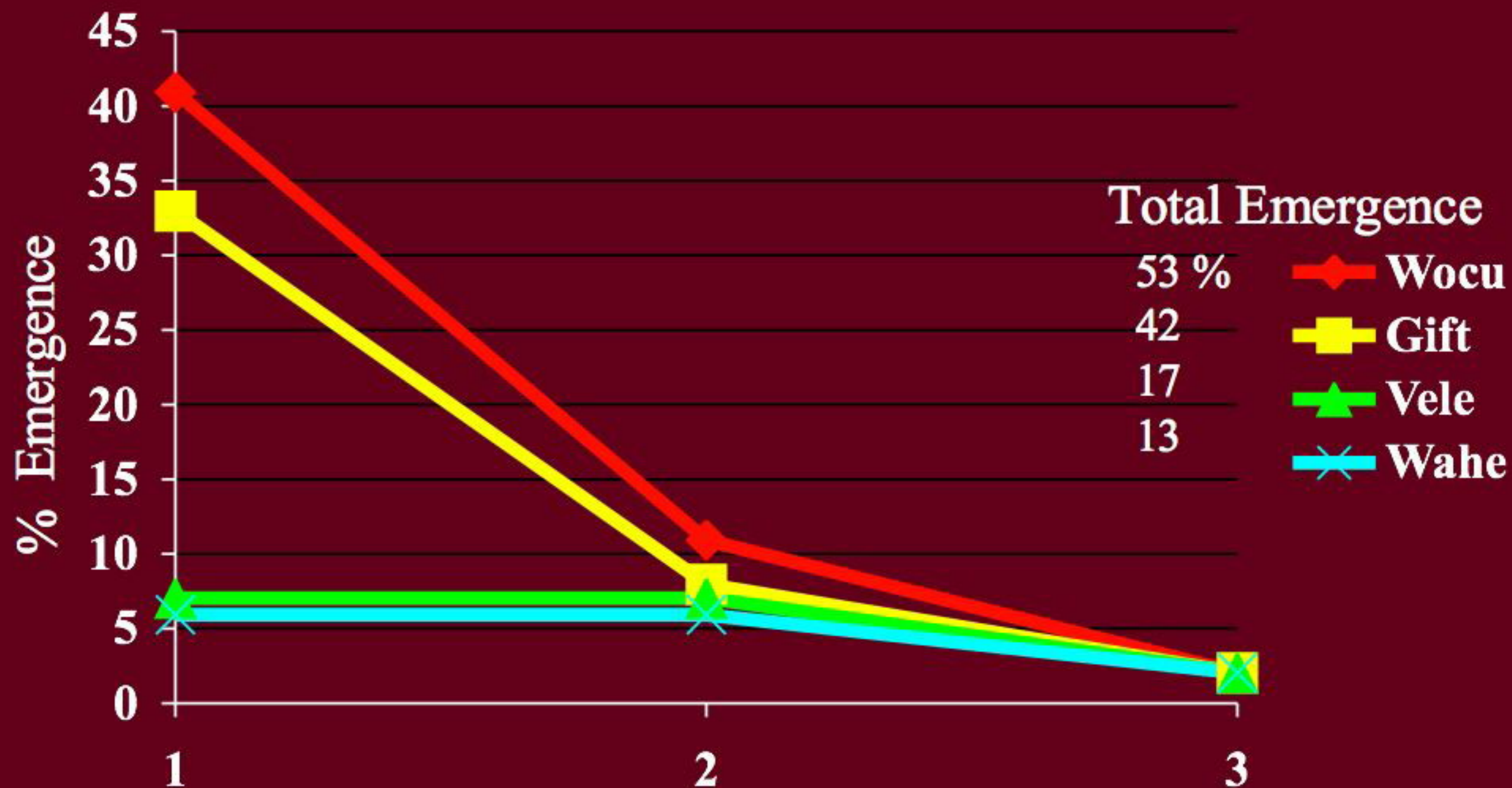
Photo: Guy Eisner.

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

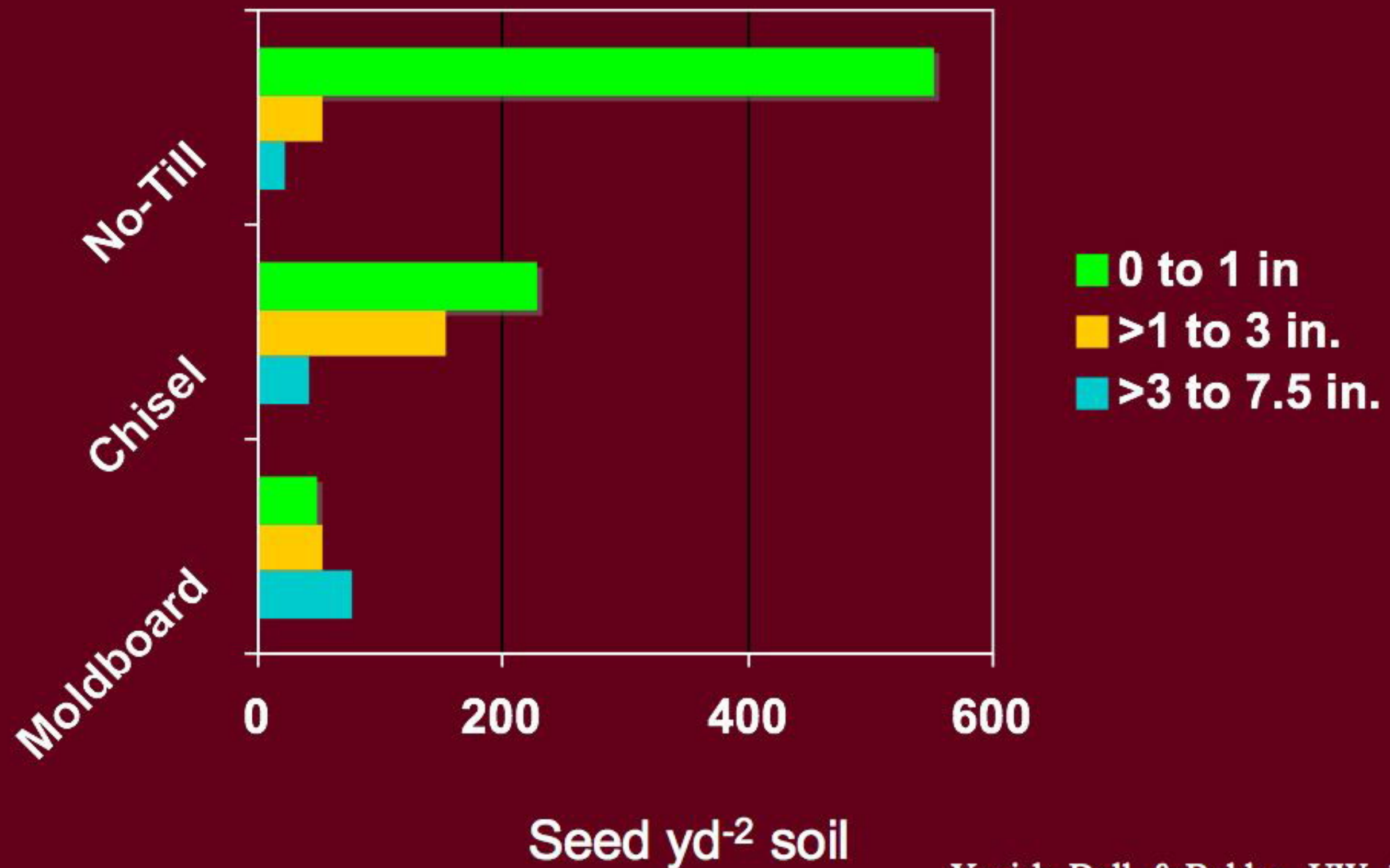
New York Times, June 12, 2005.

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.

Annual Weed Seedling Emergence Years After Seed Rain

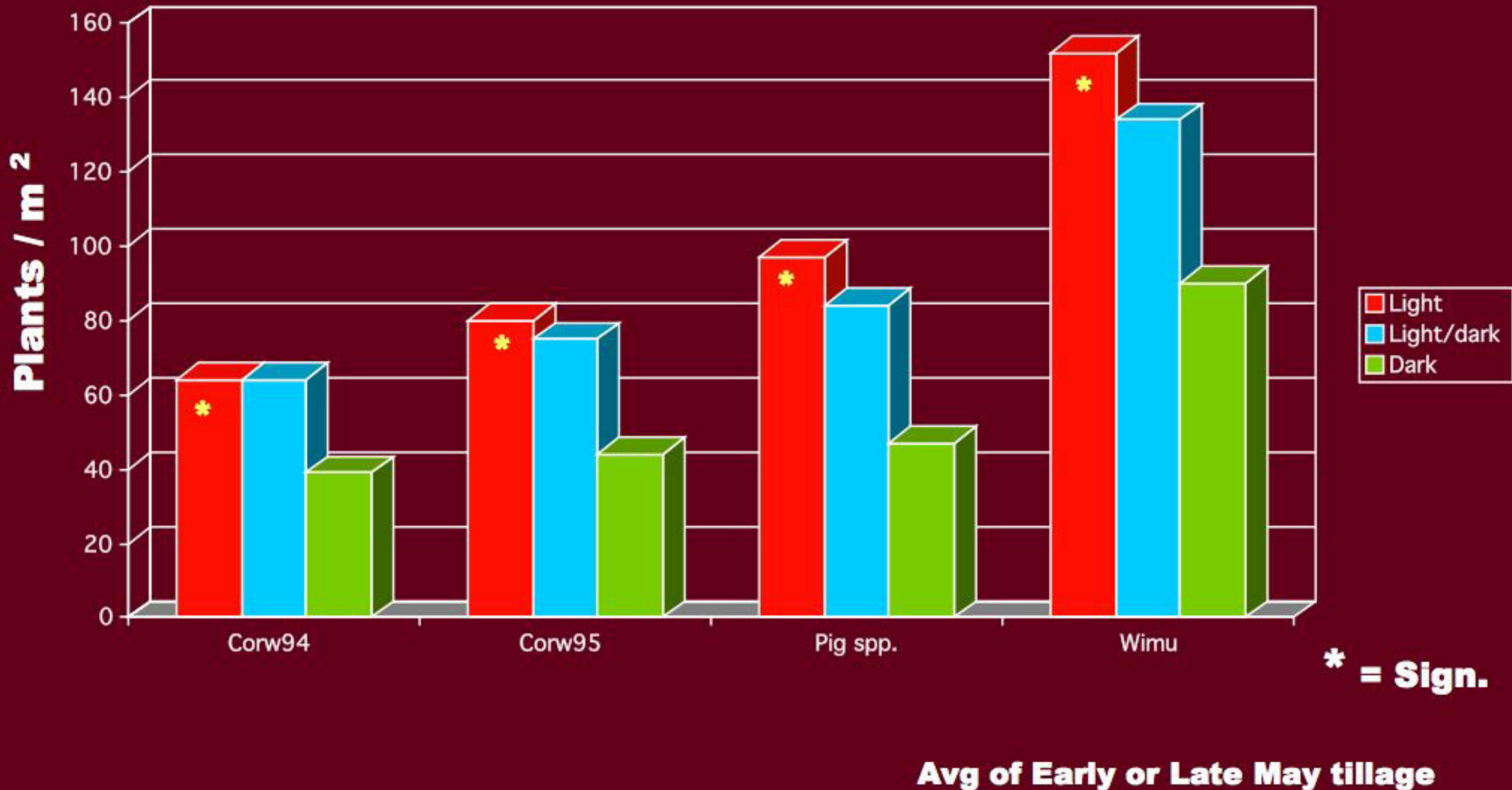


Influence of Tillage on Weed Seed Distribution in the Soil Profile



Light Effects on Annual Weed Emergence

Buhler Weed Sci
11:496-501. 1997



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**



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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**

Historically, Species Shift

- **Burning**
 - Tall grass prairies
- **Tilling the prairies**
 - Field bindweed
- **2,4-D and N fert**
 - Bdlfs to grasses
 - Triazine, acetanilides grass control
- **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**
- **Roundup?**



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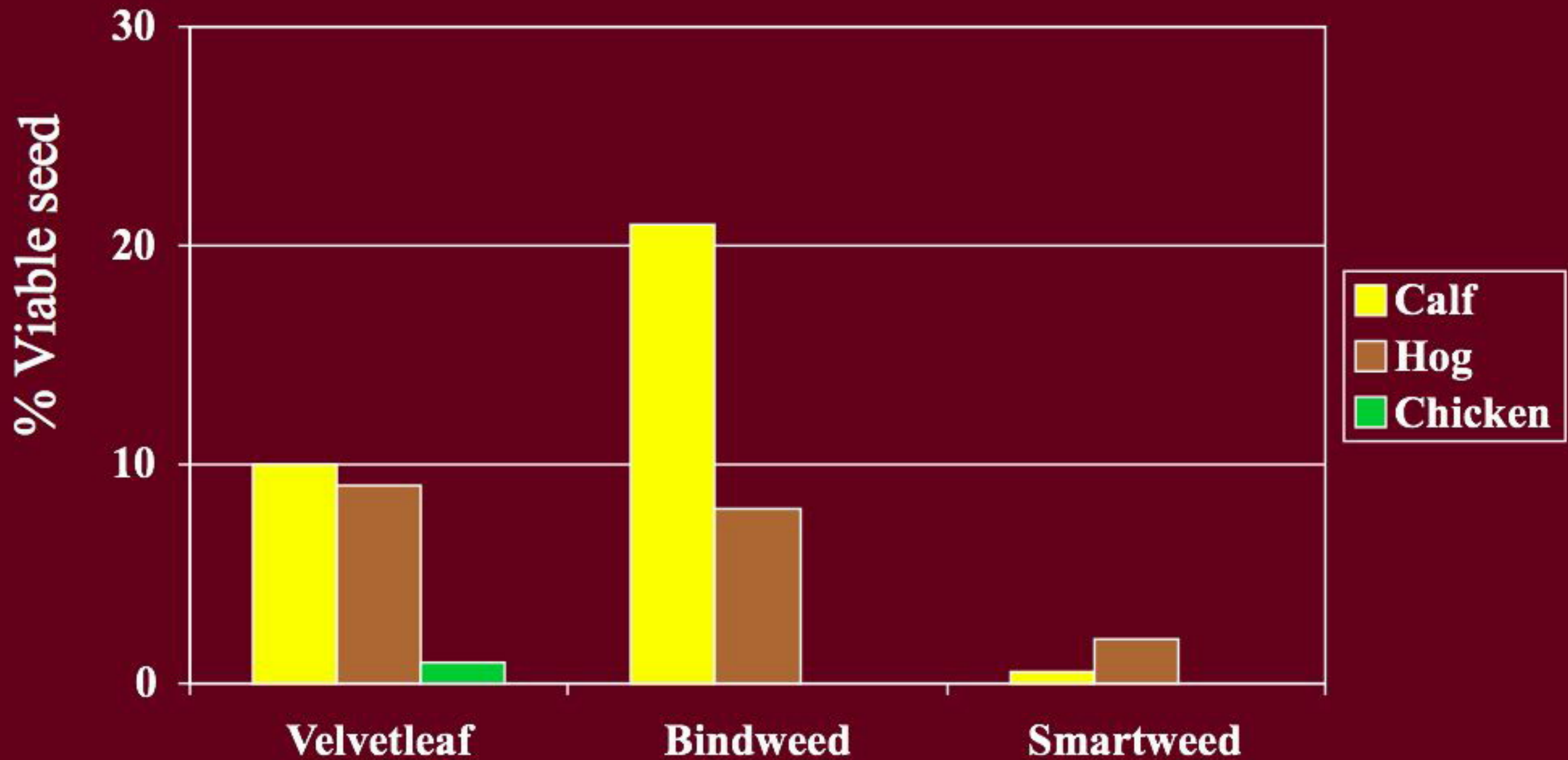
Can Silage and Manure Facilitate in the Spread of Weed Seeds?

- **Source is important:**
 - **Some weed seeds come through feed and pass through the animal**
 - **Some weed seeds bypass the animal via the bedding**

Effect of Animal Digestive Tract on Weed Seed Viability

- Results:
 - Soft seed coats had greater mortality than hard seed coats
- Of 1000 seeds fed to each animal group:
 - Calves passed 96 viable seeds
 - Hogs and horses passed 88 viable seeds
 - Sheep passed 64 viable seeds
 - Chickens passed 12 viable seeds

Digestion Effects on Weed Seeds



Adapted from Harman and Keim, 1934.



Effects of Manure Composting on Weed Seeds

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

Weed Seed in Digested Manure

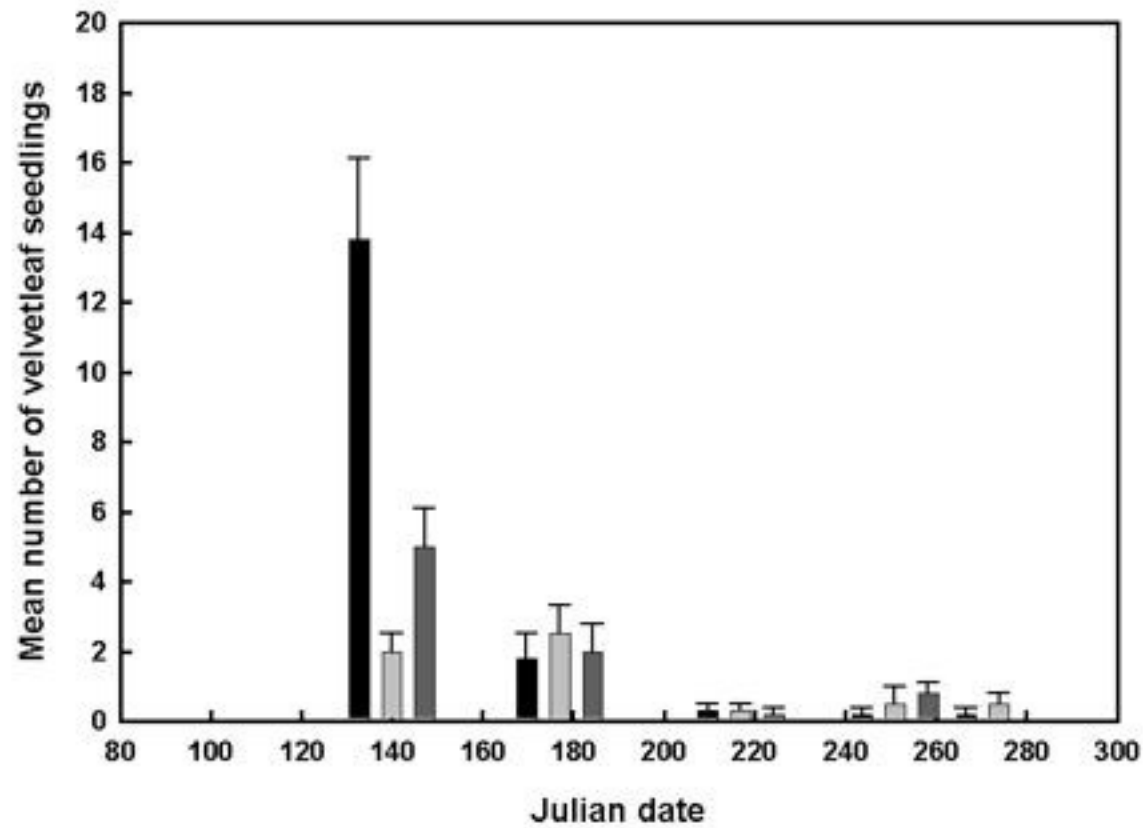
- **Anaerobic Digester – 20 days at 95 to 105 ° F**
- **Generally below the est. 140 ° F needed to kill seed in compost or manure piles**
- **Study of Manure Pile Temperatures:**
 - **Horse manure = 201° F**
 - **Cow manure = 168° F**
 - **Mixture = 188° F**

After 60 days all seeds died during the fermentation period in all manure piles



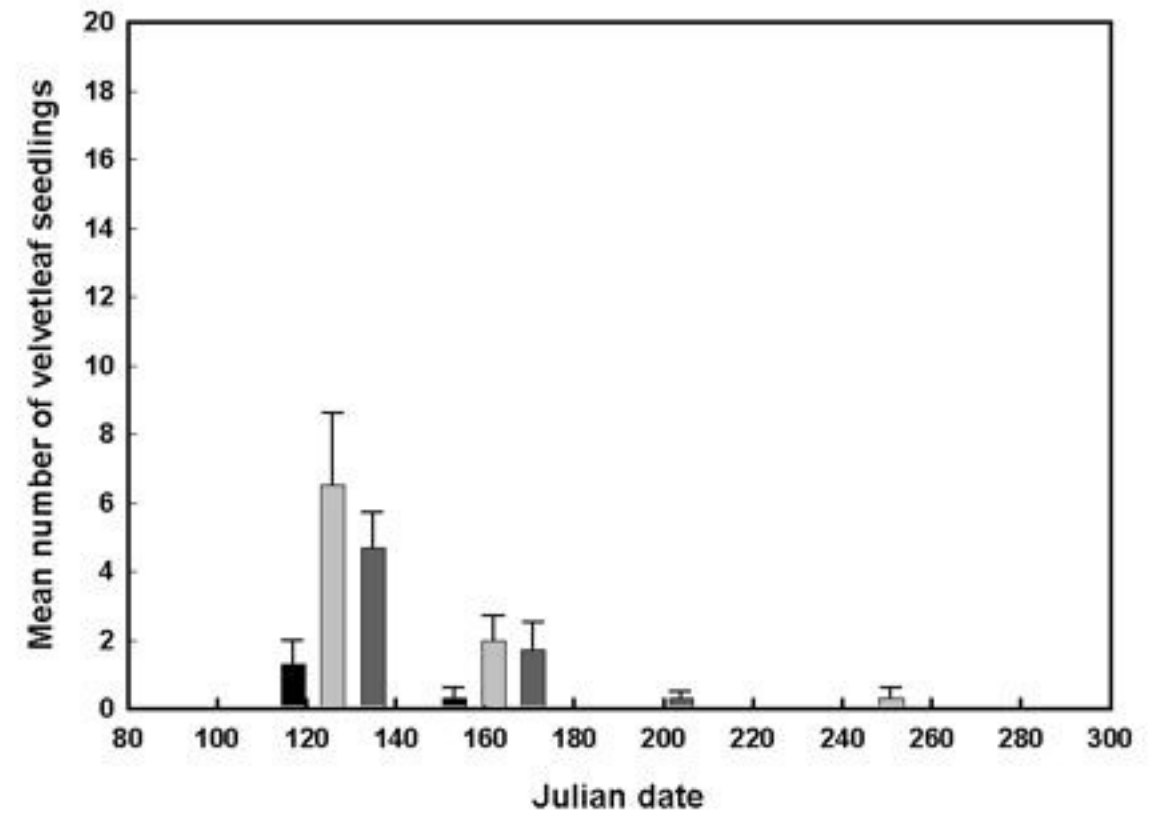
Weed Seed in Digested Manure

Figure 2a. Velvetleaf Seed Germination as Affected by Manure Storage Trial 2, First Season of Data Collection



■ Anaerobic digestion
■ Conventional manure storage
■ Inorganic fertilizer control

Figure 2b. Velvetleaf Seed Germination as Affected by Manure Treatment Trial 2, Second Season of Data Collection



■ Anaerobic digestion
■ Conventional manure storage
■ Inorganic fertilizer control



Weed Seed Survival in Anaerobic Digesters

By Elizabeth J. Katovich and Roger L. Becker
Agronomy and Plant Genetics, University of Minnesota

Jerry Doll, University of Wisconsin

MANURE IS AN IMPORTANT SOIL AMENDMENT PROVIDING valuable nutrients. However, many assume manure is always rich in weed seeds. The opposite is probably the case as most of our harvested forage is relatively free of weed seeds. Exceptions obviously exist. There is no simple method to extract weed seeds from feed or manure and to then test them for viability. So the best advice is to understand current knowledge about weed seeds in manure and how they may impact your operation. Key factors that determine the potential for weed seed problems from livestock systems are feed sources, type of animals, and type of feed and manure handling systems.

Feed Sources

Weed seeds enter livestock systems from forages, grain, and palletized feed products. Cash *et al.* (1998) estimated that for palletized products, less than 1% of weed seed survive feed grinding and palletizing. Though small in number, feed pellets can be a source of introduction of new weed species to a farm, and if one considers the volume of palletized feed fed, can be a significant source of weed seed. The biggest contribution of weed seed can come from contaminated hay and grain, however. A portion of weed seed present in feed can remain viable after passing through an animal's digestive tract. Weed seed present in bedding or in spilt-feed bypasses the animal directly entering the manure stream. Both of these weed seed sources may result in manure containing viable weed seeds. A study conducted in New York State (Mt. Pleasant and Schlather 1994) showed that farms with low amounts of weed seed in dairy manure used feed with low numbers of weed seeds. Farms with high manure weed seed counts either harvested feed from weedy fields or imported feed containing weed seeds. A California study (Cudney *et al.* 1992) showed that dairy manure from producing cows had fewer weed seeds than manure from dry cows,

presumably because the dry cows received lower quality (weedier) feed.

Type of Animals, Ensiling, Digestion, and Manure Handling

The animal source of manure can be important. Two studies in Nebraska characterized the effects of the digestive tract and manure on weed seeds (Harmon and Keim 1934). Weed seeds were fed to calves, horses, sheep, hogs, or chickens. Nearly 25% of the seeds fed to hogs and cattle were recovered in the manure, while only 10 to 12% were recovered from horses and sheep. Chickens were the most effective in destroying weed seeds with only 2% of the velvetleaf seeds fed recovered, while none of the bindweed, sweet clover, smooth dock, smartweed, wild rose and pepperweed seeds fed were recovered.

Of the seeds recovered from calves, horses, sheep or hogs, an average of 25% germinated. Although few in number, 62% of the velvetleaf seeds that survived the trip through a chicken germinated, suggesting that the gizzard may have actually scarified the seed and stimulated germination. Combining seed recovered and germination of weed seeds fed, sheep, horses, pigs, and calves passed 6, 9, 9, and 10% viable seeds, respectively, while poultry passed only 1%



For more information, please contact:

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Knowledge for a changing world

UNIVERSITY OF MINNESOTA
Extension
SERVICE

Online Bulleting on Weed Seeds in Livestock Systems

<http://appliedweeds.coafes.umn.edu/>

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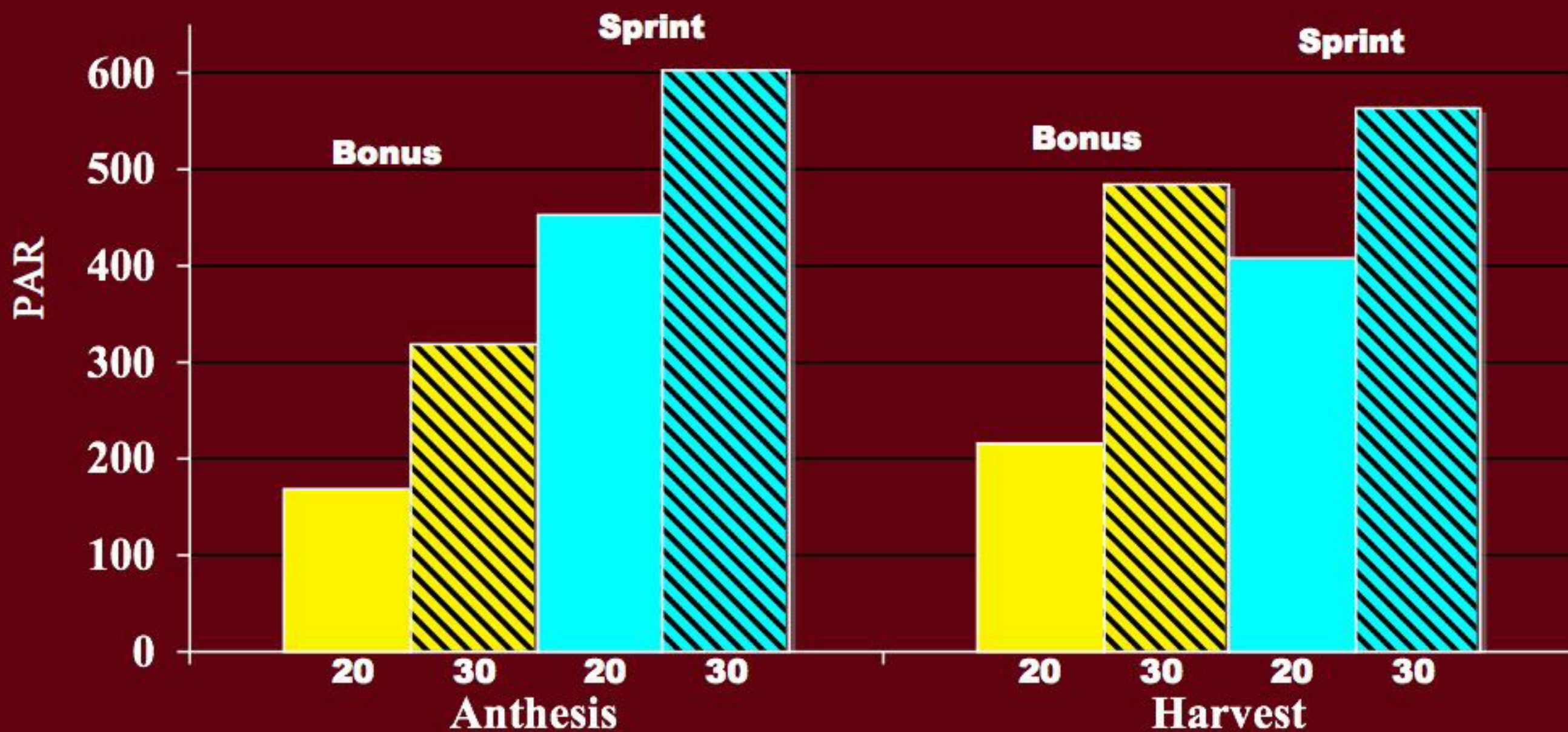
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Bisikwa et al. Sweet Corn Canopy Architecture Study



Light Utilization by Sweet Corn Variety and Row Spacing - Weed Free Plots. 1999.

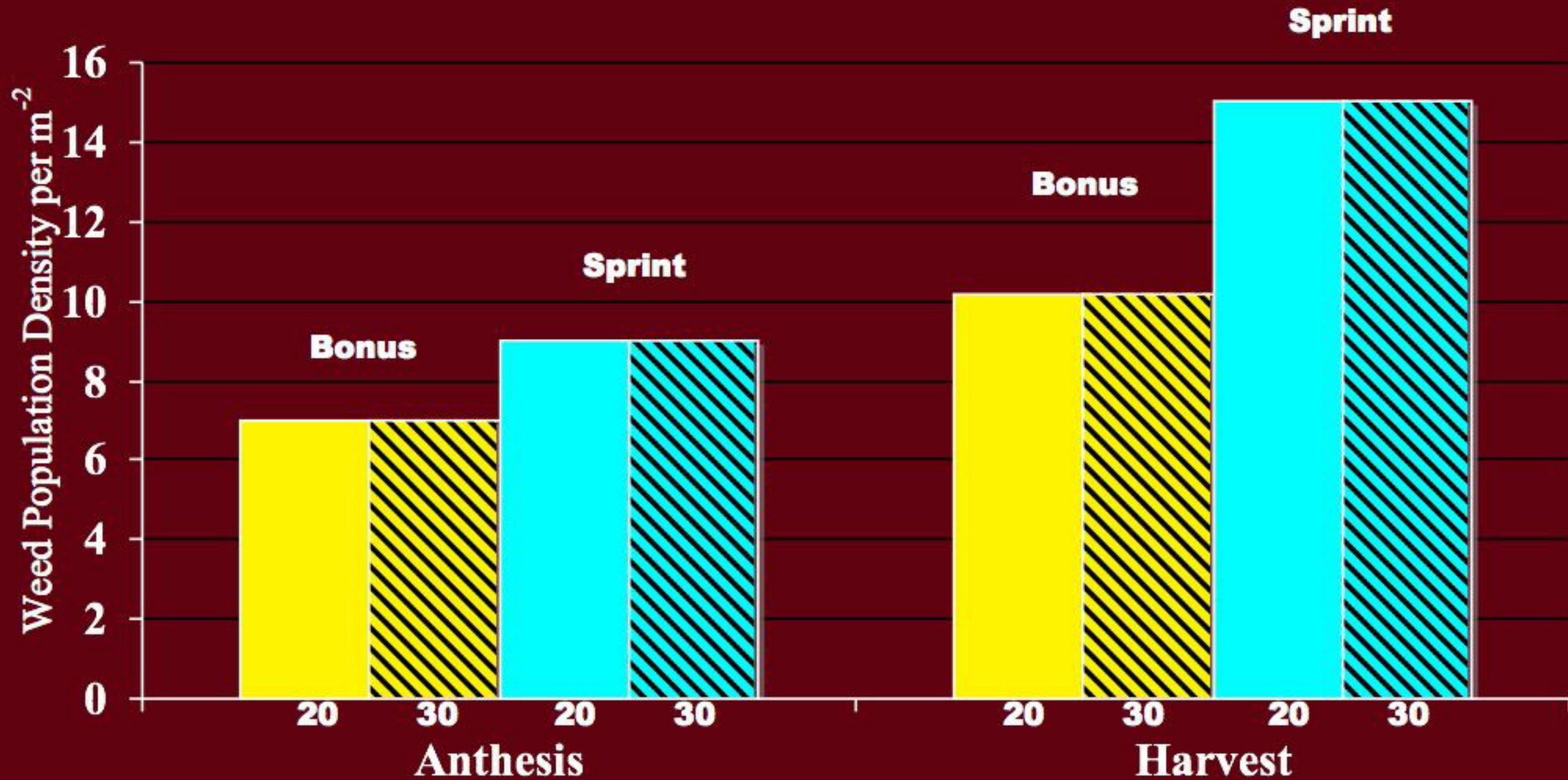


PAR = Photosynthetically Active Radiation (micro moles per m per second²)

23000 plants / A



Wild Proso Millet Weed Population Density by Sweet Corn Variety and Row Spacing



Jubilee
Low Competition
30% Light Trans, 145 in.



Sure Gold

Med. Competition, 'Short'
20% Light Trans, 117 in.



GH 1861

High Competition

11% Light Trans, 163 in.



Summary

- Differences were observed in canopy architecture among varieties
 - Did alter LAI and % Light Transmitted
- Previous Bonus and Sprint work indicated an available range of architectures to impact weeds
- Much more could be done with competitive crops to reduce the impact of weeds



North Central Soil Conservation
Research Laboratory
WeedCast 4.0
Bringing the World of Agriculture to You.

USDA

Weedcast
-Weed Control
Decision Aid-

About
WeedCast

Documentation
Programming
Guide

WeedCast Version 4

The WeedCast Software Suite is a decision aid that currently includes the WeedCast and WheatScout models. These models were created by the USDA ARS and the University of Wisconsin. The software is written in Java and is free to download and use. The source code is released under the GPL.

What Is WeedCast?

WeedCast is an easy to use software program that forecasts three types of weed growth: Emergence Potential, Emergence Timing, and Seedling Height. The forecasted data provides valuable information that can be used to aid in making weed management decisions. WeedCast is designed to function with a minimal amount of input.

- Select the weed or weeds of interest and the following site properties using list boxes: **Last Year's Crop, Tillage System, Soil Type, and Soil Water Content**
- Enter your local weather information using a simple spreadsheet editor.
- Work in progress: Download your weather data!
- Enter a date range and click view output to see your forecasts.

Resulting data is displayed in a spreadsheet form and may be graphed from within the program.

What Is WheatScout?

WheatScout is a decision aid that predicts the effects of a variety of herbicides on green foxtail and wild oat in wheat crops. It requires similar information to Weedcast, but also requires some scouting information.

Download

The two models are included in one software package. Version 2.1 may be downloaded from here:

Features

Open Source
(GPL License)
Easy to use, run the model with only basic information
Add new weeds or herbicides
Easily change model settings
Save simulation results and graphs for later use

Screenshots



[Weedcast Main Window](#)

WeedCast

<http://weedcast.net/>

Have we
made progress?

Destroy

**THE RUST-SPREADING
BARBERRY . . .**

Protect Small Grains



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Tune in next season for the continuing saga of.....

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