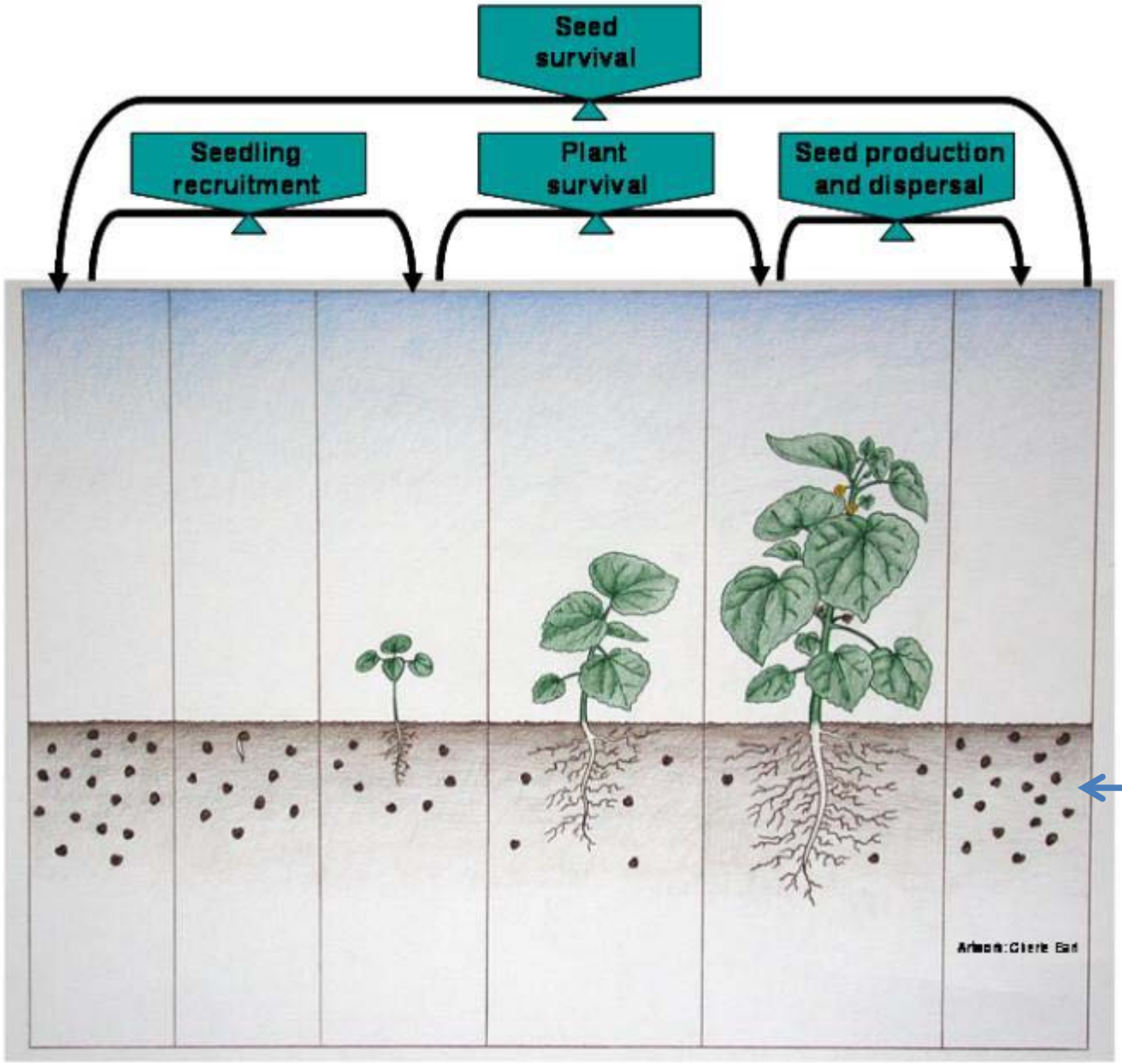
Strategies for managing the weed seedbank and encouraging weed seed predation

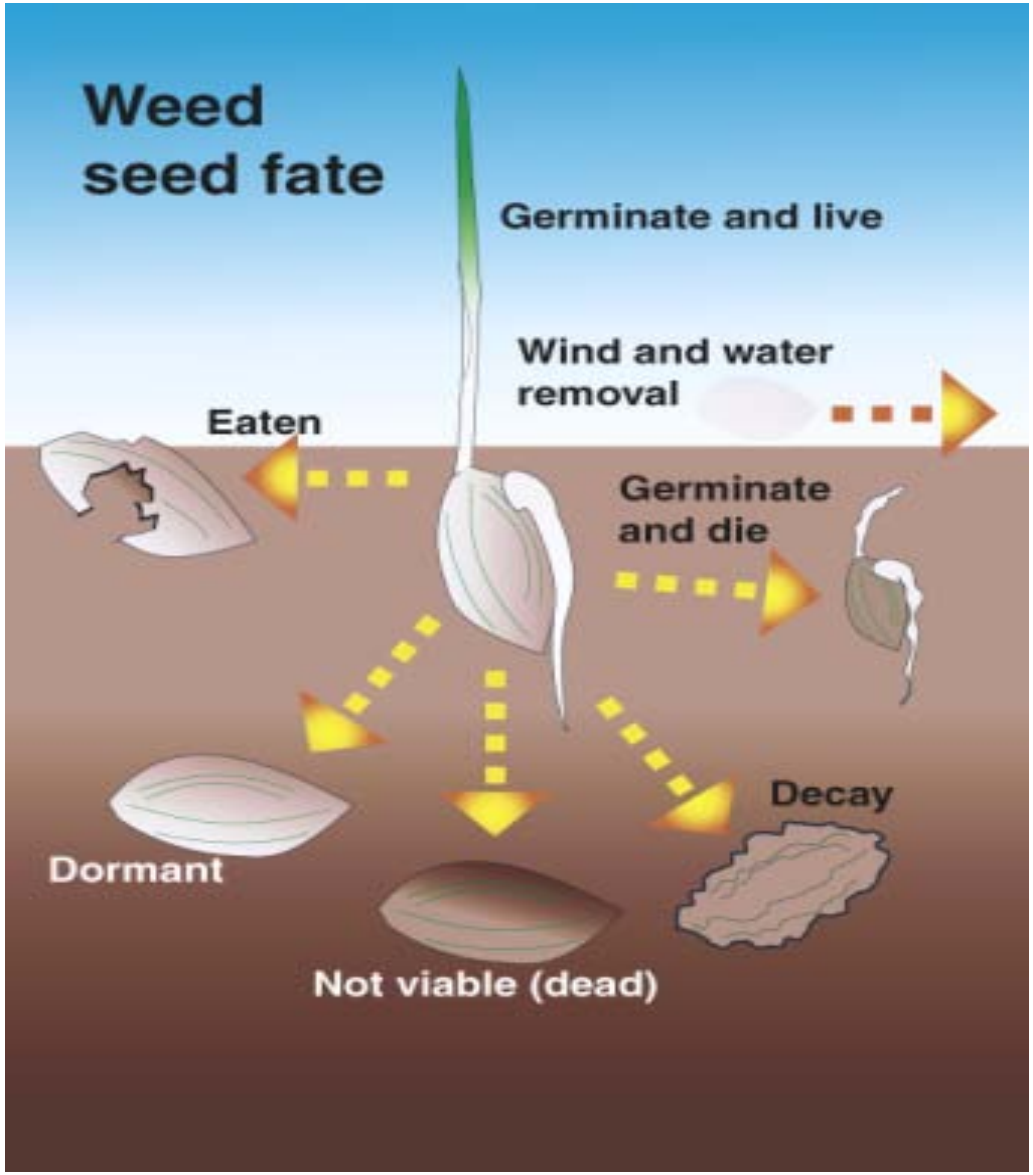
Adam Davis

USDA-ARS Global Change and Photosynthesis Research Unit

Urbana, IL



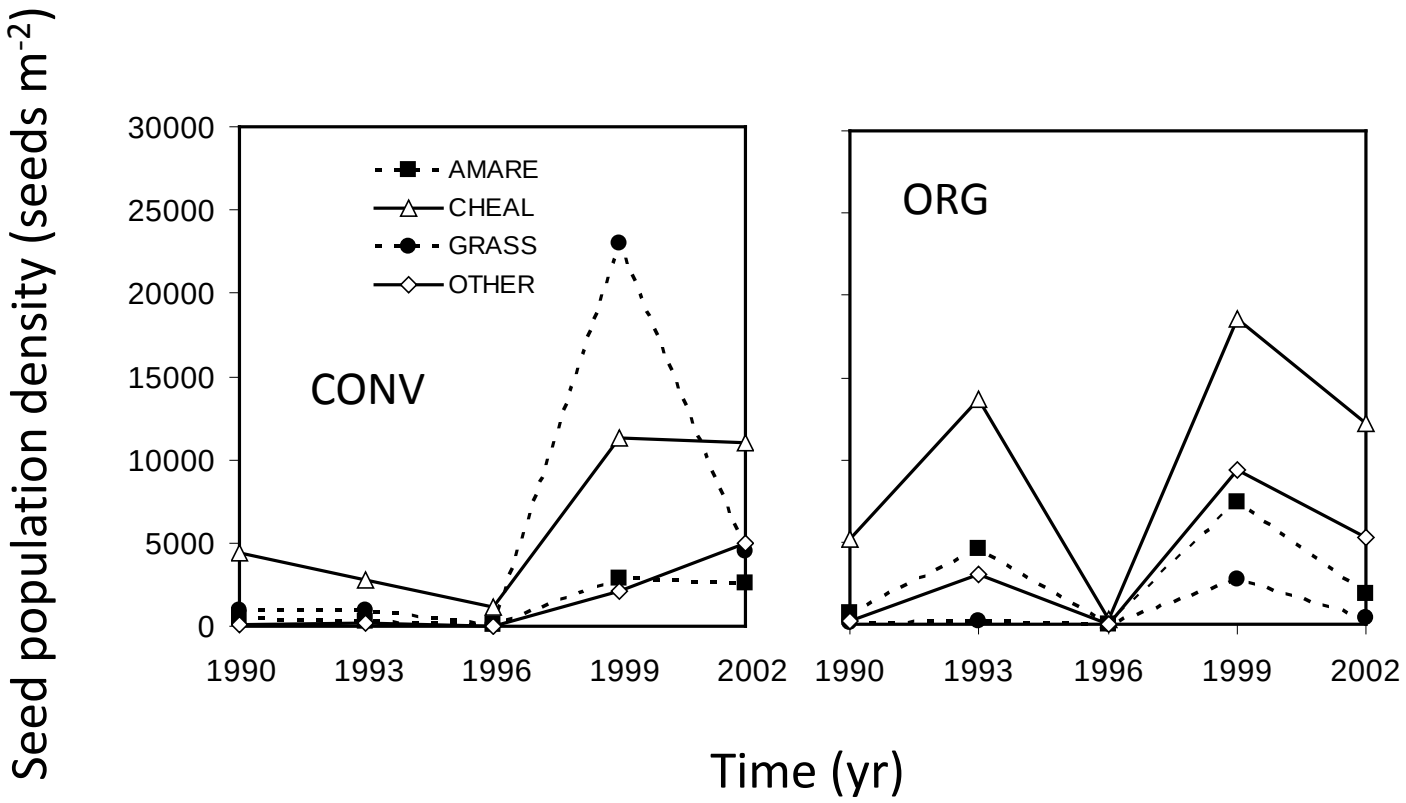
Artwork: Cherie Earle



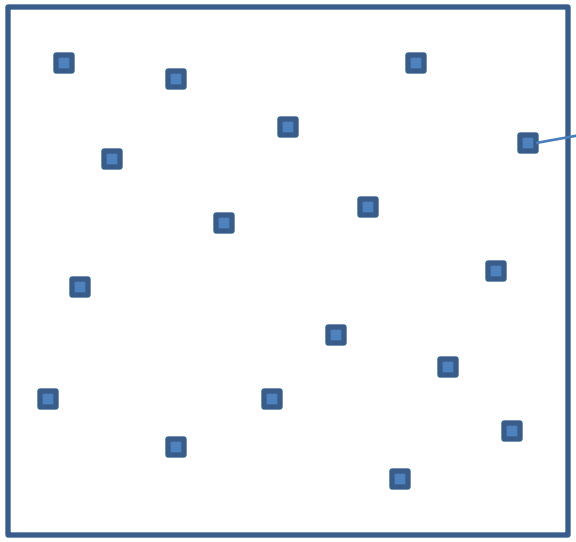
Artwork: Steve Deming

1. How prevalent is weed seed return?
2. Does it matter?
3. What can we do about it?

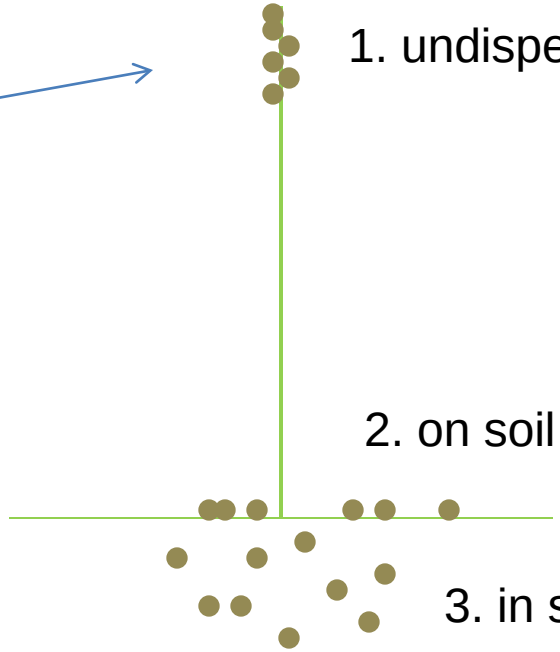

JAN 27 2005


Seed population density (seeds m-2)
30000
25000
20000
15000
10000
5000
0
AMARE
CHEAL
GRASS
OTHER
CONV
ORG
1990
1993
1996
1999
2002
Time (yr)

Survey: weed seeds at harvest time



16 fields (8 corn, 8 sb)
30 samples/field



1. undispersed, standing

2. on soil surface

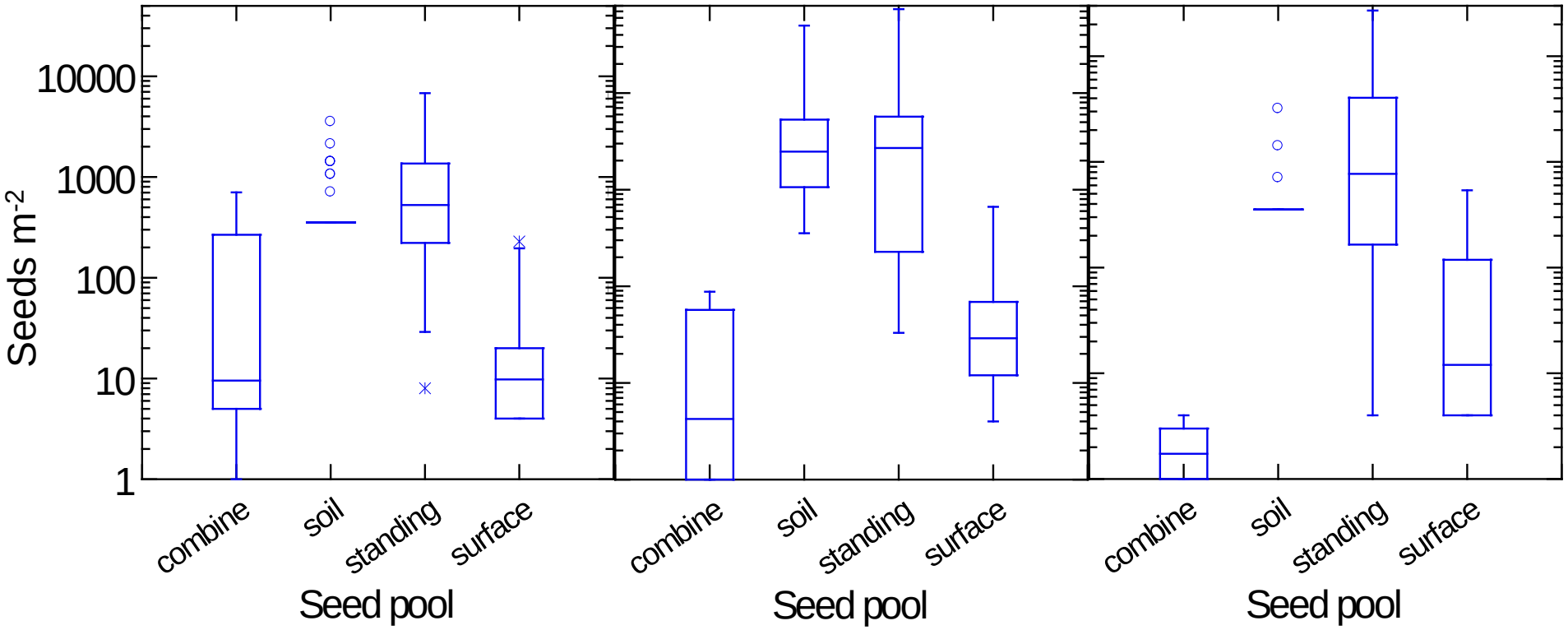
3. in soil seedbank

4. caught by combine

giant foxtail

redroot pigweed

velvetleaf



26 species total

Davis 2008

Weed seedbank is persistent

Years required for X % reduction in seed number

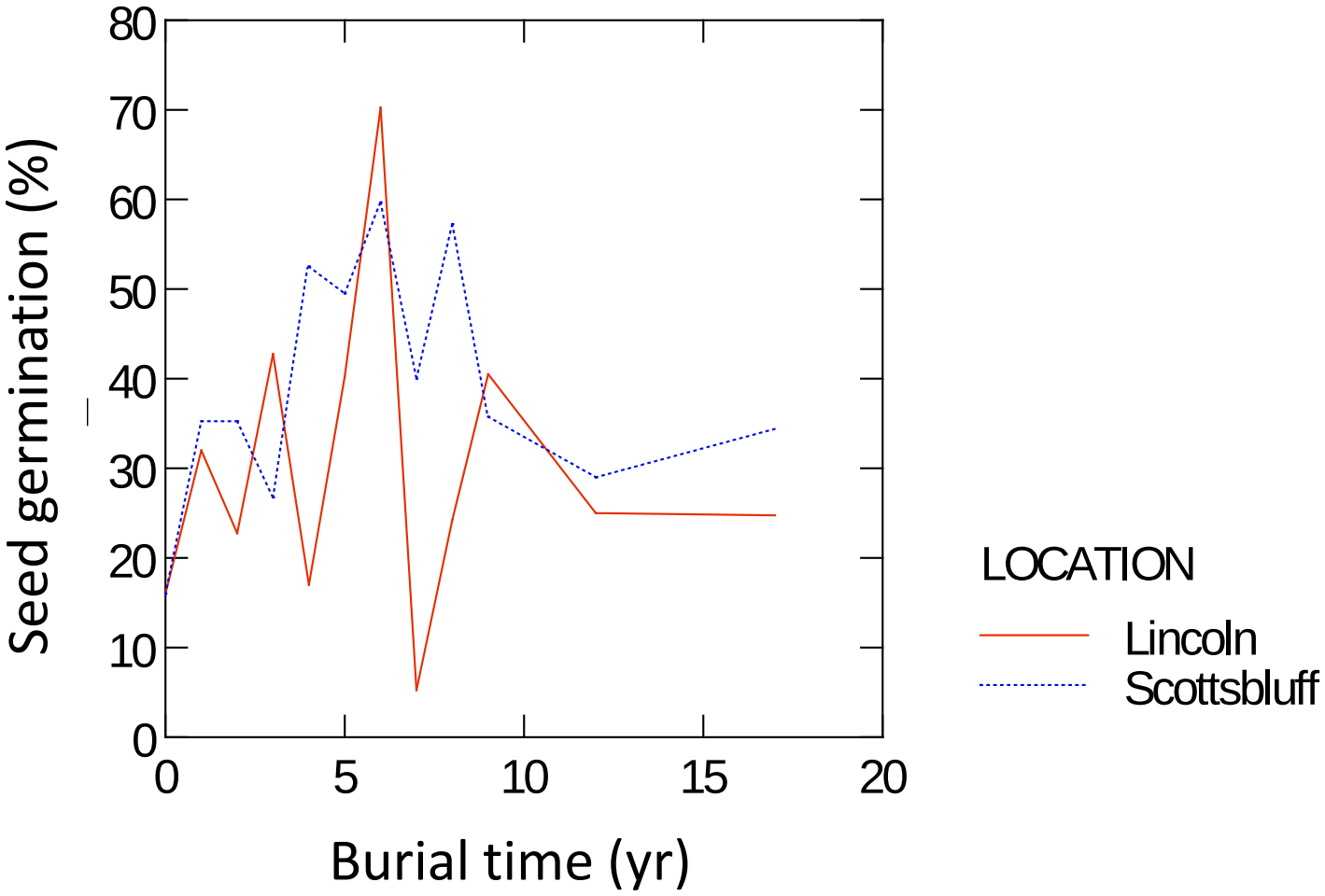
	50%
– Common lambsquarters	12
– Velvetleaf	8
– Common chickweed	3
– Smartweed	4
– Redroot pigweed	4
– Common ragweed	2.5
– Crabgrass, giant foxtail	< 1
– Kochia	< 1

Weed seedbank is persistent

Years required for X % reduction in seed number

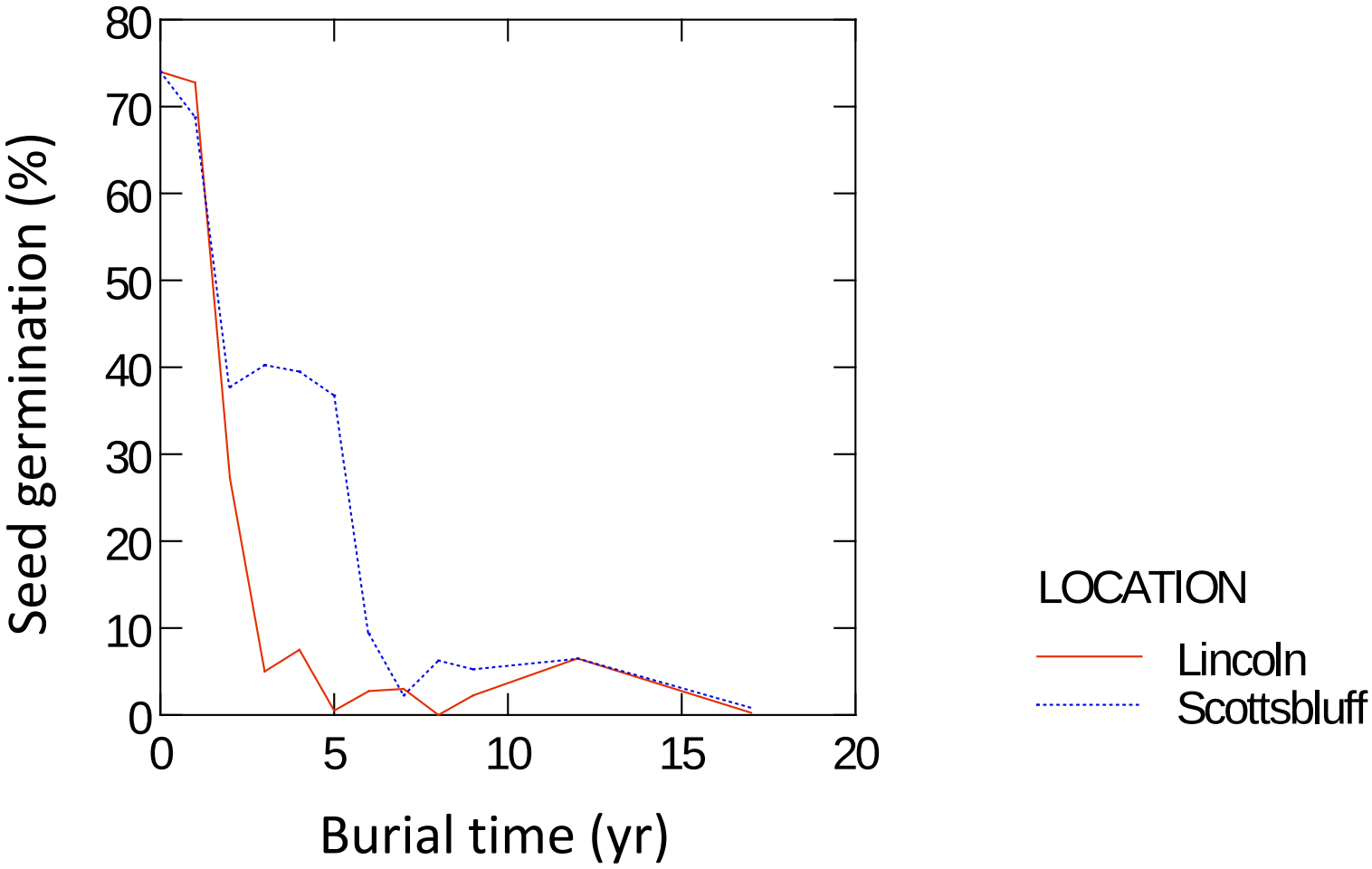
	50%	**99%**
– Common lambsquarters	12	78
– Velvetleaf	8	56
– Common chickweed	3	18
– Smartweed	4	30
– Redroot pigweed	4	26
– Common ragweed	2.5	10
– Crabgrass, giant foxtail	< 1	6
– Kochia	< 1	6

velvetleaf



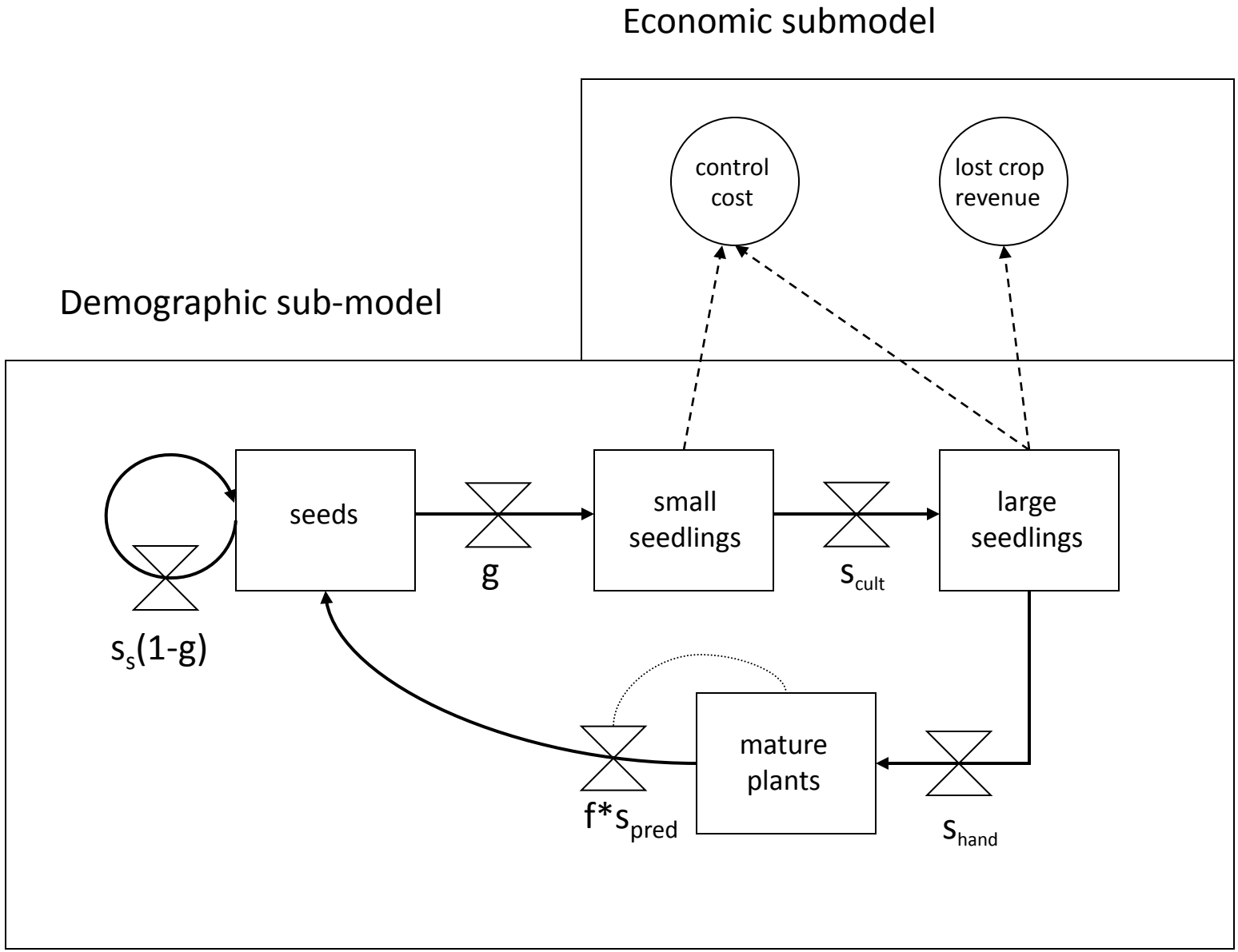
Burnside et al. 1996

redroot pigweed

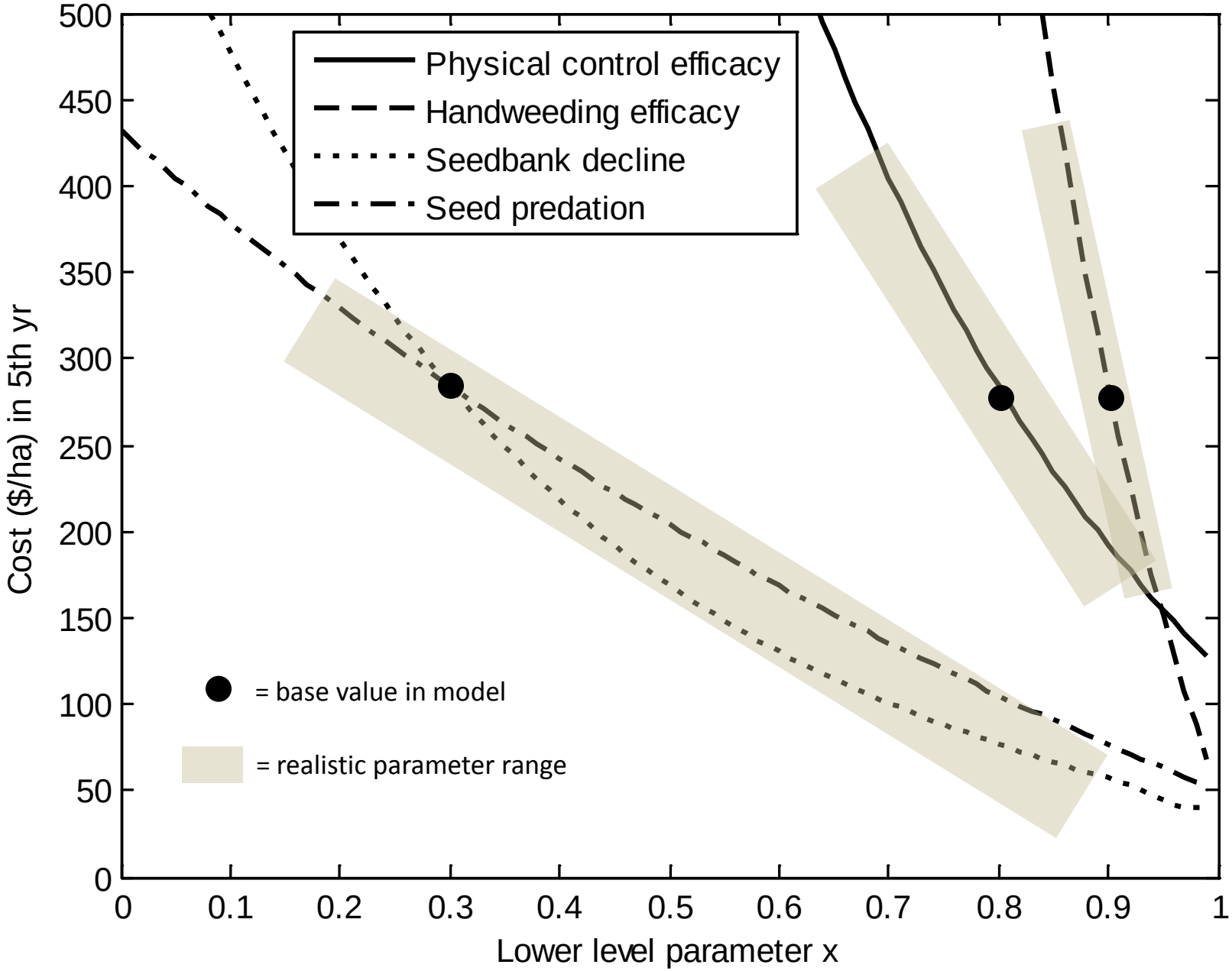


Burnside et al. 1996

Why should we manage the weed seedbank?



Liebman and Davis (2009)



Liebman and Davis (2009)

DIAS

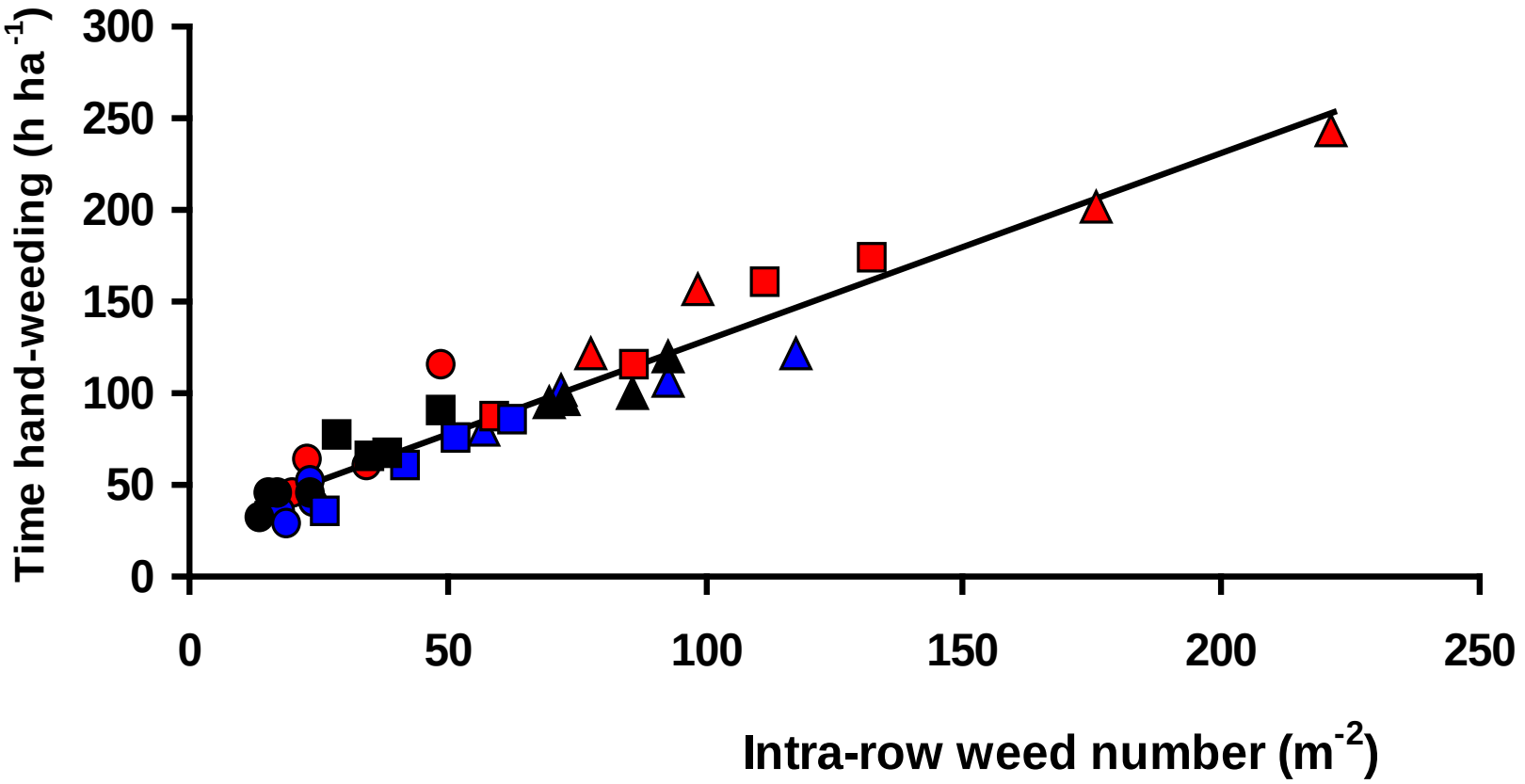
Hand weeding intra-row weeds:

200-500 hours per hectare in carrot and direct sown onion and leek

Melander and Rasmussen, 2001

Relationship between weed density and time consumption for hand weeding

DIAS



Melander and Rasmussen, 2001

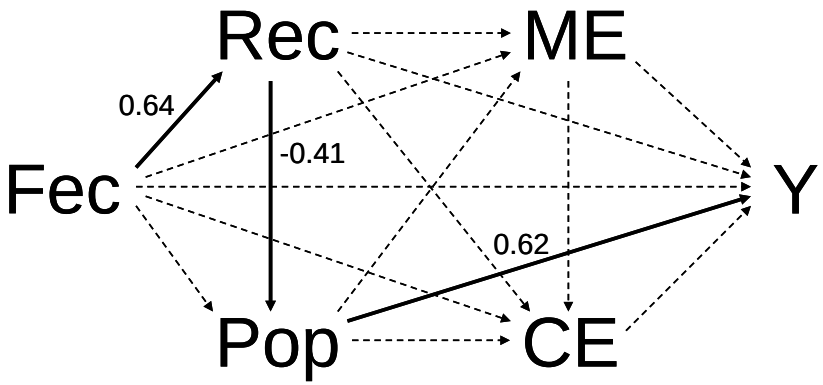
Do seed escapes matter?

Davis and Williams. 2007. Weed Sci. 55:502-507

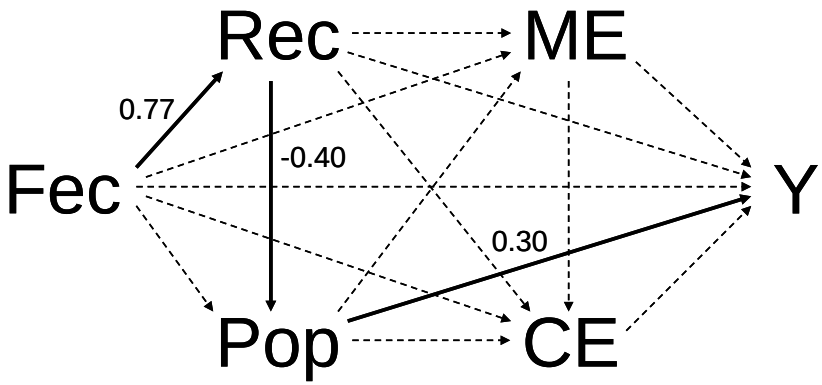
Yes.

Wild proso millet fecundity in sweet corn had effects on following snap bean crop.

2005

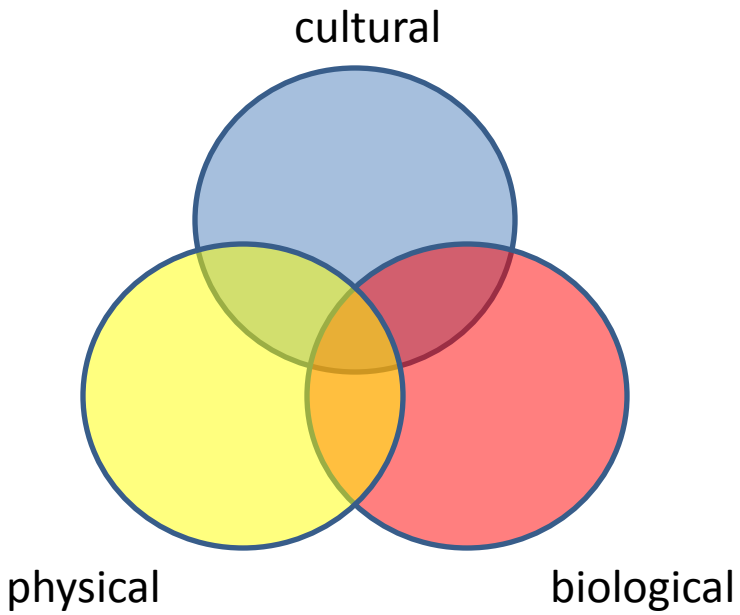


2006

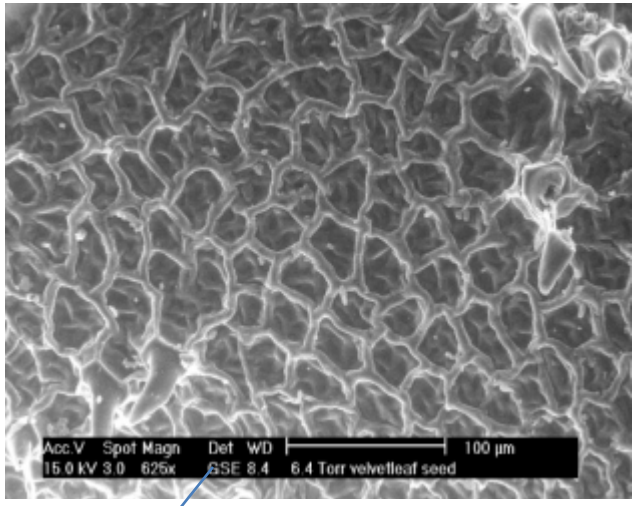


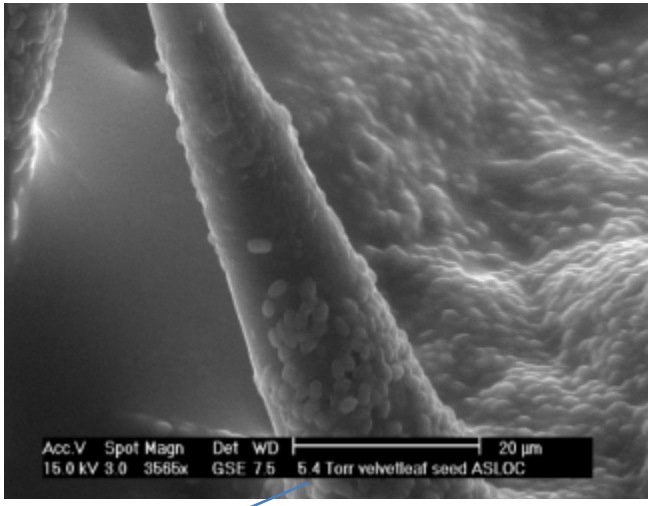
Davis and Williams. 2007. Weed Sci. 55:502-507

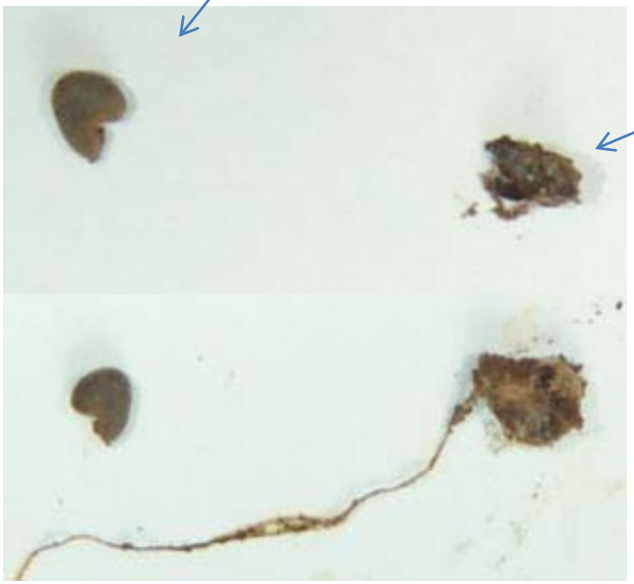
Ecological management of weed seedbanks



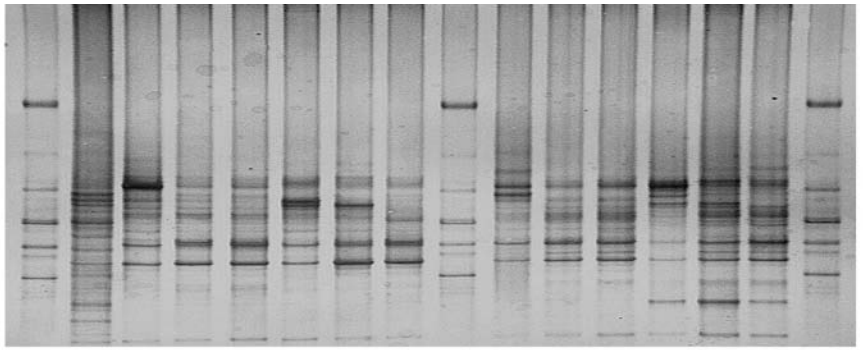
Biological: I. Seed survival in soil seedbank



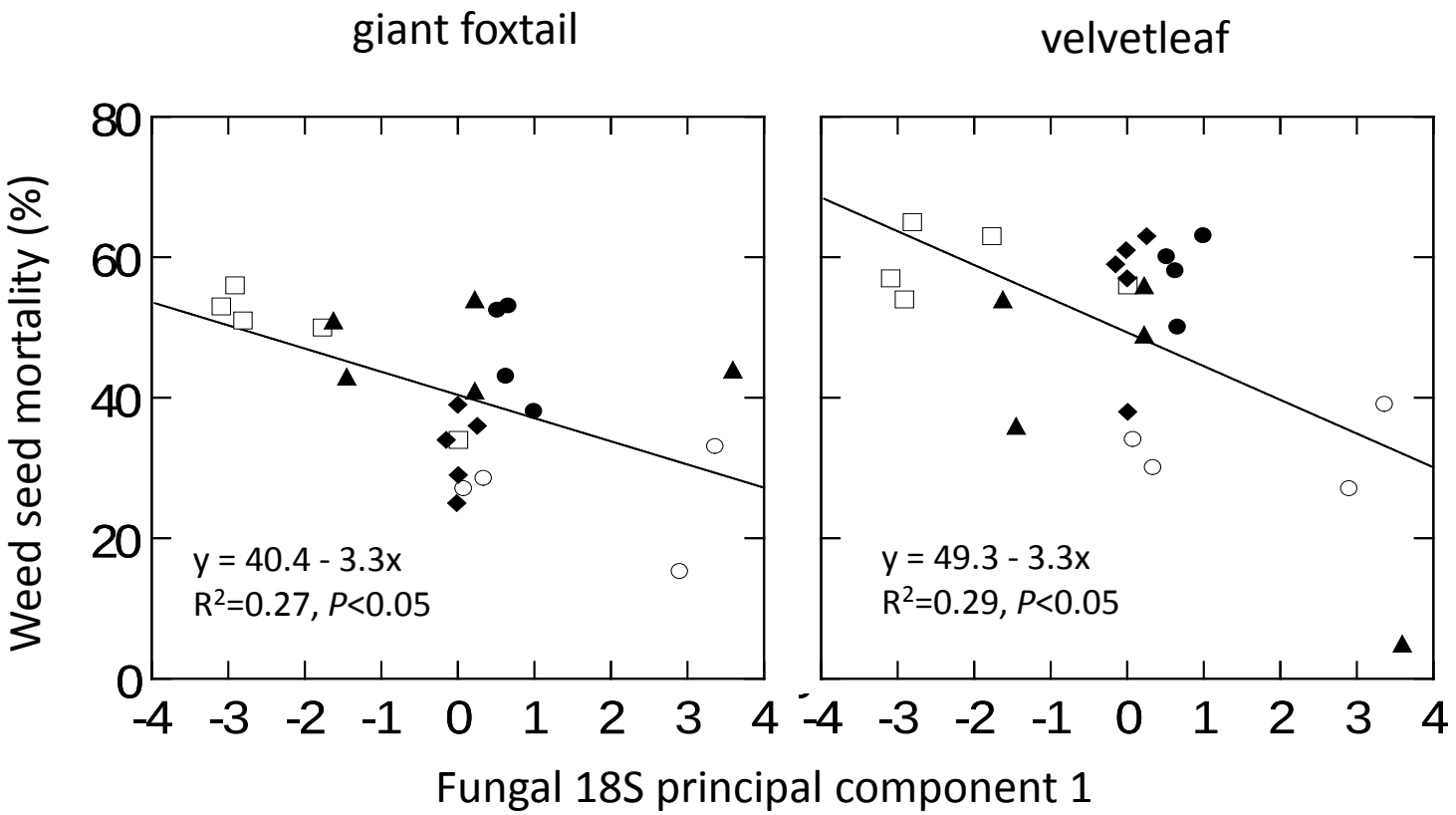




intact decayed



Chee-Sanford et al. (2006)



◆ organic 3-yr rotation

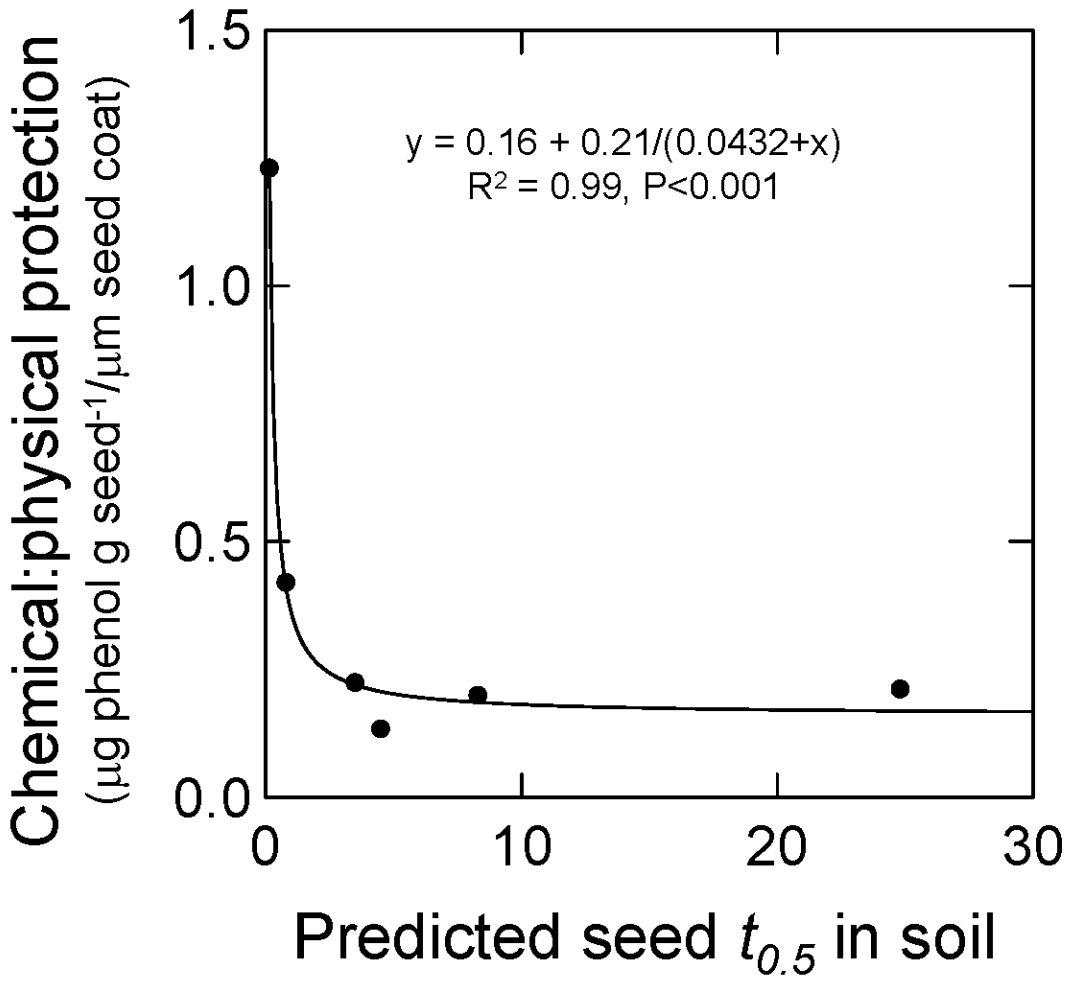
□ conventional 3-yr rotation

▲ old field

● conventional 4-yr rotation

○ reduced input 4-yr rotation

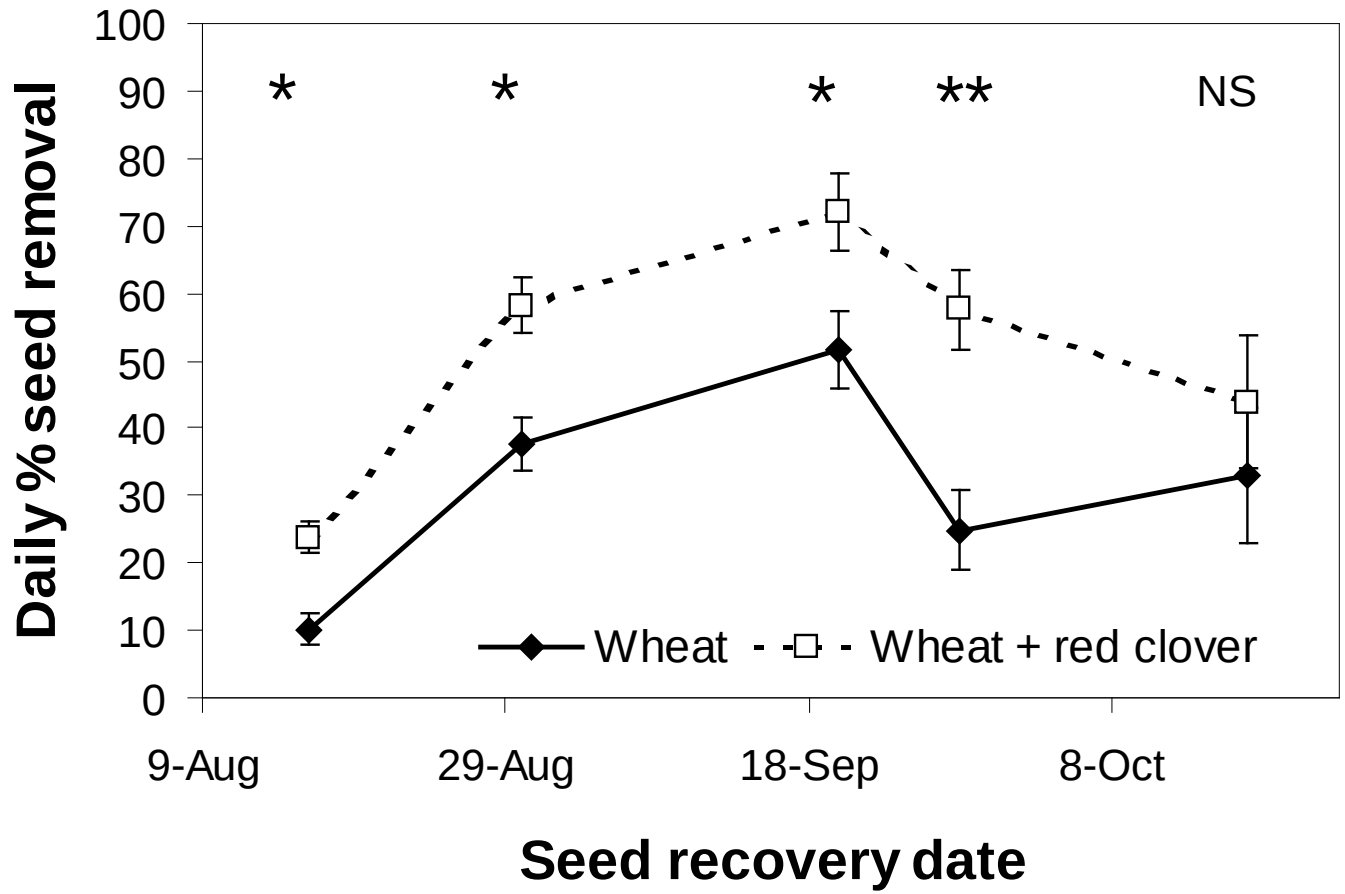
Davis et al. (2006)



Davis et al. 2008. Weed Sci. 56:676-684

Biological: II. Seed predation

Common predators of weed seeds…. We need *more* of these in our cropping systems!

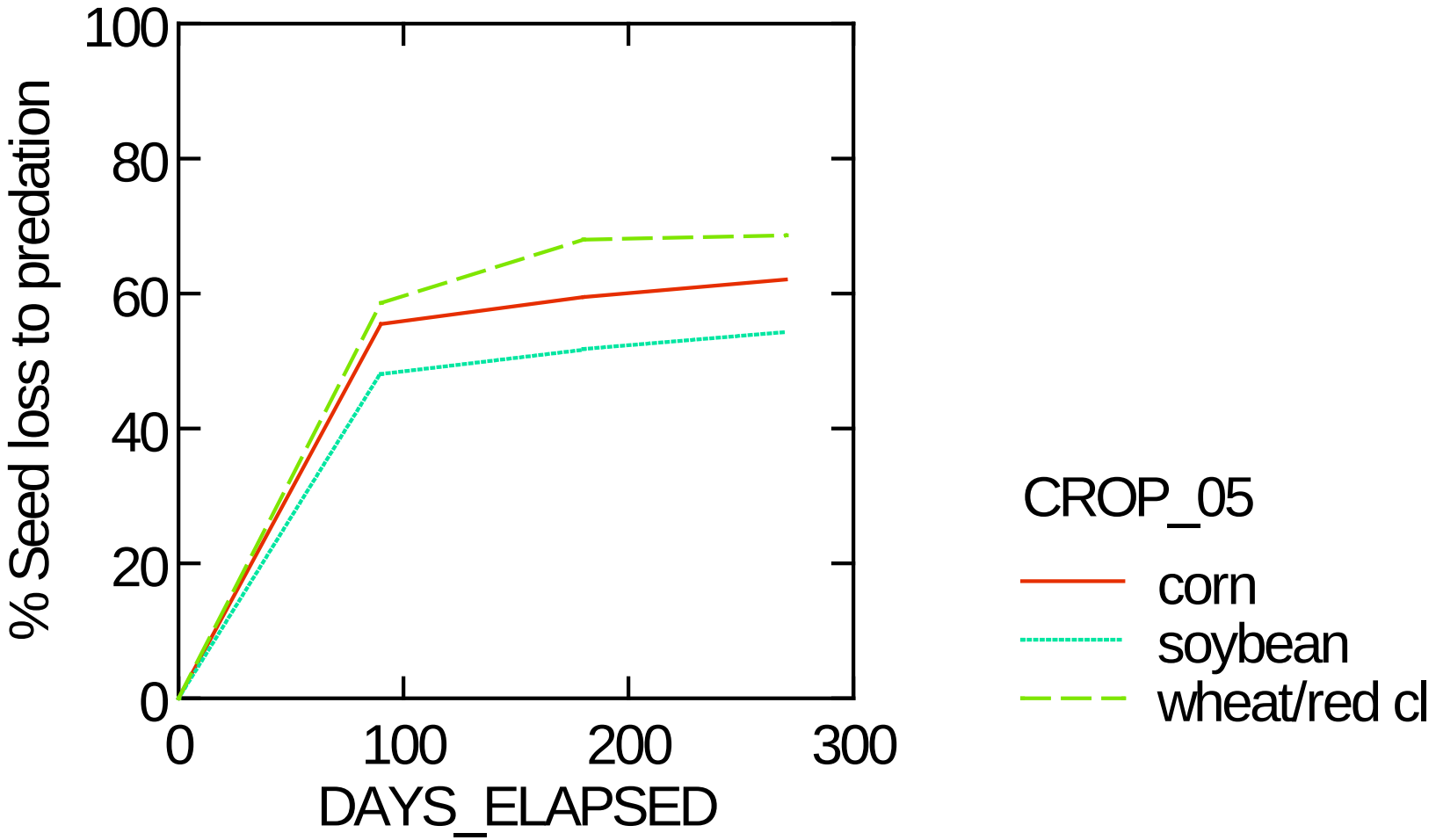


Davis et al. (2003)

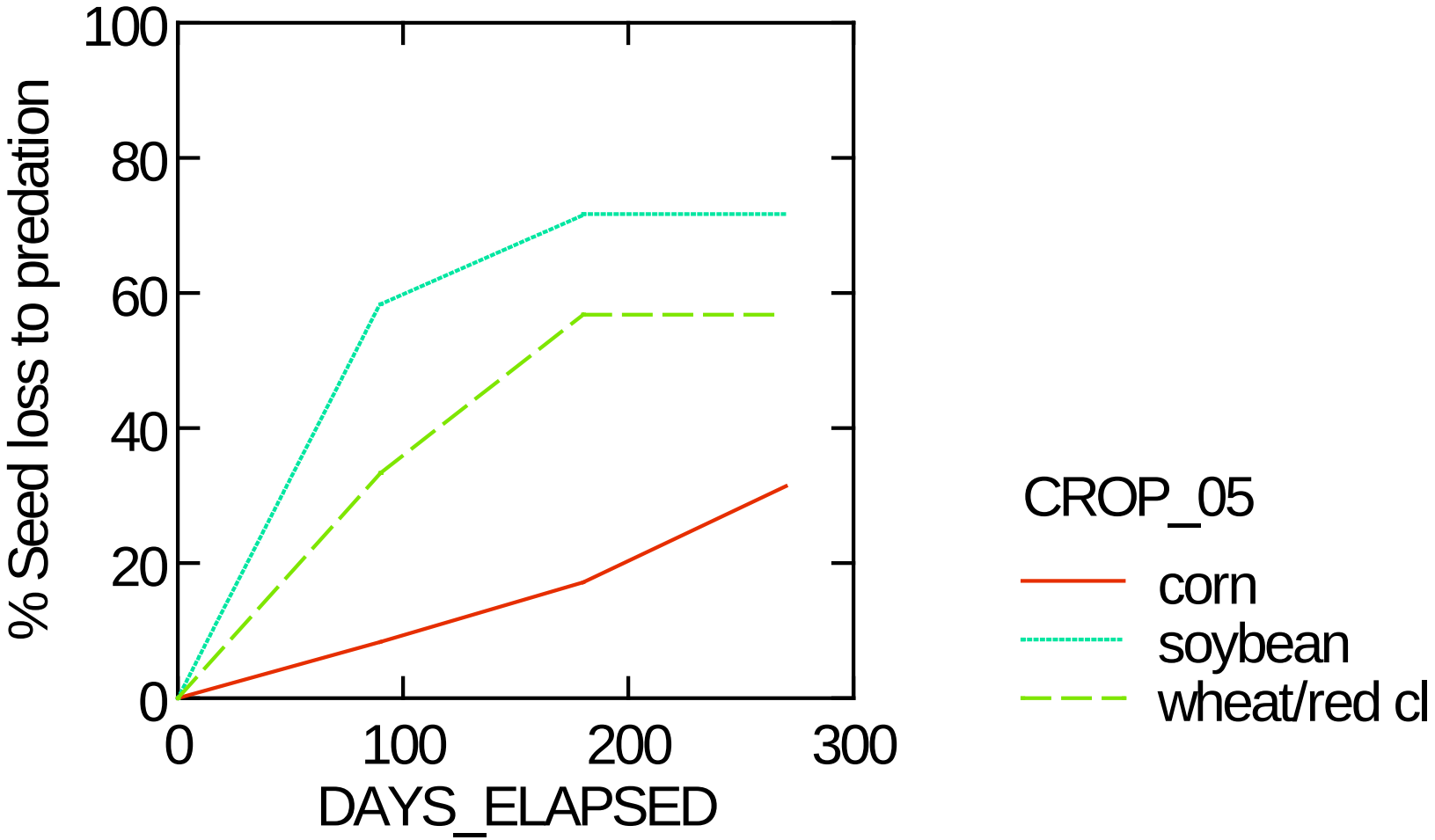
Annual rate of seed predation in field crops

Urbana, IL
2004-2008

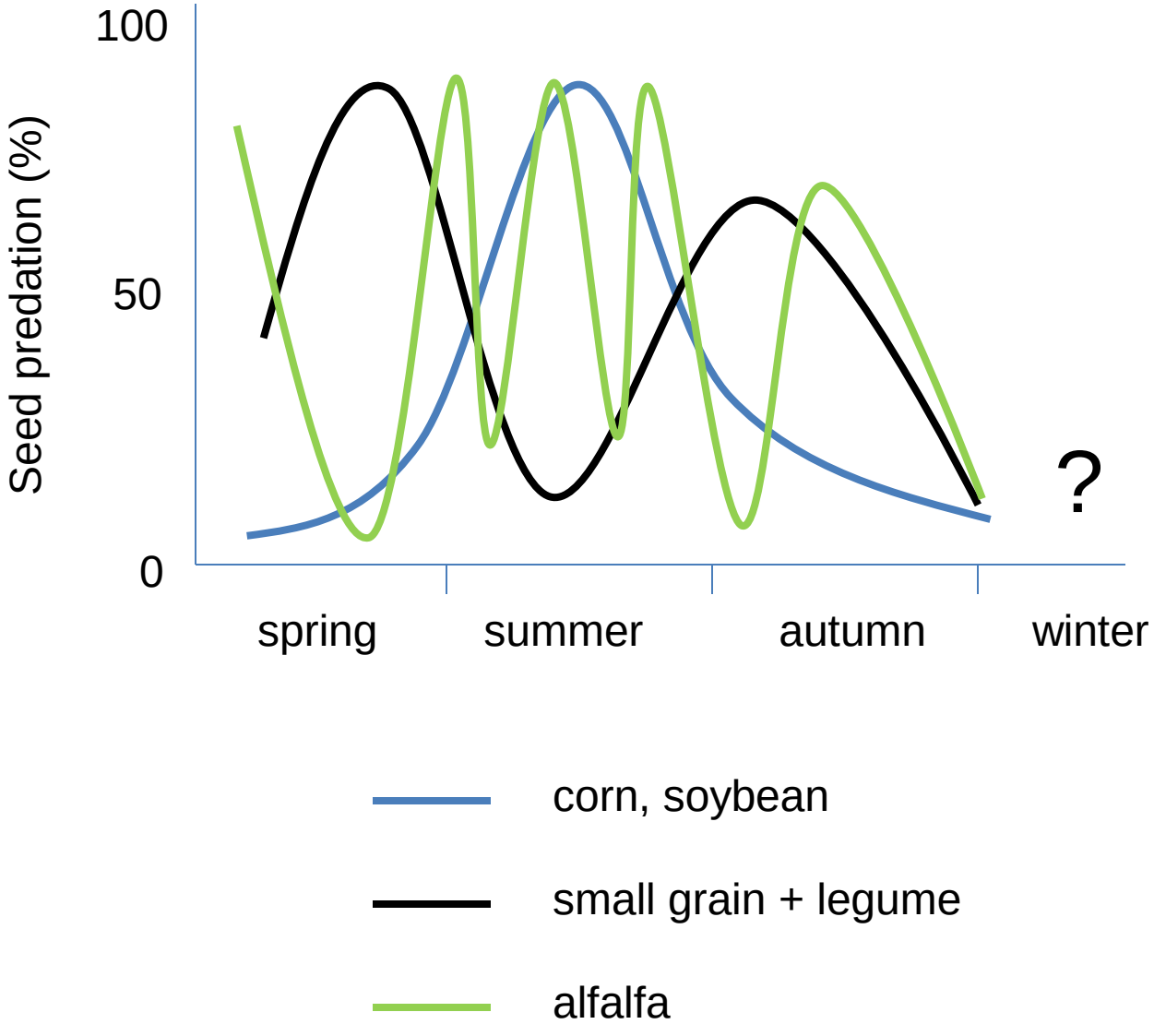
Weed seed predation over time (giant foxtail)



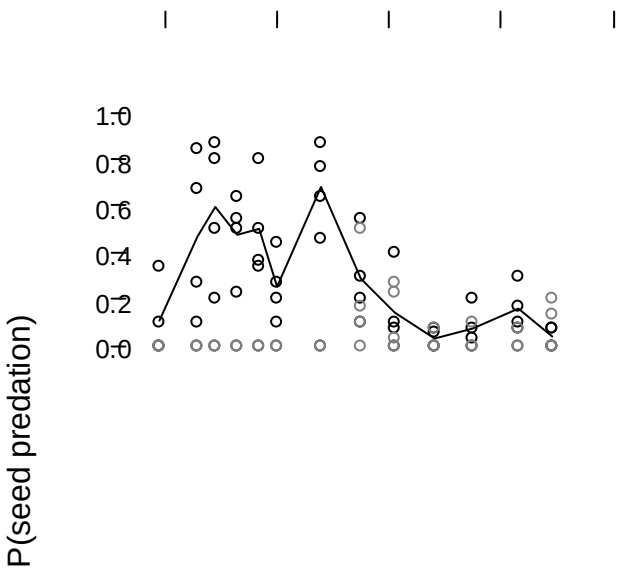
Weed seed predation over time
(giant ragweed)



Can we maintain high seed predation rates throughout year by diversifying crops?



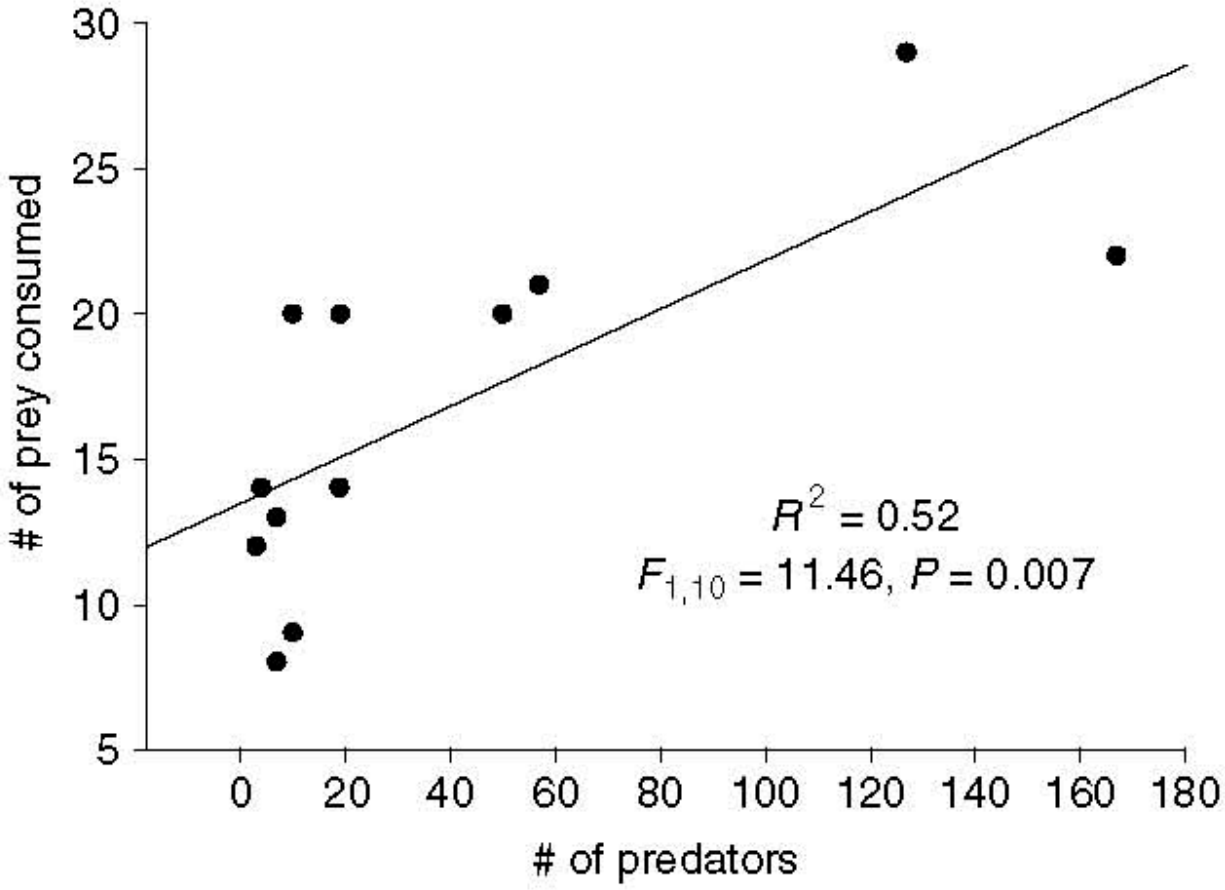
after Heggenstaller et al. (2006)


1.0
0.8
0.6
0.4
0.2
0.0
P(seed predation)
Day of Year

+

+

=

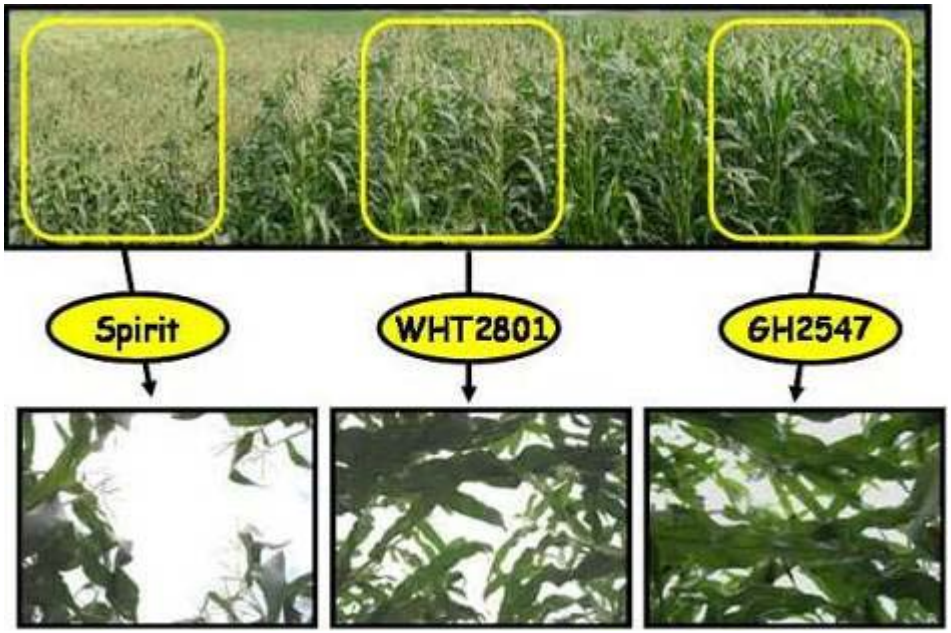


Lundgren et al. 2007

beetle banks

Cultural: I. Cover crops and mulches

Cultural: II. Weed suppressive crop cultivars



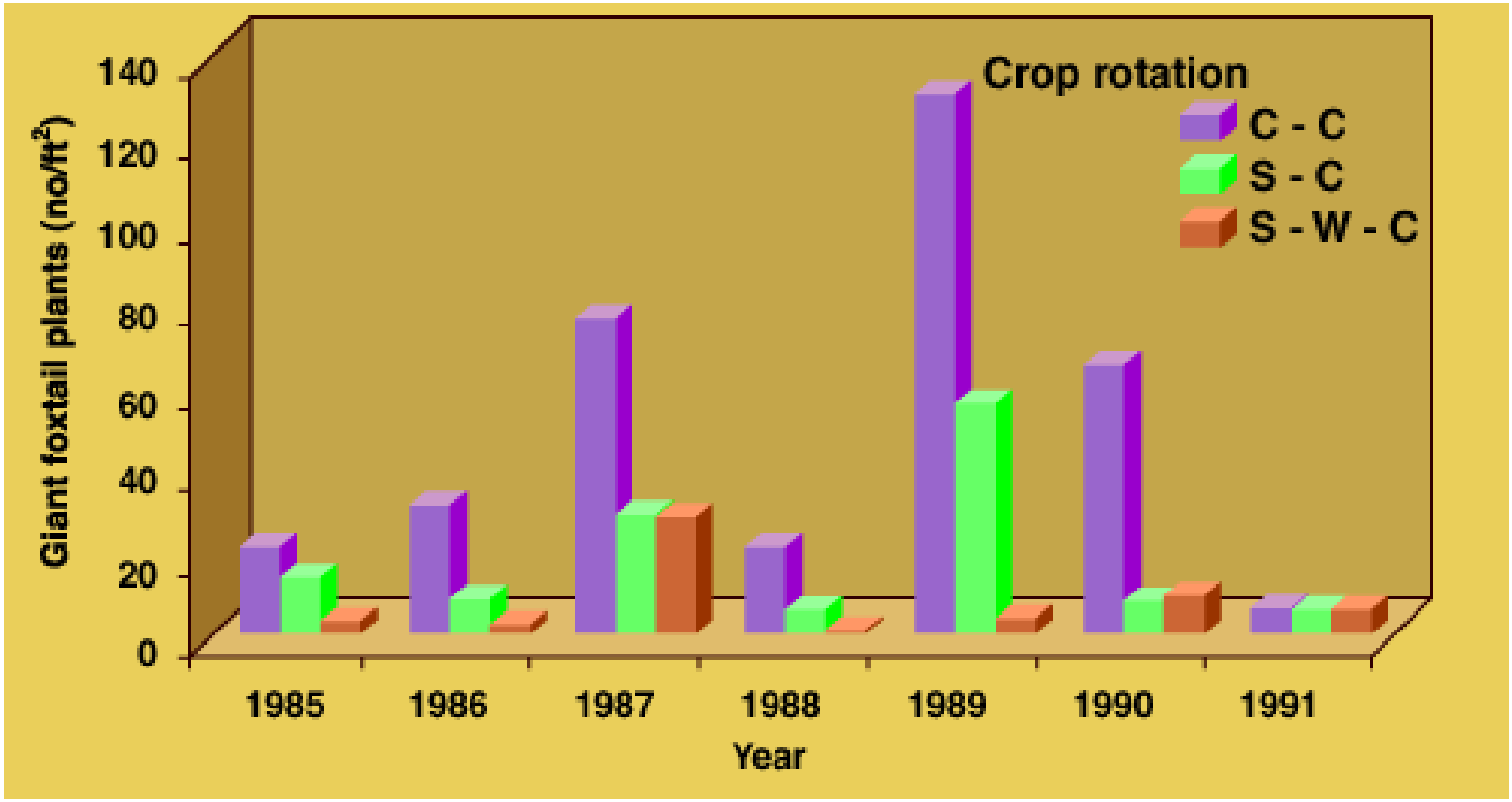
crop yield loss:

weed seeds:

Williams et al. 2008

Cultural: III. Crop population and spatial arrangement

Cultural: IV. Crop rotation and diversification



Schreiber 1992

Physical: I. Improved intrarow control efficacy to reduce hand-weeding costs

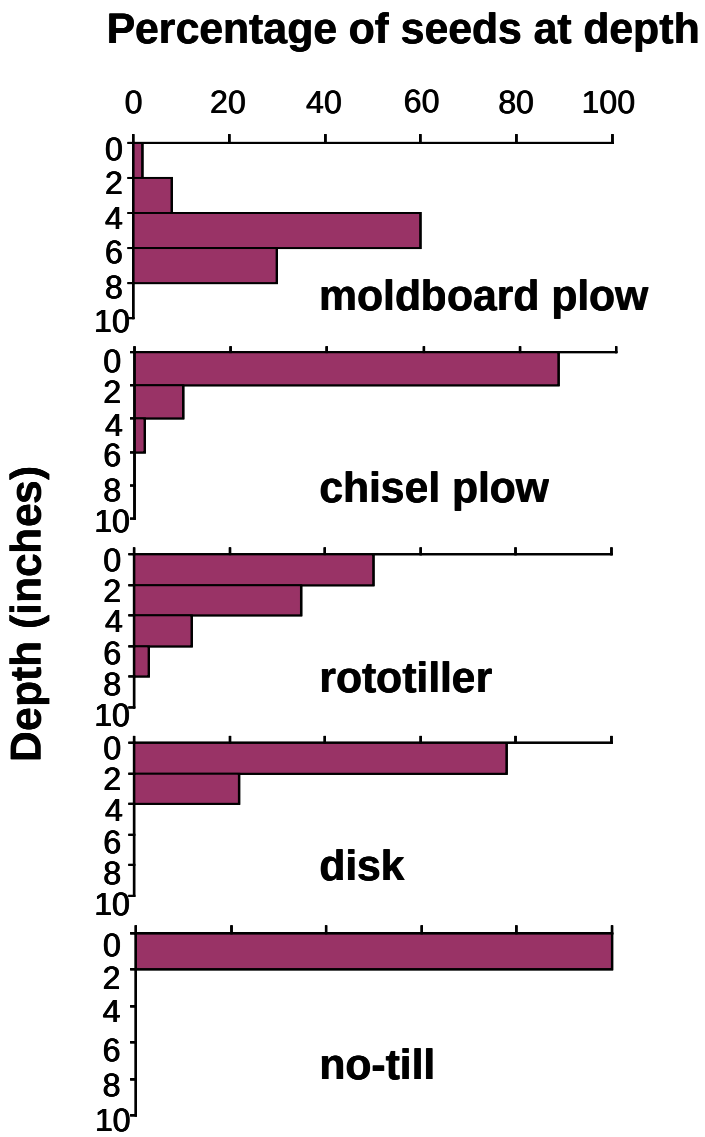
Band-steaming reduced
intra-row weeds in sugar beet

Melander & Jørgensen 2005

More physical and thermal tools: intrarow

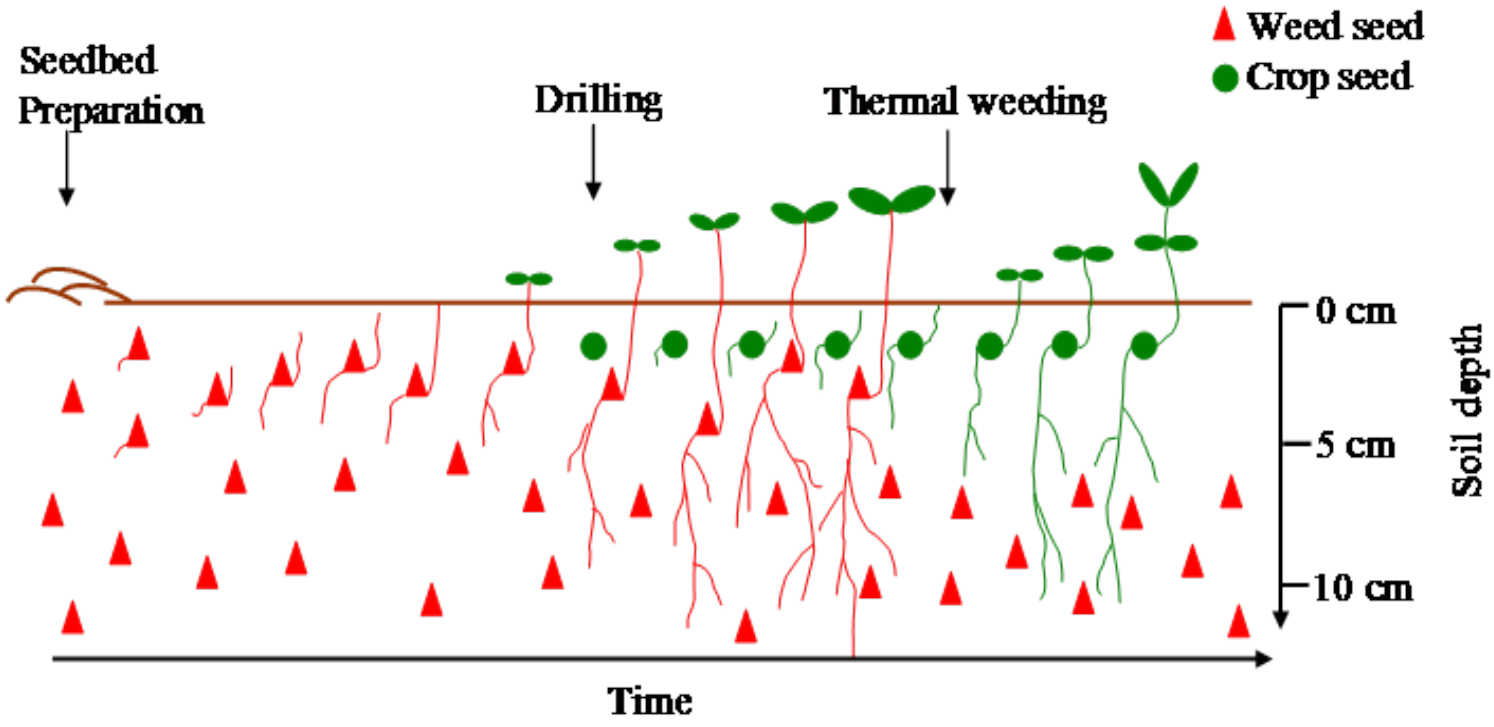
Physical: II. Tillage as one-time rescue for massive seed input

Photo: Adam Davis


Percentage of seeds at depth
0
20
40
60
80
100
Depth (inches)
0
2
4
6
8
10
moldboard plow
chisel plow
rototiller
disk
no-till

Mohler (2001)

Physical: III. Stale seedbed



Physicalweeding.com

Physical: IV. Weed seed collection at harvest

Bibliography

Davis, A. S., K. A. Renner, C. Sprague, L. Dyer and D. Mutch. 2005. Integrated weed management...One year's seeding. Michigan State University Extension Bulletin E-2931. Pp. 112.

Hartzler, R. G. and D. D. Buhler. 1998. Weed seeds and the seedbank: implications for management. Iowa State University. IPM-48. Pp. 1-6.

Menalled, F., J. Dauer, T. Fox and K. Renner. 2001. Managing your farm to increase weed seed predation. Michigan State University. E-2749. Pp. 1-6.

Menalled, F. D., M. Liebman and K. Renner. 2006. The ecology of weed seed predation in herbaceous crop systems. ed. Pp. 297-327 H. P. Singh, D. R. Batish and R. K. Kohli .) Binghamton, NY: Haworth Press.

*Scientific literature mentioned in presentation available upon request (contact Adam Davis: asdavis1@illinois.edu) or John Masiunas: masiunas@illinois.edu)