Weed Management in Organic Cereals in Maine

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USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

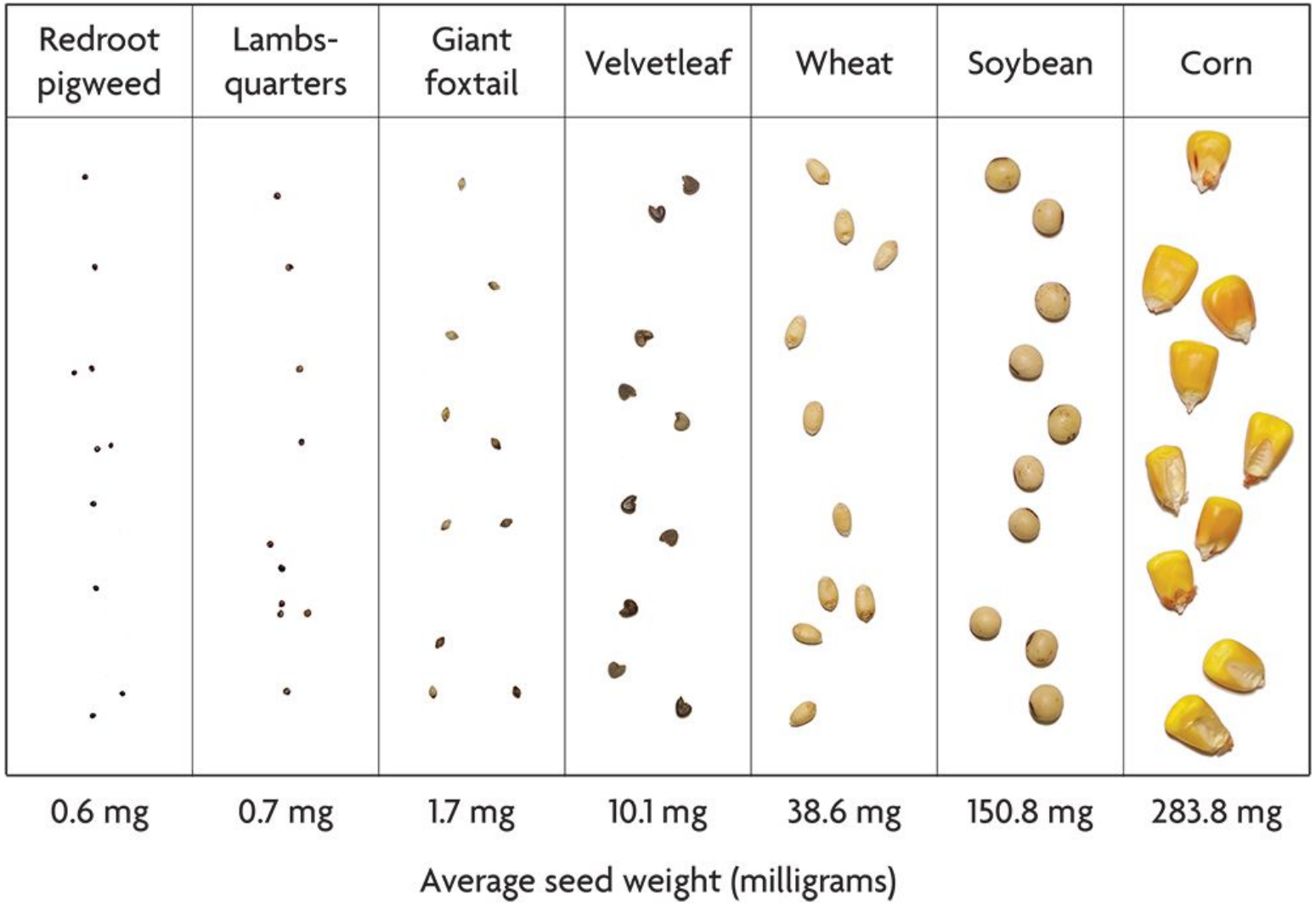
General Principles that I think about

- What is a weed?
- Weed seed bank
- Management practices to maximize competitiveness
- Crop rotations
- Mechanical weed control
- Get to know your weeds

What is a weed?

- A **weed** is a plant considered undesirable in a particular situation, growing where it conflicts with human preferences, needs, or goals. **Source: *Wikipedia***
- Weedy Traits
  - **Very high growth rate**
  - **High fecundity**
  - **SEED DORMANCY**
  - Phenotype plasticity
  - Can evolve quickly and adapt to human agriculture systems

Initial seed mass advantage towards crop

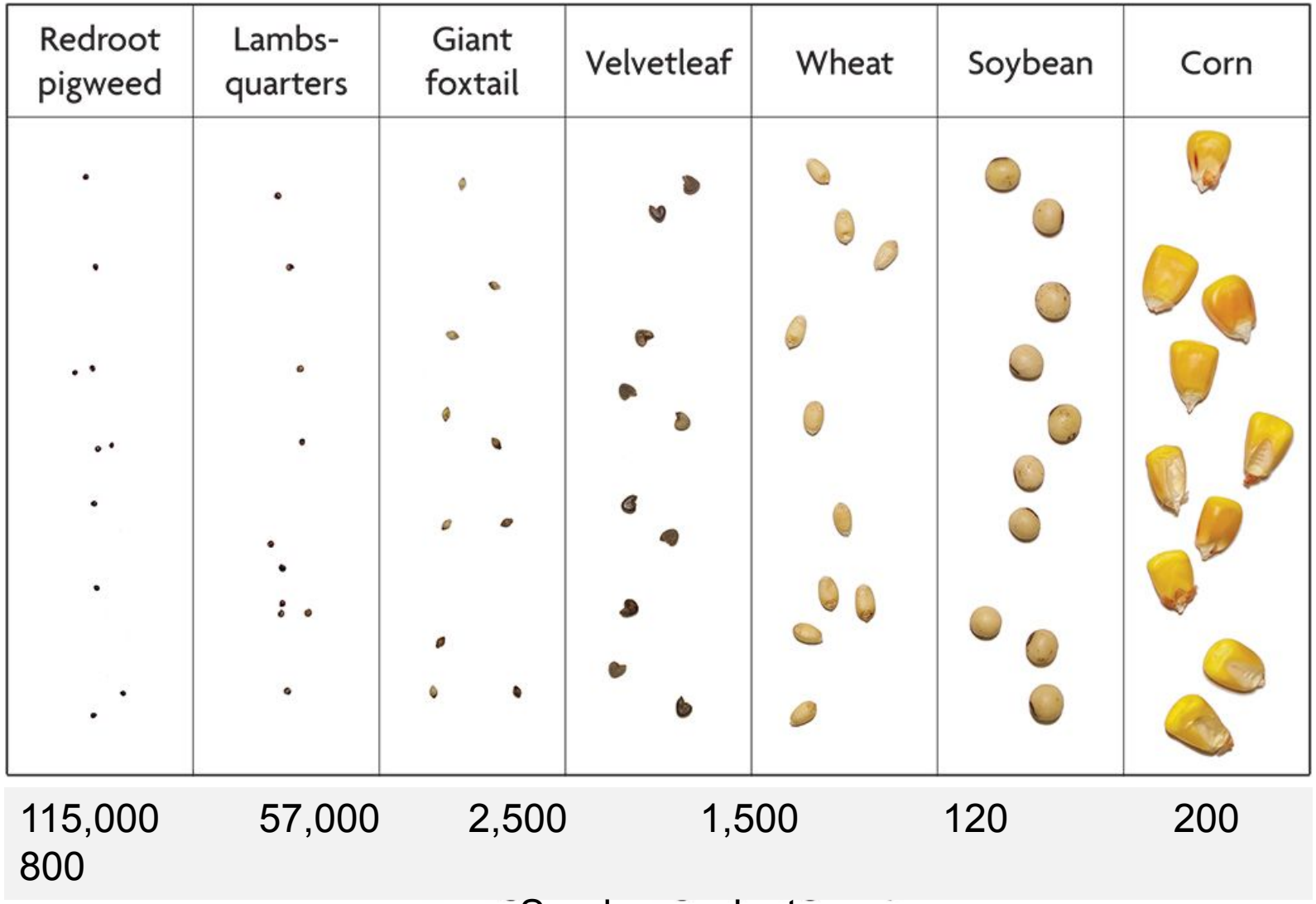


Source: **Manage Weeds On Your Farm**. Charles L. Mohler, John R. Teasdale, Antonio DiTommaso

Table 2.2. Growth Rates of Some Weeds and Crops in Relation to Seed Size (from Seibert and Pearce 1993)			
Species	**Seed Weight (mg)**	**Initial Growth Rate (mg/day)**	**Relative Growth Rate (mg/mg/day)**
Common lambsquarters	0.41	0.14	0.35
Velvetleaf	7.8	1.9	0.24
Cocklebur	38	7.1	0.19
Sunflower	61	12	0.2
Soybean	158	24	0.16

Source: **Manage Weeds On Your Farm**. Charles L. Mohler, John R. Teasdale, Antonio DiTommaso

Seed Production



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Seed Dormancy

Redroot pigweed	Lambs-quarters	Giant foxtail	Velvetleaf	Wheat	Soybean	Corn
Medium	Medium	Medium	Long	None	None	None

dormancy

Source: **Manage Weeds On Your Farm**. Charles L. Mohler, John R. Teasdale, Antonio DiTommaso

Weed Seed Bank

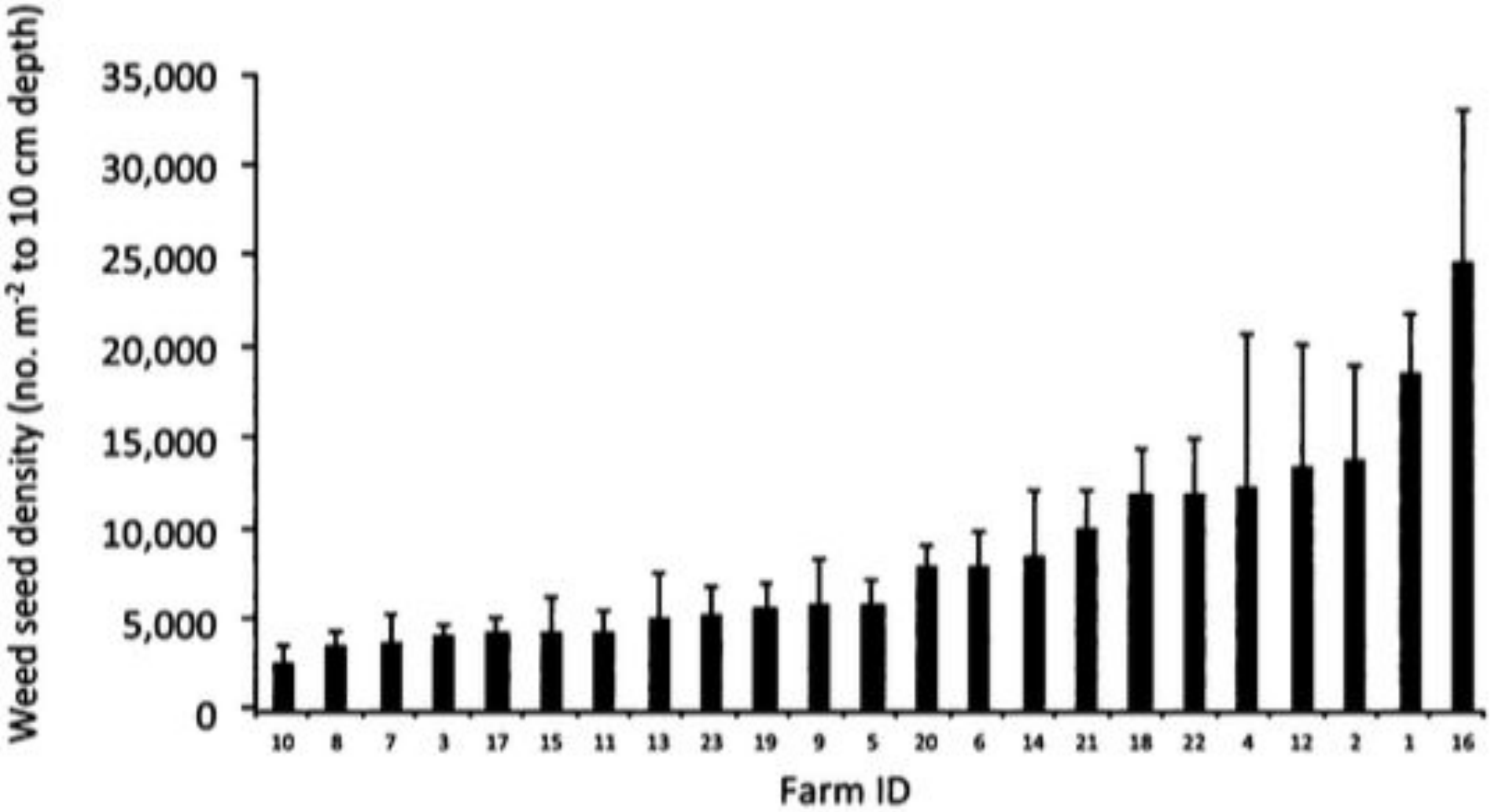
- **Should always be thinking about this**
- **Deposits vs. withdrawals**
- **Different species will require different approach**
- **Can go from moderate to severe in one growing season but takes a lot longer to got the other way…but doable!**
- **Consider abandoning a crop before creating a mess.**

Table 1. Most abundant species in New England farm weed seedbanks.

Common name	Scientific name	Weed seed density[a]
Crabgrasses	*Digitaria* spp.[b]	2,456 ± 738
Hairy galinsoga	*Galinsoga quadriradiata*	840 ± 372
Common lambsquarters	*Chenopodium album*	789 ± 155
Redroot pigweed	*Amaranthus retroflexus*	545 ± 141
Barnyardgrass	*Echinochloa crus-galli*	390 ± 136
Marsh yellowcress	*Rorippa islandica*	292 ± 87
Common purslane	*Portulaca oleracea*	284 ± 111
Mustards	*Brassica* spp.	271 ± 140
Yellow woodsorrel	*Oxalis stricta*	262 ± 64
Chickweed	*Stellaria media*	239 ± 79

[a] No. m^{-2} to 10 cm depth.
[b] Mixture of *D. sanguinalis* and *D. ischaemum*.

Total of 6368 seeds m^{-2} = 26 mil. seeds/acre
2,500 seeds m^{-2} = approximately 10 mil. seeds/acre
239 seeds m^{-2} = approximately 1 mil. seeds/acre

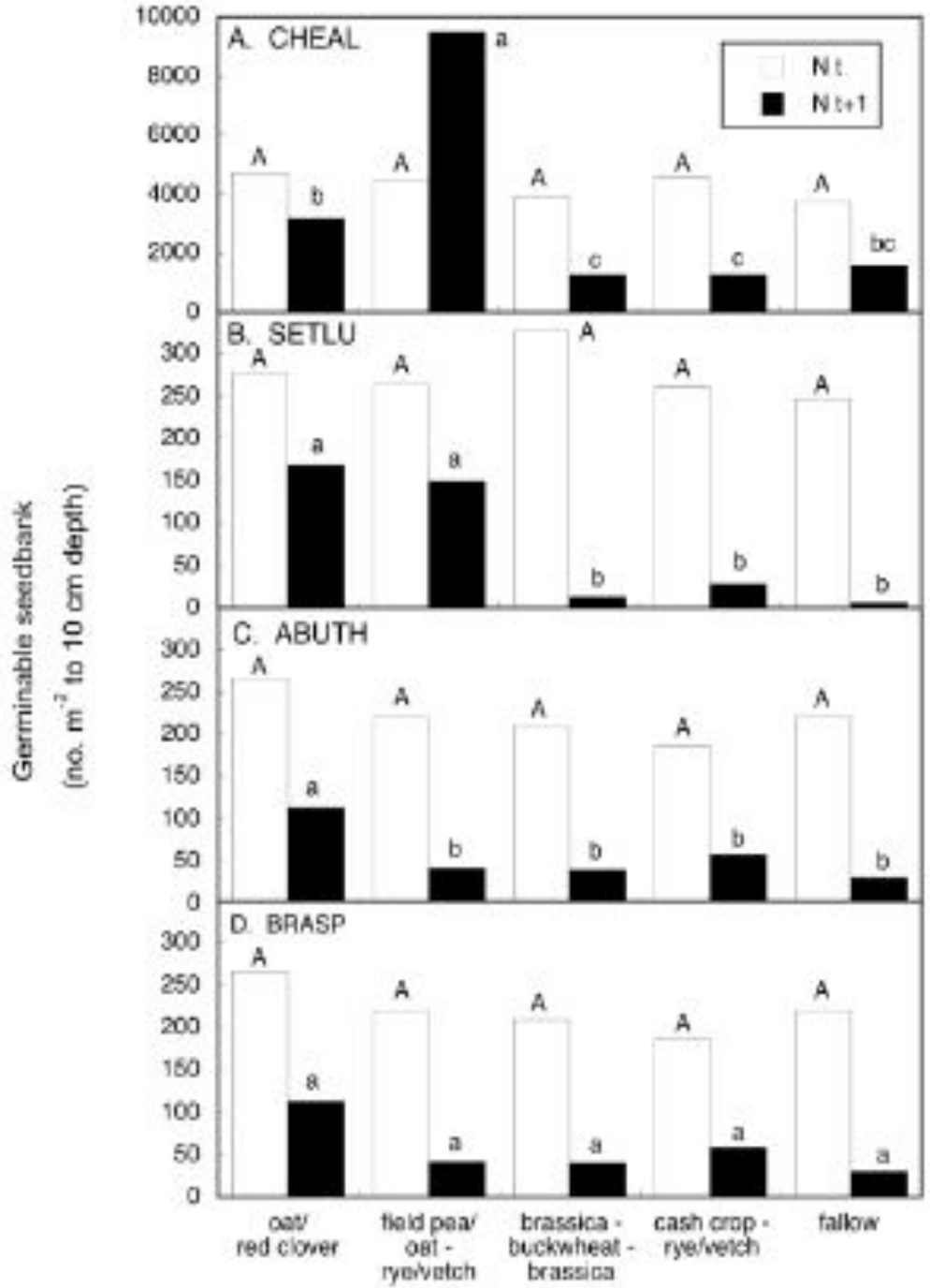


Total Germinable weed seed density of 23 vegetable farms in the Northeast

- 24,000 seeds m^{-2} = 100 mil. seeds/acre
- 2,500 seeds m^{-2} = approximately 10 mil. seeds/acre

One Year reduction in Seedbank under differ cropping systems

System 1	*fallow*			(4)
System 2		*green bean*	*rye/vetch*	(4)
System 3	*oat/pea*		*rye/vetch*	(3)
System 4	*oat/red clover*			(1)
System 5	*brassica*	*buckwheat*	*brassica*	(3)



Management practices to maximize competitiveness

No crop

Crop

Photo: E. Gallandt

Cereals are Competitive!

Take advantage of this!

- **Winter grains vs spring grains**
- **Plant as early as possible**
  - **As soon as soil is ready to work, April**
- **Population and spacing**
  - **Plant populations of 2 mil./acre**
- **Seed depth - 1.5” into firm seedbed**
- **Grain type – oats, barley, wheat**
- **Fertility**
  - **Wheat/barley 60 lbs. N/acre, Oats 30 lbs. N/acre**

Photo: E. Gallandt

Plant Early

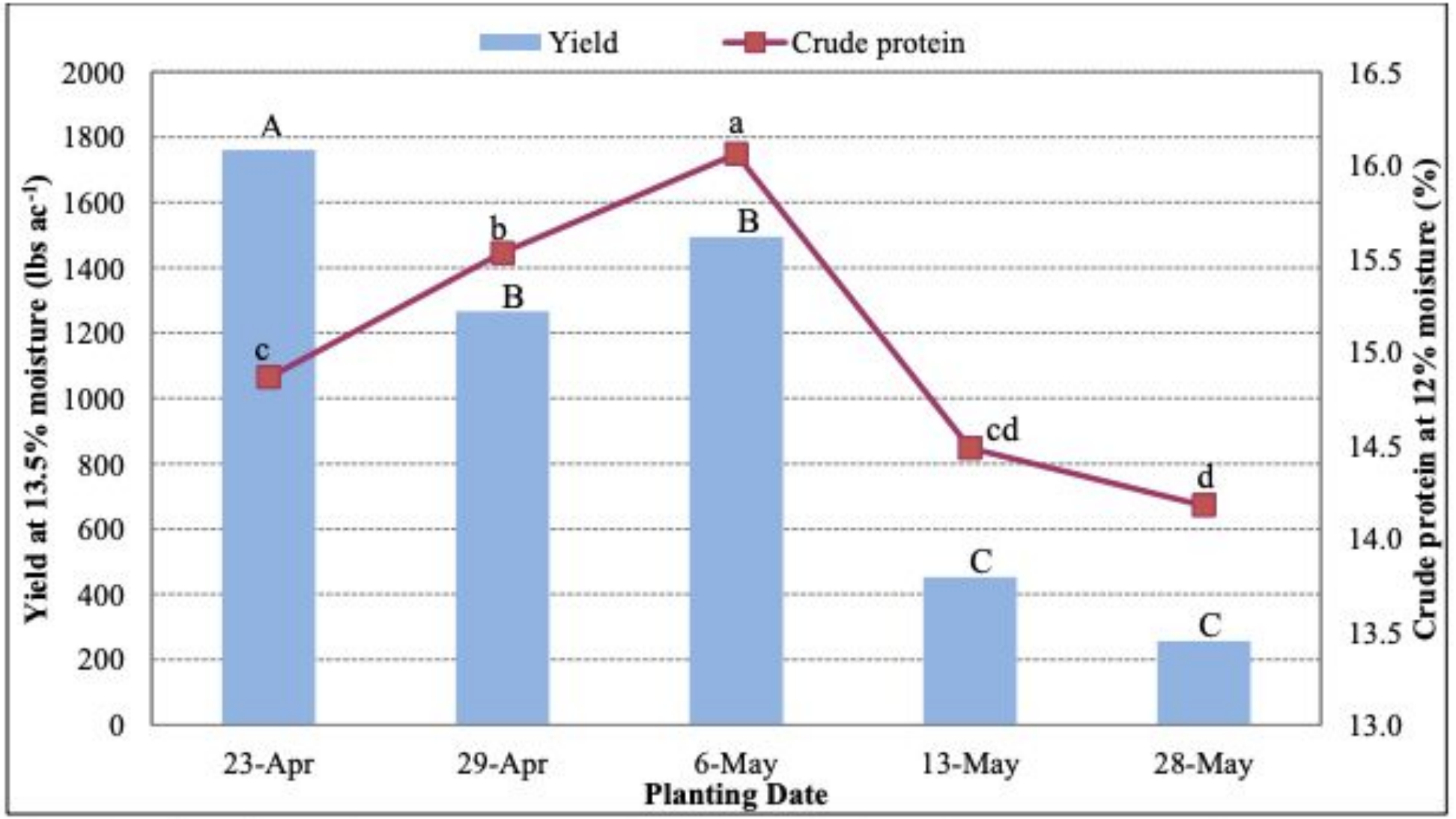
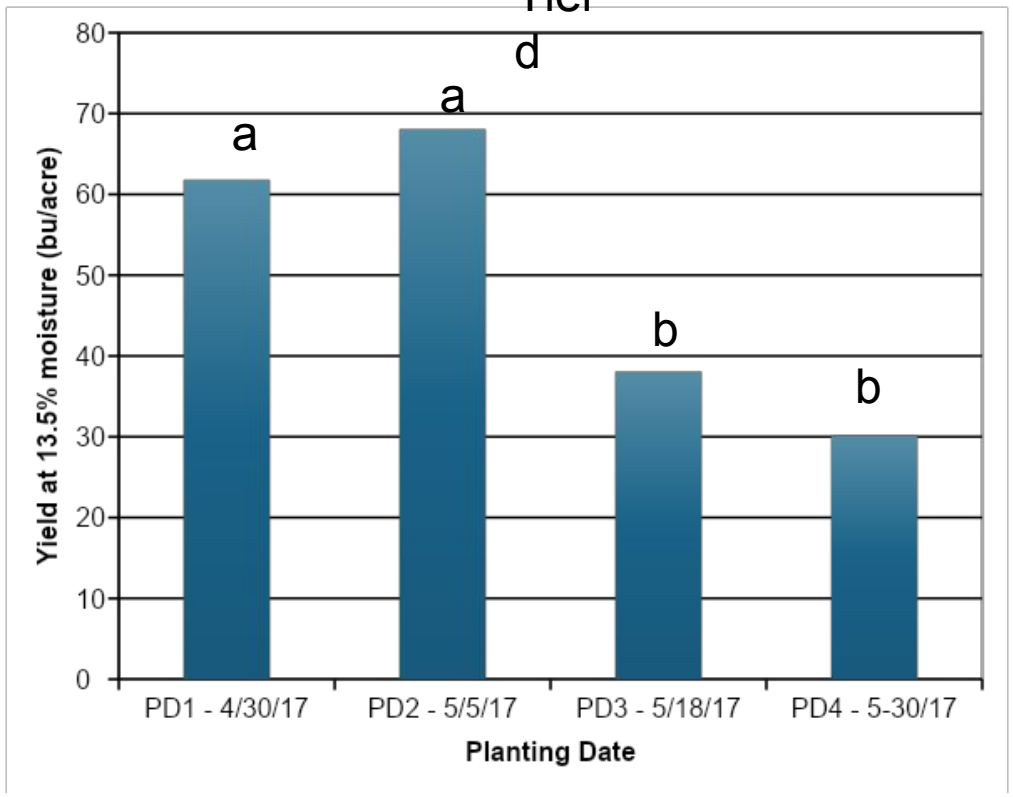


Figure 3. Effect of planting date across all spring wheat varieties on yield and crude protein, Alburgh, VT. Treatments with the same letter did not differ significantly from one another (p=0.10). Compare capital letters for yield and lower-case letters for crude protein.

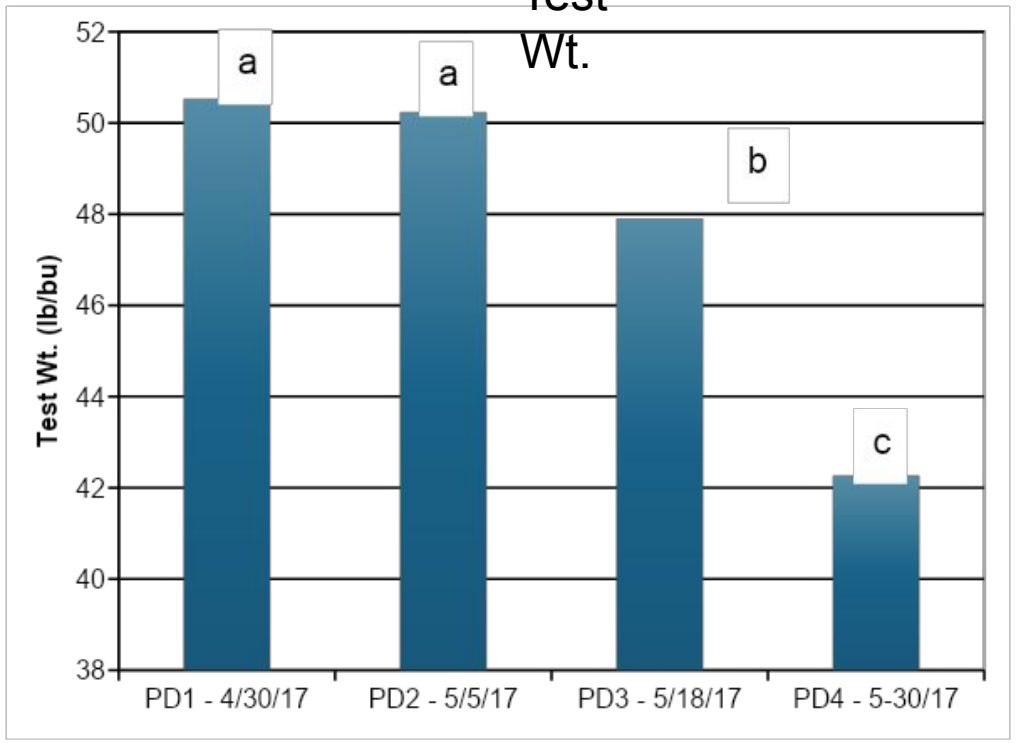
Maine Barley Planting Date Trial – 2017

Newdale planted at 1.3 mil seeds/acre

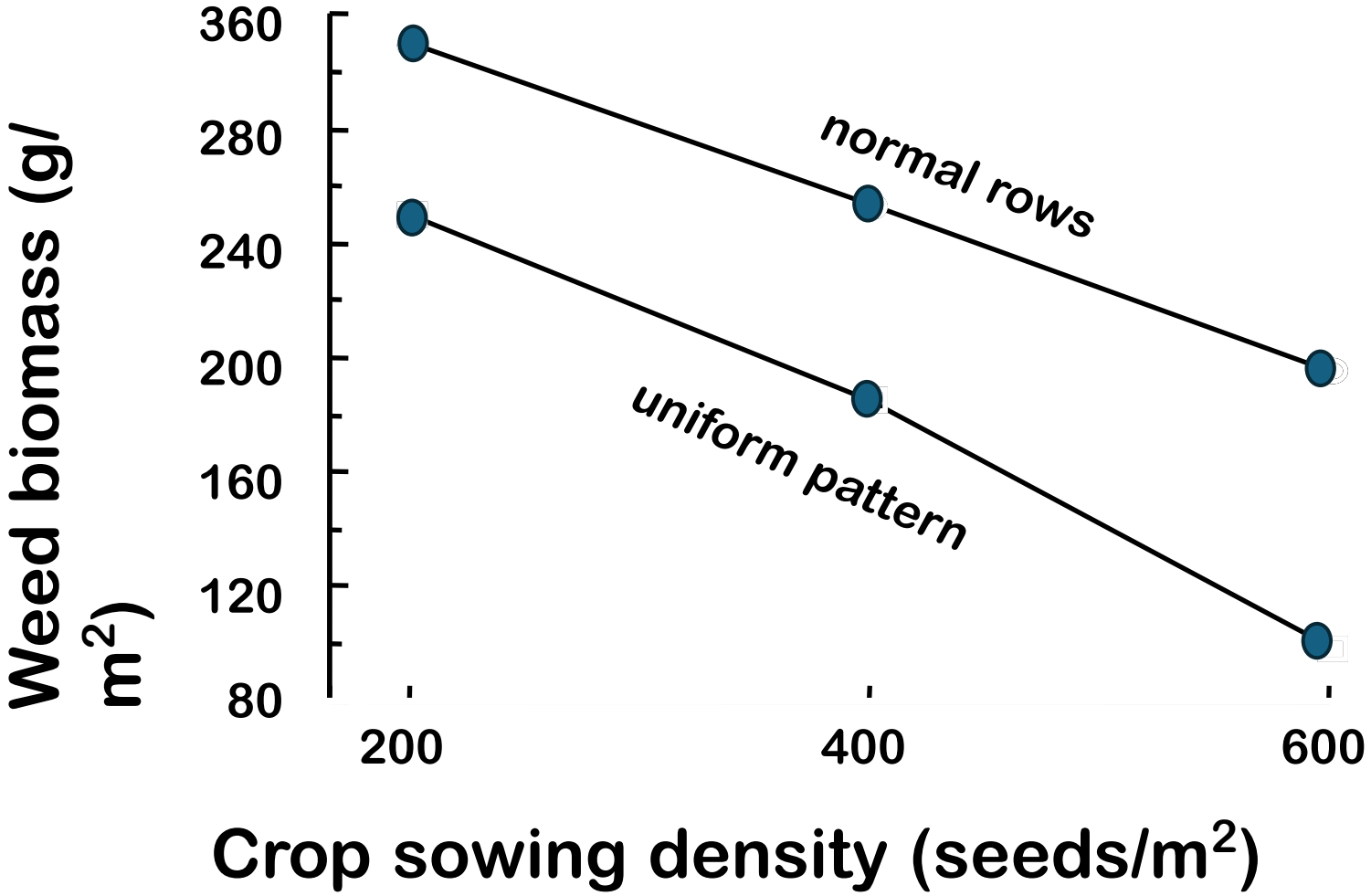
Yiel
d

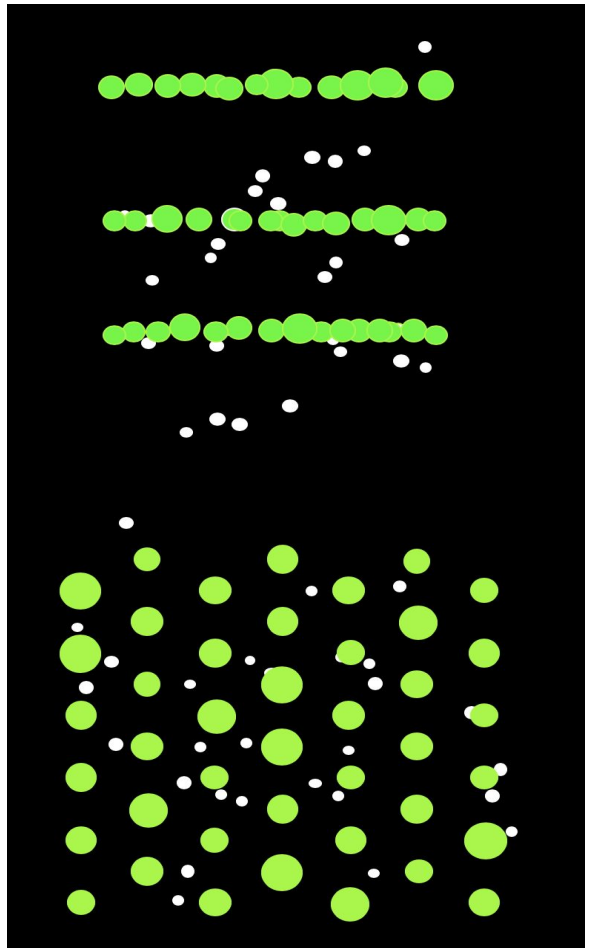


Test
Wt.



Weed biomass vs. sowing density





Jake Weiner, University of Copenhagen

high density rows

high density uniform

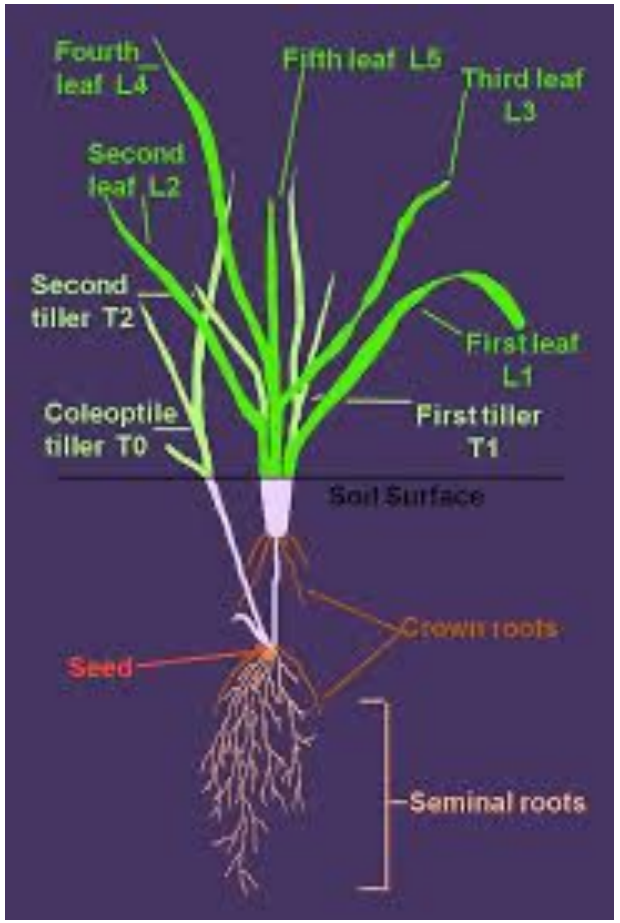
Jake Weiner , University of Copenhagen

Winter wheat planted on 9/20/24. Pictures taken on 11/27/24

1 mil live seeds/acre

2 mil live seeds/acre

Effect of Planting Depth on Wheat



Planting Depth (inches)	50% Emergence (DAP)	Plant Stand Counts (Pl/ft^2)
0.5”	7.2 c	27.4 b
1”-1.5”	6.0 d	31.7 a
2”- 2.5”	8.5 b	32.2 a
3”- 3.5”	9.5 a	30.0 a

Ron Rickman and Tami Johlke USDA Agricultural Research Service

Crop Rotation

- Major goal is to disrupt pest life cycles
  - Rotate between crops with different planting and harvest dates
  - Rotate between crops with different fertility requirements (nitrogen) needs – High, Medium, Low
  - Rotate between crops with different row arrangements
  - Rotate between annuals and perennials
  - Include a year that allows for several tillage events to deplete perennial weed energy reserves and annul weed seedbank

Crop Rotation

- Long season row crops
  - Corn, soybeans, dry beans
    - Higher revenue crops
    - Later planting (late May, early June) – allows for stale seedbed
    - Can do in intensive cultivation events – depending on equipment, timing and weather can achieve almost 100% weed control
- Winter grains
  - Risk - Winter kill/damage
  - Little risk from summer annuals
- Short season annuals
  - Spring grains, field peas, buckwheat, cover crop
- Perennial sods
  - Good to replenish soils
  - No seed rain in these crops
  - Reduction of the seedbank is slower (several seasons) with perennials

Year 1 - Long season row crop

- Corn for grain or silage, Soybeans, Dry Beans
  - Risk – low risk
  - High revenue – 150 bushel x $7.50 = $1,125
  - Plant late May, early June – allow for stale seedbed
  - Fertility, plowed in legume/grass sod. Starter fertilizer
  - Aggressive mechanical weed control with tine harrows and several row crop cultivation events.

Year 2 – Short season crop with late planting date

- Buckwheat
  - Risk – Markets and highly variable yields
  - Lower revenue – 900 lb./acre x $0.40/lb. = $360/acre
  - Plant in late June, early July
  - Long fallow period before planting

Year 3 - Winter annuals

- Winter Wheat, Winter Rye, Triticale, Spelt
  - Risk – moderate for winter kill/damage, low risk if crop survives
  - Medium revenue – 50 bu./acre x $12.00/bu. = $600/acre
  - Could no-till into buckwheat stubble

Year 4 - Short season, early planted spring annuals

- Wheat, Barley, Oats, field peas
  - Risk – potential yield impact due to weeds, increase in weed seedbank
  - Low revenue – 30 bu/acre x $12.00/bu. = $360/acre
  - Plant early
  - Fertility – Manures for cereals
  - Harvest in early to mid-August
  - Establish perennial sod in August

Year 5 and 6 - Perennial sod

- Perennial ryegrass
  - Risk – Markets, perennial weeds
  - Mow two to three times during growing season
  - Good to replenish soils
  - No annual weed seed rain in these crops

Clemson announces 'Alfalfa in the South' field day Denise Attaway

Mechanical Weed Control

- Tine Harrow
- Rotary hoe
- Any others?
  - Precision cultivation with guidance system
  - Weed Zapper
  - Combcut

Tine Harrow

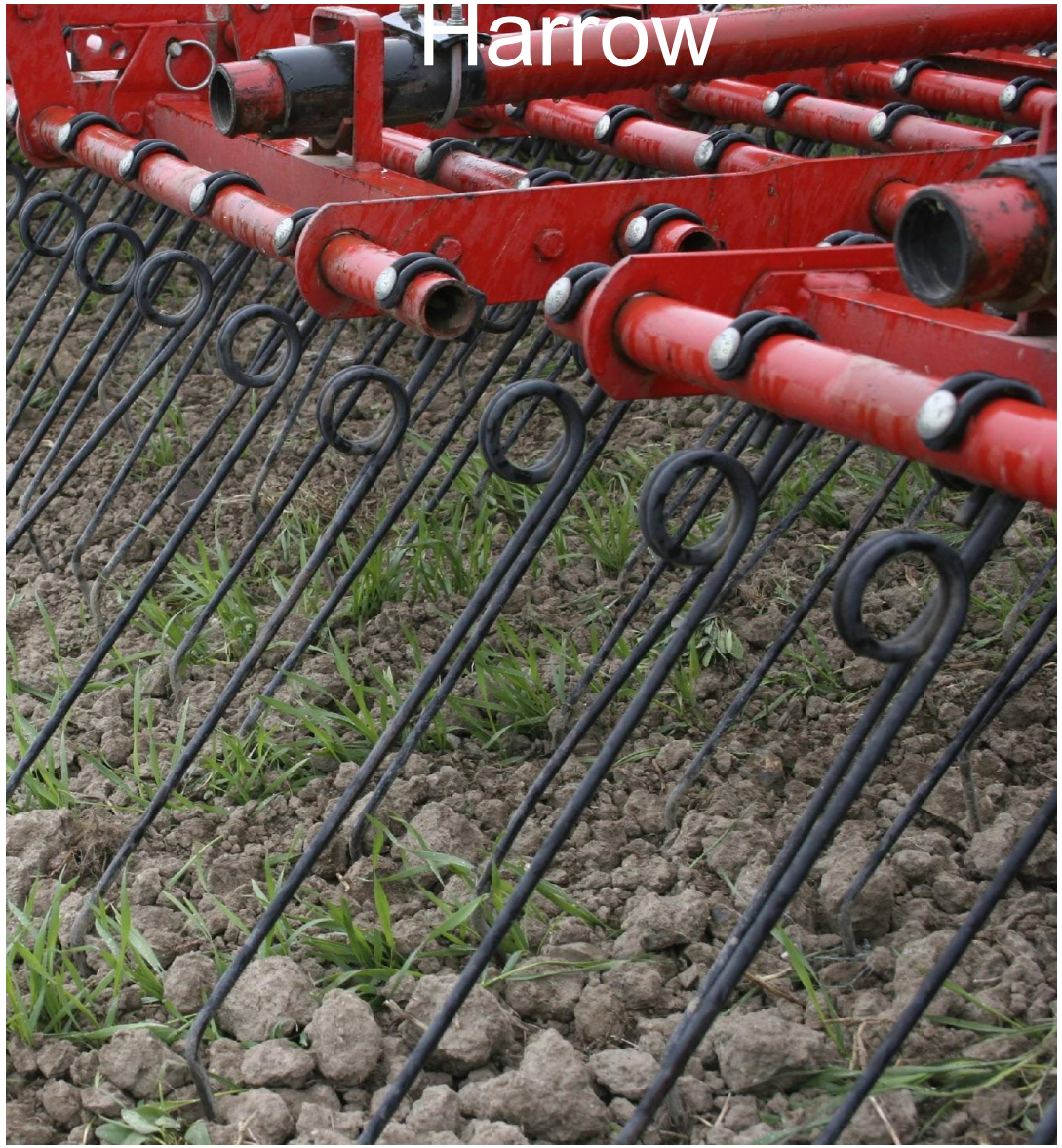


Photo: E. Gallandt

Rotary Hoe

Photo: Equipment Hub

Timing

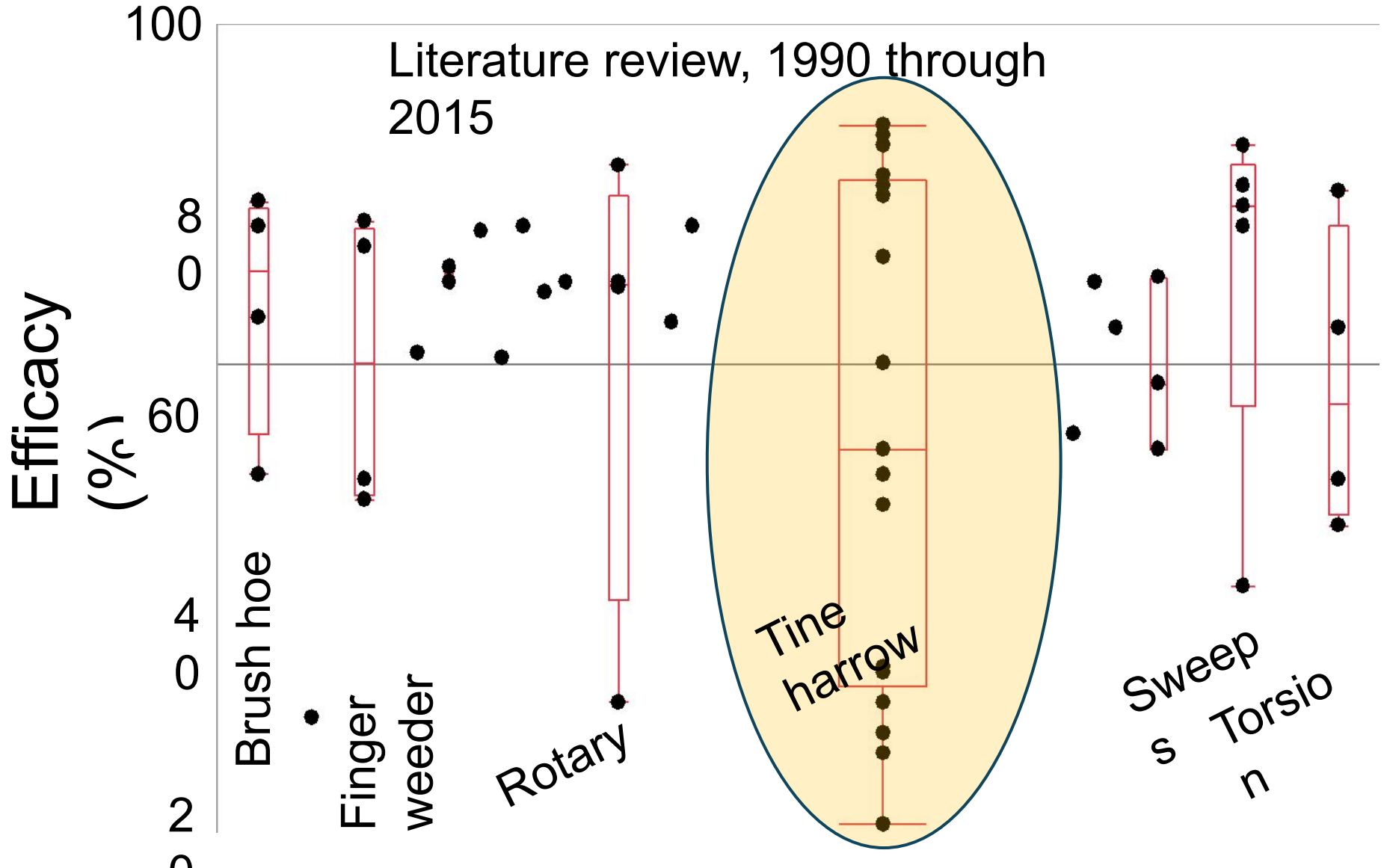
Photo: E. Gallandt

Timing

Photo: E. Gallandt

55 Experiments

Slide: E. Gallandt



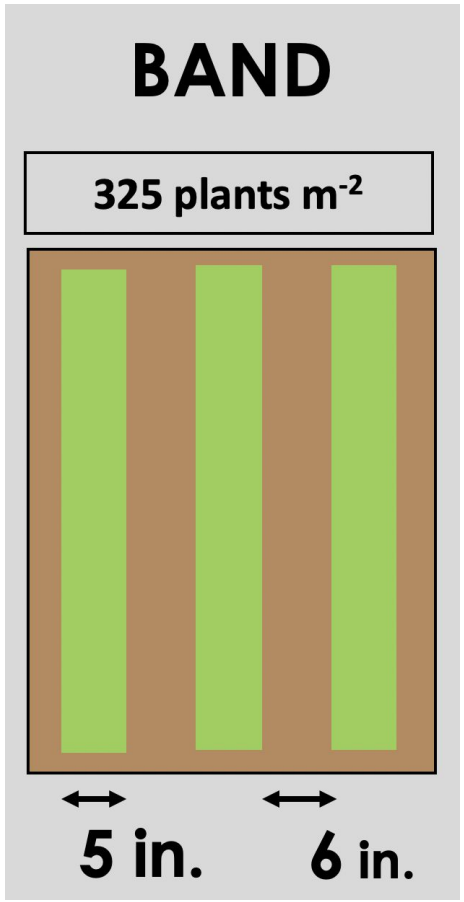
Gallandt, E.R., D. Brainard, & B. Brown (2018).

Sweeps between rows

Photo: E. Gallandt

Photo: E. Gallandt

Photo: E. Gallandt


BAND
325 plants m-2
5 in.
6 in.

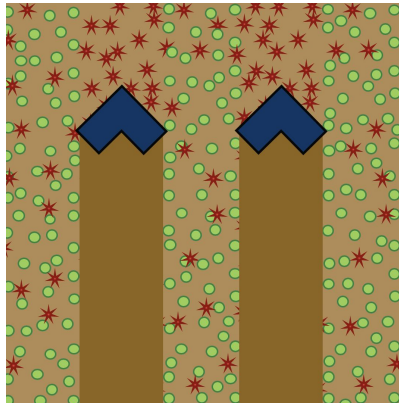

5 in.


Photo: E. Gallandt

The Weed Zapper

Don't Just Kill Weeds **Annihilate Them.**

Meet The Machine →

Lyckegård Group AB
Sweden

Know Your Weeds

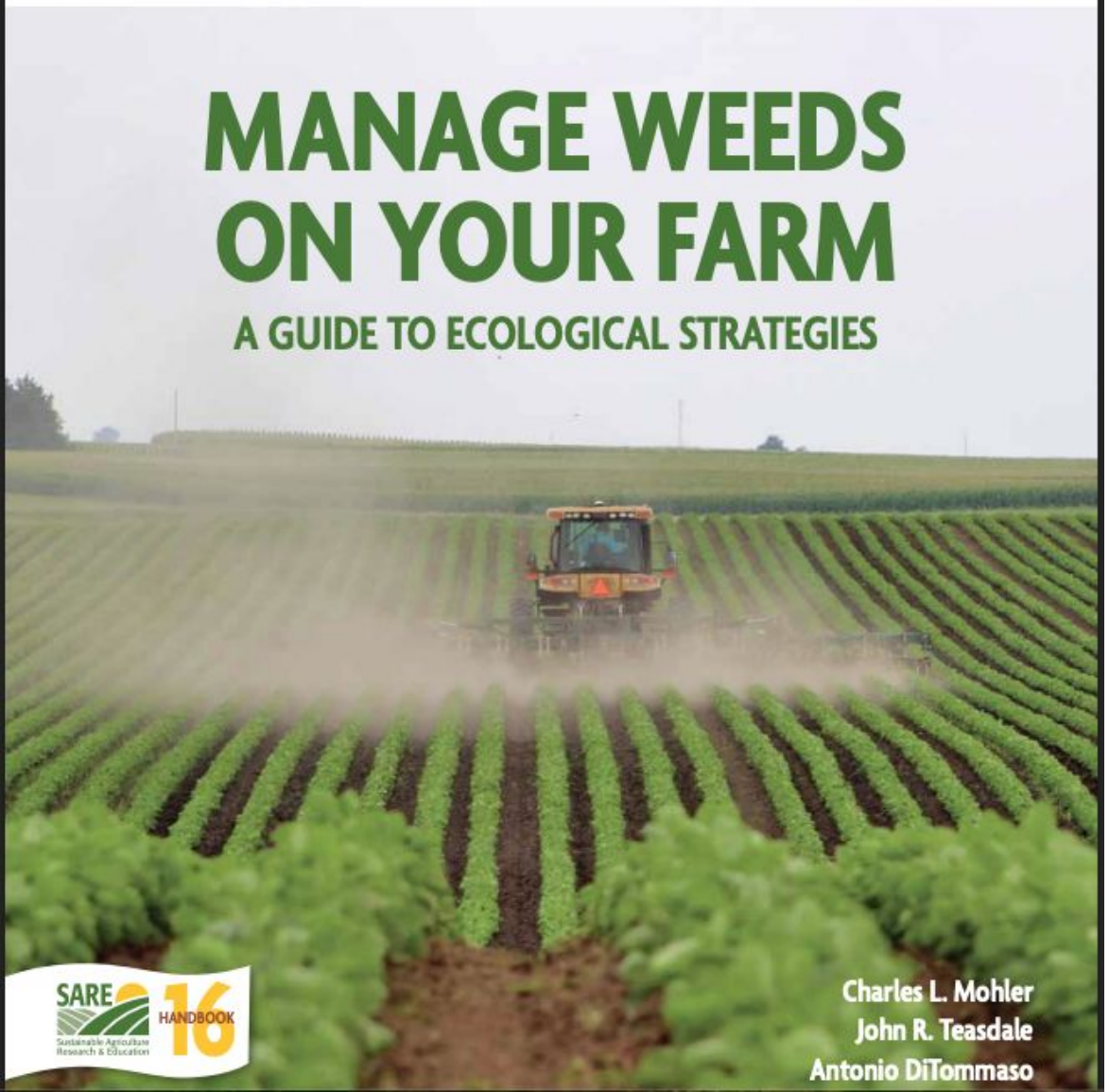
Common Lambsquarters

- Seed Production
  - Is described as “intolerant of heavy shade” but will still produce seed in dense shade.
  - Seed production varies depending on conditions
    - In low growing vegetables – 30,000 to 370,000 seeds/plant
    - In corn – 8,000 to 175,000 seeds/plant
    - Rapeseed – 175 to 2,250 seeds/plant
- Dormancy and emergence
  - Can remain for many decades
  - In undisturbed soils, annual declines of 8-35% can be expected.
  - In disturbed soils, declines can be as high as 30-50%
  - Most seed is dormant after seed rain.
  - Germinates best with daytime temps of 64-77℉, mid to late May
  - Secondary dormancy can be induced by warm weather in the summer
  - Is broken by light, the presence of nitrate and large day/night temperature fluctuations. All of these conditions occur during or immediately after tillage.
  - Compared to other weeds it has one of longest emergence durations.
- Key management strategies
  - Plant early and at high populations.
  - Frequent tillage events that encourage germination and take out seedlings can effectively and in a short time frame draw down the seed bank.
  - Tine harrow and rotary hoe.
  - Long term sods will not greatly deplete the seedbank

Know Your Weeds

Wild Mustard and Wild Radish

- Seed Production
  - Under competitive conditions seed production ranges from 200 to 3,500 seeds/plant
  - Quebec wheat fields - 50-150 seeds/plant
- Dormancy and emergence
  - Peak emergence in early to mid spring.
  - Most seeds are dormant after seed rain.
  - Seed decay at or near the surface occurs at 22/45% per year.
  - Optimum temps for germ 50-68°F.
  - Exposure to light and nitrogen strongly induces germination
- Key management strategies
  - Hard to control with cultivation
  - Responds favorably to excess nitrogen
  - Sensitive to shading so plant at high populations
  - Keeping seed near surface in highly disturbed systems increases seedbank depletion
  - Seed bank declines around 30% per year



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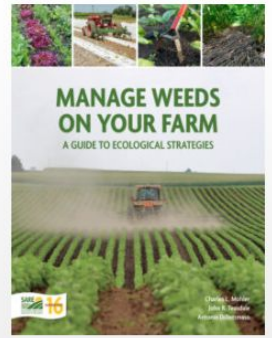

https://www.sare.org/resources/manage-weeds-on-your-farm/

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Thank you and please invite me to visit your farm!

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