Cover Crops in Organic Systems

Matt Ryan – Cornell Sustainable Cropping Systems Lab

Cornell CALS
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E-mail me for more information and papers

Acknowledgements and funding

- Mary Barbercheck
- Joe Bassett
- Fay Benson
- Bryan Brown
- **Kiera Crowley**
- James Cagle
- Bill Curran
- Christophe David
- Art Degaetano
- Mark Dempsey
- Janice Degni
- Miguel Gomez
- Claire Keene
- **Jeff Liebert**
- Klaas Martens
- **Uri Menalled**
- Steven Mirsky
- **Chris Pelzer**
- Thor Oechsner
- Joséphine Peigne
- **Sarah Pethybridge**
- Liz Pickard
- Terry Rose
- Tom Ryan
- Ed Scheffler
- Erin Silva
- Jeff Stayton
- Paul Stachowski
- Jenn Thomas Murphy
- John Wallace
- Bethany Wallace
- Sandra Wayman
- Harold van Es
- Mark VanGessel
- Laura Vincent-Caboud
- Léa Vereecke

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NORTHEAST COVER CROPS • COUNCIL • SOWING SUSTAINABILITY

SAVE THE DATE

March 4, 2021

Northeast Cover Crop Council's First *Virtual Conference*

Mark your calendars to join your fellow cover crop enthusiasts for a day of interactive online presentations, posters, panels, and training sessions.

CCA CEUs will be available. Registration opens soon, $75 per ticket.

Contact Victoria.Ackroyd@usda.gov for more information.

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*New this year: submit a **cover crop video** to our contest!*

Get filming this fall! Highlight and show off your latest cover crop planting/project.

*Submit an **ePoster**!*

Are you interested in sharing a poster on an ongoing project? Prepare a poster to share during our online poster session.

*Are you interested in becoming a **Sponsor**?*

Visit http://northeastcovercrops.com/ for upcoming details.

NORTHEAST COVER CROPS • COUNCIL • SOWING SUSTAINABILITY

Northeast Cover Crops Council's

2021 Video Contest

Show off your latest cover crop planting/project at our first ever *Virtual* Conference on March 4, 2021. **Get filming this fall!** Upon submittal, your video will be entered into our ***Cover Crop Video Contest*** where Conference attendees will vote on their favorite videos during the event!

Visit http://northeastcovercrops.com/ for upcoming details on how and when to submit your video.

Details to Include in Your Video:

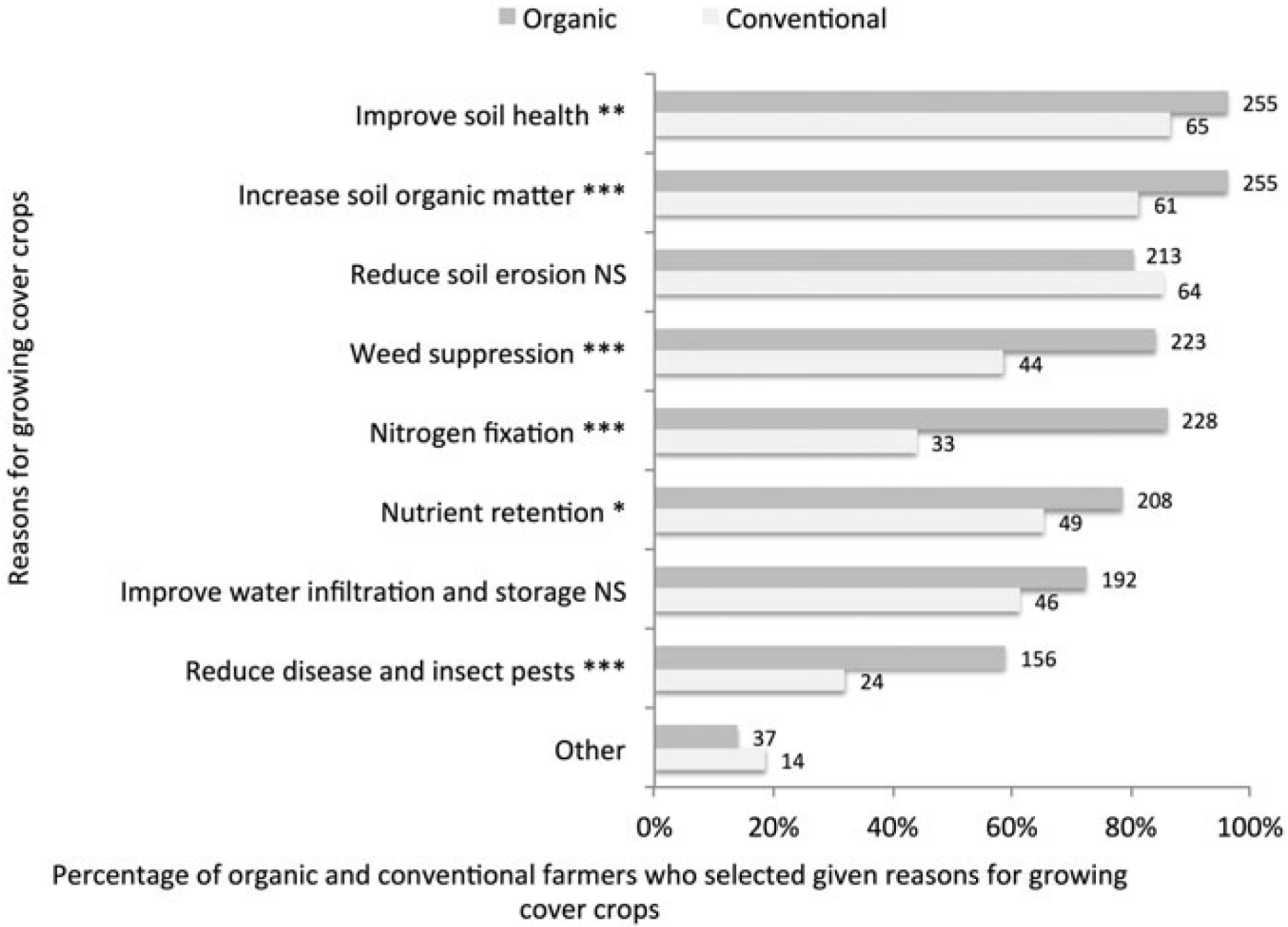
- ⇒ Tell us your name, the farm/site name, and the general location.
- ⇒ Highlight a current/ongoing project/planting, or repurpose an older video you have on cover crops.
- ⇒ Explain why you chose that particular cover crop/mix or project, and what the specific goals are, if any, that you hope to meet through planting this cover crop (i.e. nitrogen fixation, improve soil health, reduce erosion, etc.).
- ⇒ Describe equipment you are using, and any relevant information about the site (i.e. the history of that field, cash crop, tillage practices, how long it has been cover cropped, etc.).
- ⇒ Videos should be no more than 5 minutes in length.

Video Tips & Tricks:

- ⇒ Smart Phone videos are great. However always shoot in landscape style, avoid shooting vertical.
- ⇒ Consider having someone else hold the camera/phone, and to brace it on a stationary surface to minimize shakiness. A tripod or stabilizing device can be very useful.
- ⇒ Be sure you are at FULL battery before recording, and if possible, bring a backup battery/power source.
- ⇒ Before recording, make sure you know your video goals—what do you want the audience to know? You may want to write down key points to capture/say before recording so you don't miss anything.
- ⇒ Short, concise videos are generally preferred.
- ⇒ Consider the weather—wind can impact the microphones sound by adding background noise. Use a Bluetooth microphone with a wind screen if possible when filming in the field.
- ⇒ If you want to take a few shots (or insert pictures/text) there are many different free, intuitive video editing softwares available to edit those together into one video, such as MiniTool Movie Maker.
- ⇒ Use a standard file type when uploading videos, such as MP4 or MOV.
- ⇒ Get creative and have fun!

Helpful Resources for Creating Videos:

- ⇒ 'How to Make a Video with eOrganic' Course: https://eorganic.info/node/7345
- ⇒ Dr. Eric Brennan USDA-ARS YouTube Channel with various tips on video creation/editing: https://www.youtube.com/channel/UCnnF1-A2Uacfv7D361QNJ5g
- ⇒ Oregon State University's Video Production Resources: https://is.oregonstate.edu/sms/consultation/video-production-resources/field-production-guide



Percentages of organic (n = 265) and conventional (n = 75) farmers who grow cover crops who selected the given reasons for growing cover crops.

The question was: 'Why do you grow cover crops? (Select Multiple)'. Numbers at the end of the bars indicate the count of respondents answering each question. Stars indicate significant differences between organic and conventional growers based on a chi-square test: * is $P < 0.05$, ** is $P < 0.01$, *** is $P < 0.001$.


46% reduction in
weed biomass

Problems with soil tillage

- Increases susceptibility to erosion
- Reduces soil carbon and degrades soil health
- Requires substantial labor and fuel

I & J Roller-Crimper (10 ft wide cylinder, 2625 lbs. water-filled weight)

Organic corn no-till planted into hairy vetch terminated with a roller-crimper in Pennsylvania




Traditional tillage-based organic production **Rotational no-till**

Compared with traditional organic corn-soybean-wheat

- **27% less diesel fuel**
- **31% less labor**
- **13% less energy use**
- **6% less GHG emissions** [1]

No-till planting soybean into rolled-crimped cereal rye can **improve soil health, increase water infiltration, and protect soil from erosion**, compared to planting into tilled soil without a cover crop [2]

1) Mirsky, SB, MR Ryan, WS Curran, JR Teasdale, J Maul, JT Spargo, J Moyer, AM Grantham, D Weber, and T Way. 2012. Conservation tillage issues: Cover crop-based organic rotational no-till grain production in the Mid-Atlantic region. *Renewable Agriculture and Food Systems* 27:31-40.

2) Crowley, KA, HM van Es, MI Gómez, and MR Ryan. 2018. Tradeoffs in cereal rye management strategies prior to organically managed soybean. Agronomy Journal 110:1–13.

Cover crop compatibility with cash crops

Soybean into cereal rye

- Aim to deplete soil N levels to starve weeds
- Too much N can cause winter cereals to lodge, making rolling difficult and giving weeds an advantage

Cover crop compatibility with cash crops

Corn into hairy vetch

- Supplement manure or compost prior to vetch
- Mixtures of hairy vetch and rye will suppress more weeds

Systems approach

- Requires greater attention
  - Advanced planning
  - Adaptive management
- New equipment for rolling and no-till planting
- Different pests
  - Perennial and early emerging weeds (e.g. common ragweed)
  - Seed corn maggot, true army worm, black cutworm
- Crop compatibility

Late August - Early September

Cereal rye is seeded in late summer

March

Cereal rye protects the soil over winter

April - May

Cereal rye grows rapidly in the spring and can reach six feet tall.

Late May - Early June

Cereal rye is terminated with a roller at 50% anthesis.

Late May - Early June

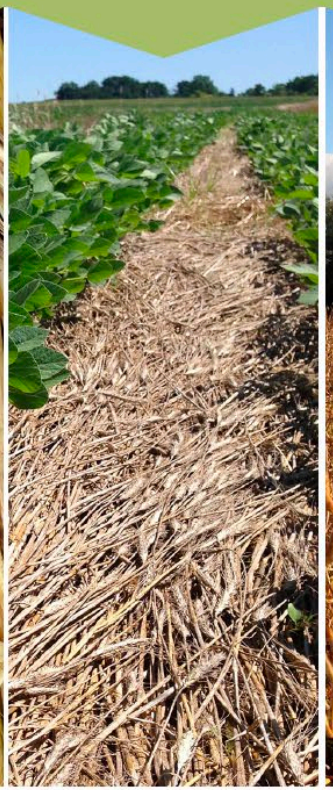
Soybeans are no-till planted into the residue.

June

Soybean seedlings emerge and grow through the residue.

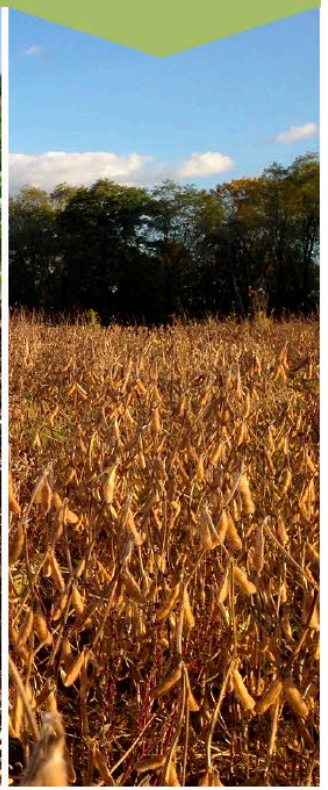
September - October

Mulch suppresses weed emergence until soybean canopy shades out weeds.



October - November

Soybeans are harvested in the early fall.



Liz Pickard, Sandra Wayman, Chris Pelzer, and Jeff Liebert

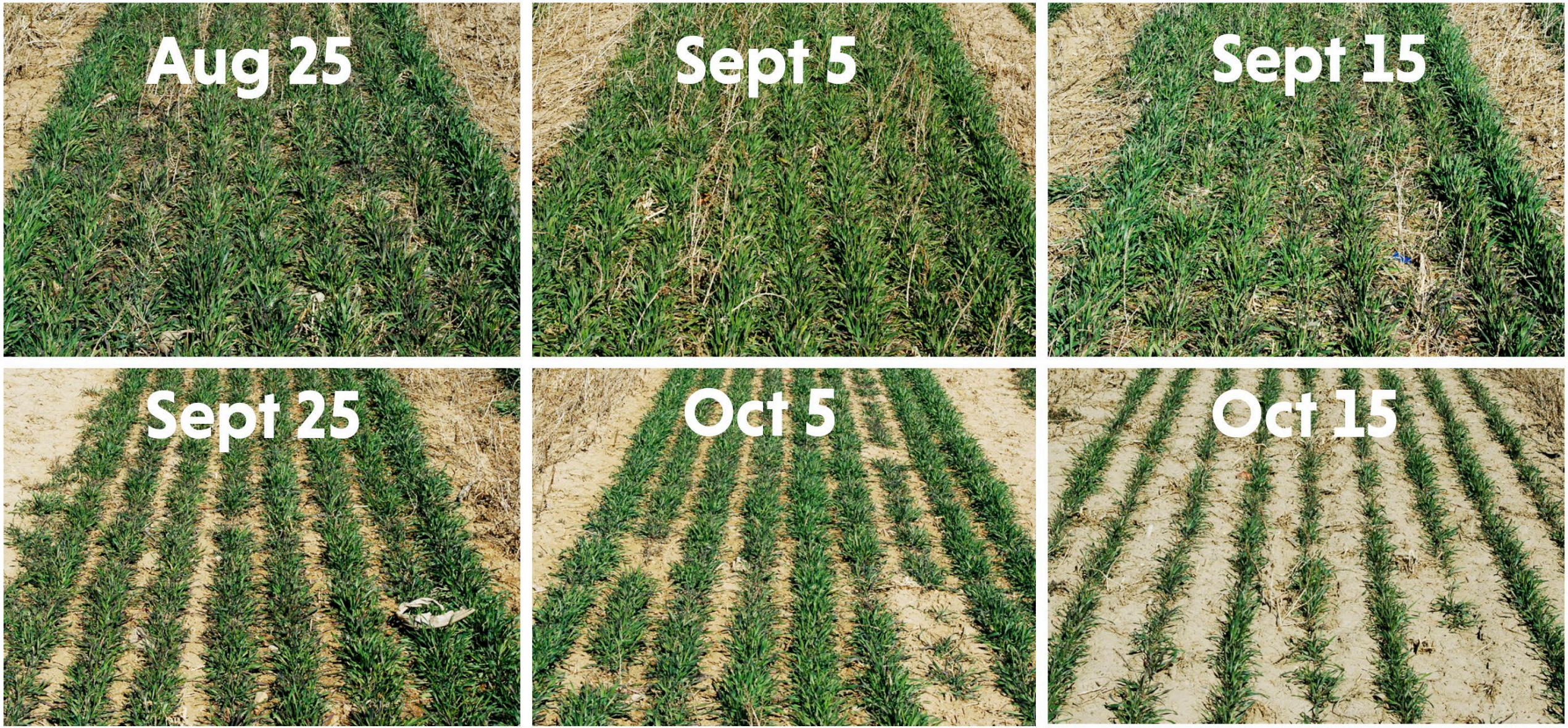


Figure: Ground cover on April 1 in plots where cereal rye was seeded on six dates in the fall as part of an experiment conducted in central Pennsylvania. Photo credit Steven Mirsky and Bill Curran.

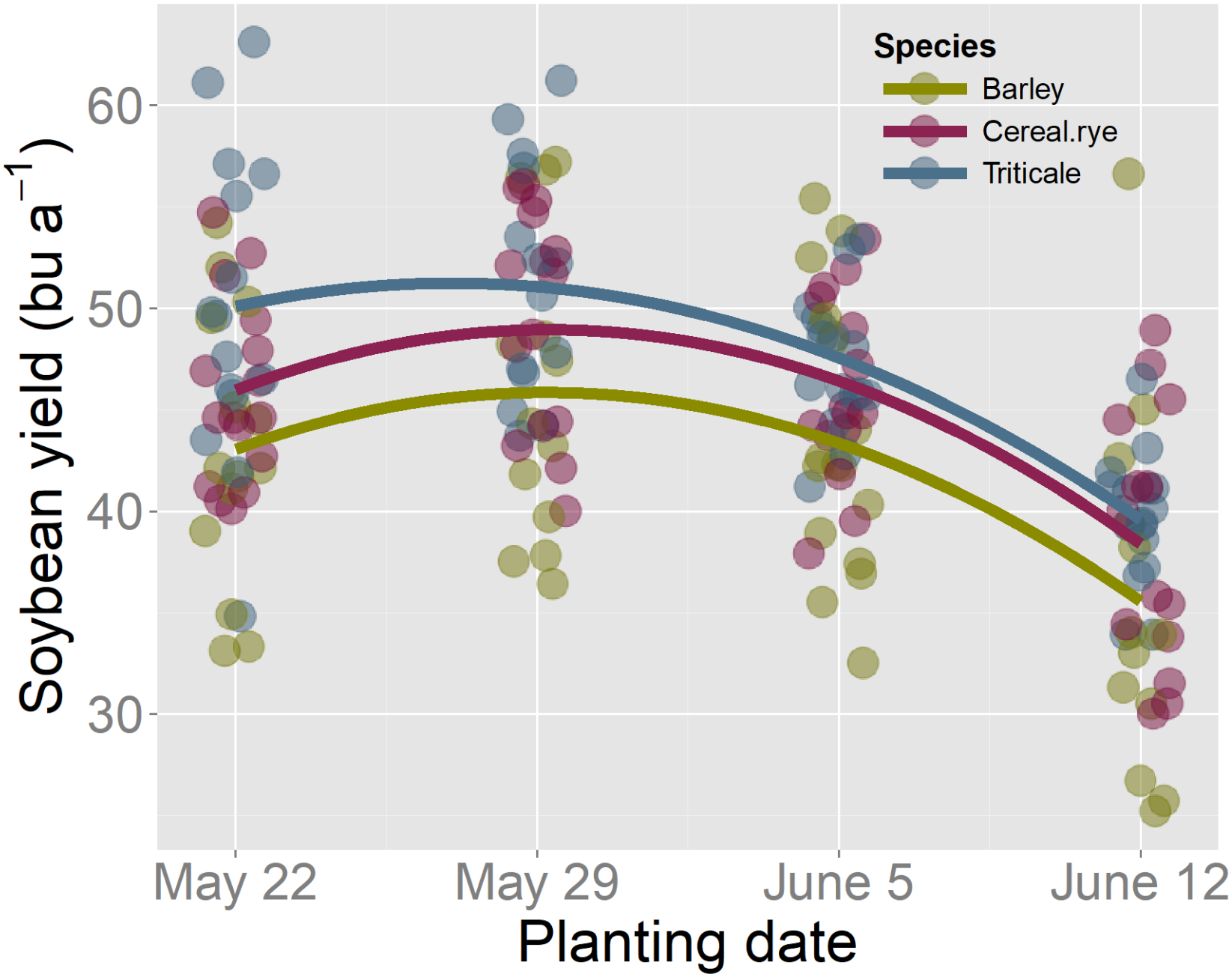
Rolled too early

Effective termination

Keene CL, WS Curran, JM Wallace, MR Ryan, SB Mirsky, MJ VanGessel, and ME Barbercheck. 2017. Cover crop termination timing is critical in organic rotational no-till systems. Agronomy Journal. 109:272-282.

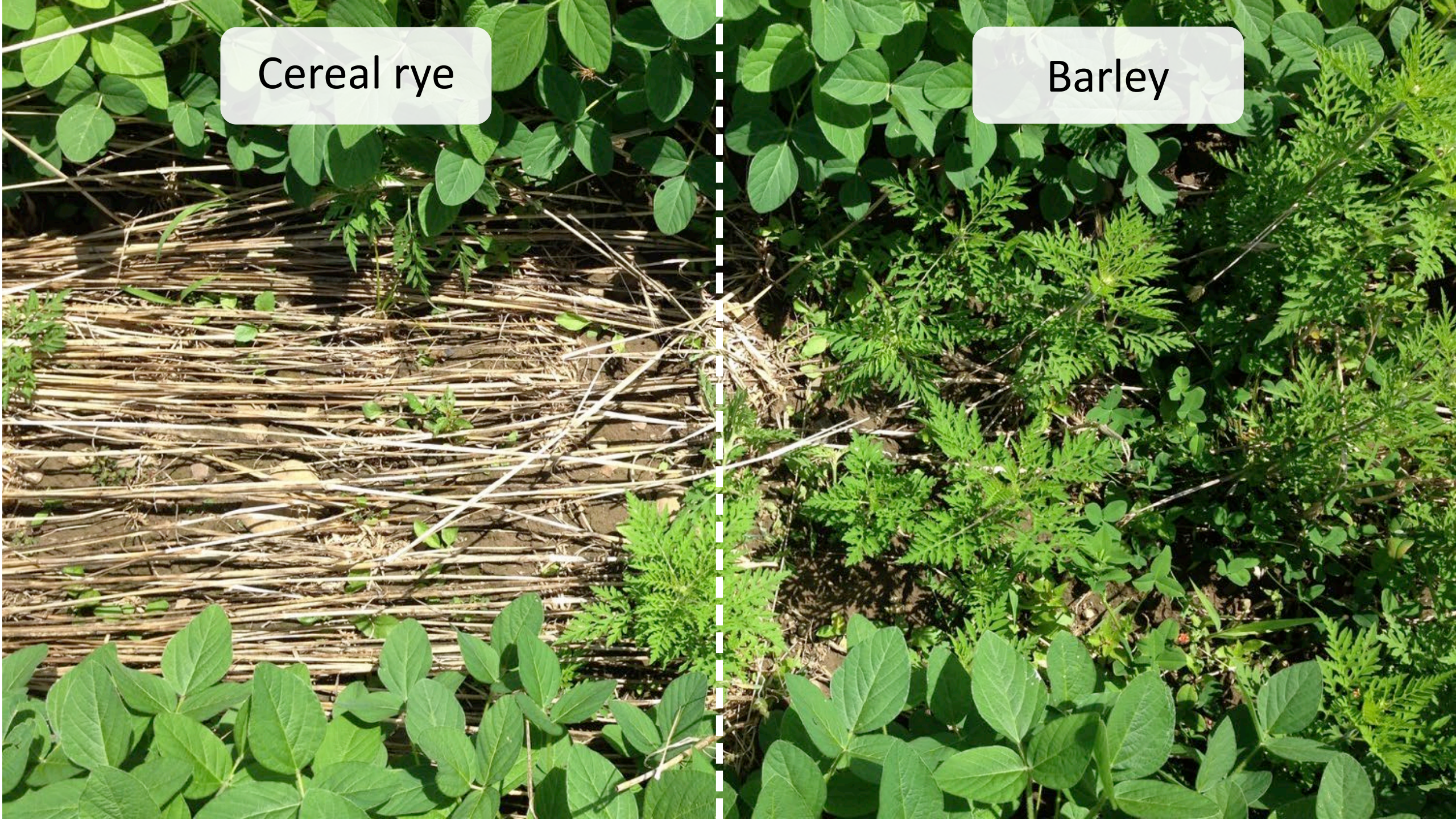
Yield of soybean no-till planted into different cover crops across dates

Greatest yields at early planting dates despite incomplete cover crop termination



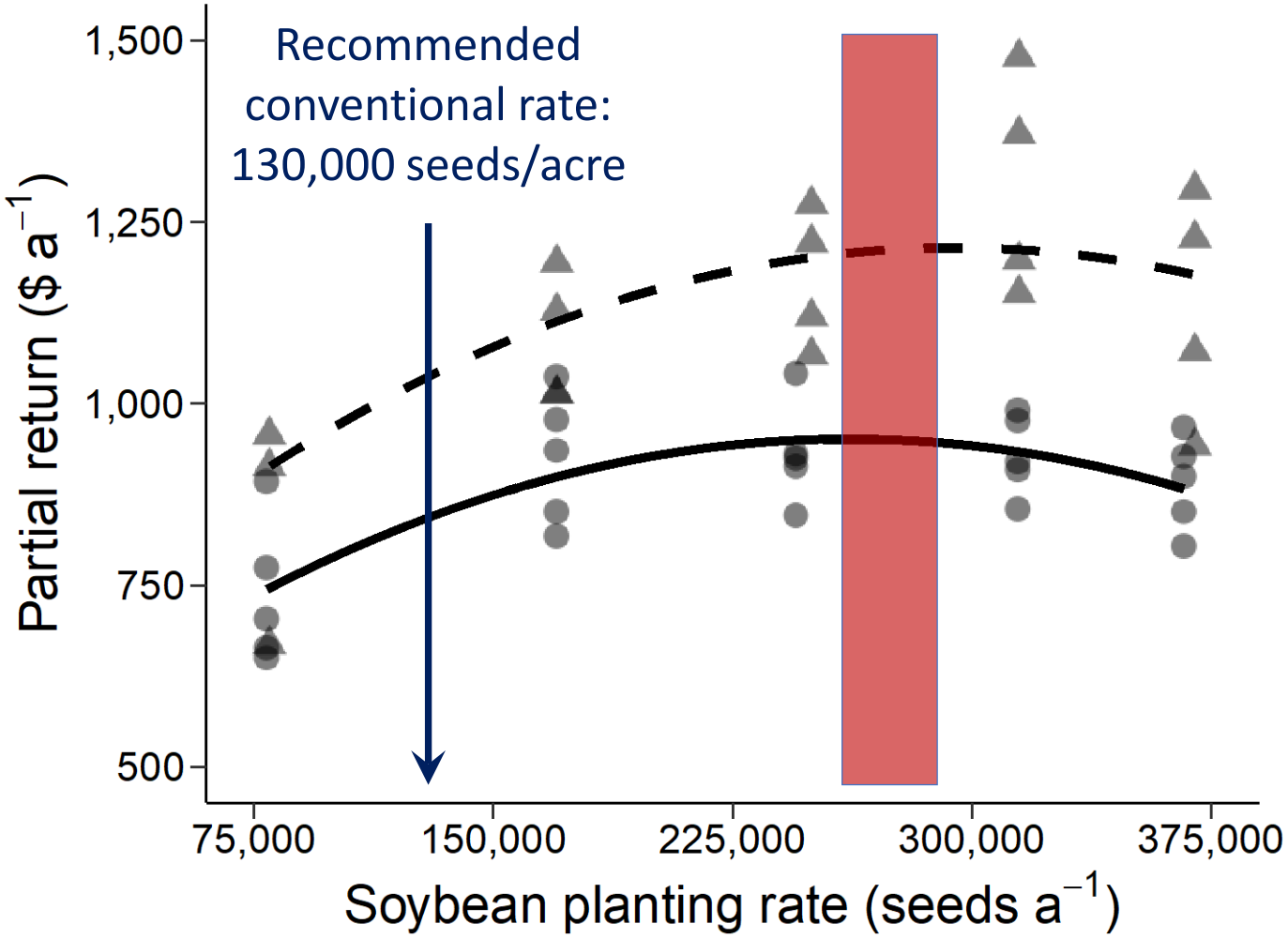
Aurora, NY (2015)

Jeff Liebert


Cereal rye
Barley

Weed suppression across soybean planting rates

Partial profitability in organic no-till



Maximum partial return at 260,000 to 290,000 seeds/acre

Liebert, JA, and MR Ryan. 2017. High planting rates improve weed suppression, yield, and profitability in organic no-till planted soybean. *Weed Technology* 31:536-549.

Obstacles to overcome

- Establishing rye on time and inadequate biomass in spring
- Dry conditions before and after soybean planting
- Early season insect pests that are attracted to mulch
- Equipment and fitting into existing crop rotations

Adaptive Management

Spring is a critical time for organic no-till soybean production. Scouting fields both early in the spring and tracking soil moisture and weather conditions closer to soybean planting can help farmers identify and avoid problems.

Prior to seeding:
Does the field have relatively low population of perennial weeds?

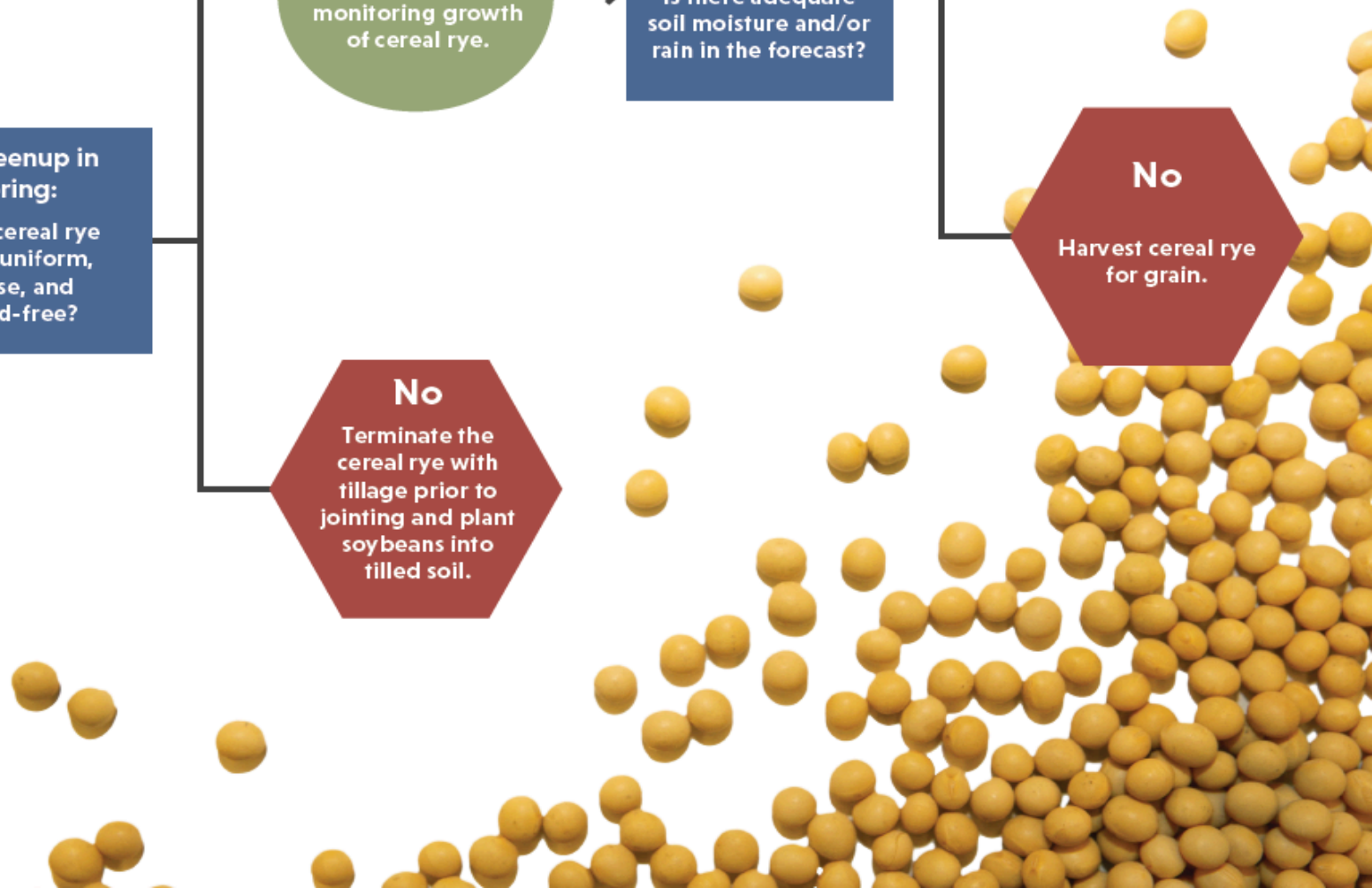
- **No** — Work on reducing weed populations.
- **Yes** — Proceed with seeding cereal rye in early September.

At greenup in spring:
Is the cereal rye stand uniform, dense, and weed-free?

- **No** — Terminate the cereal rye with tillage prior to jointing and plant soybeans into tilled soil.
- **Yes** — Proceed with monitoring growth of cereal rye.

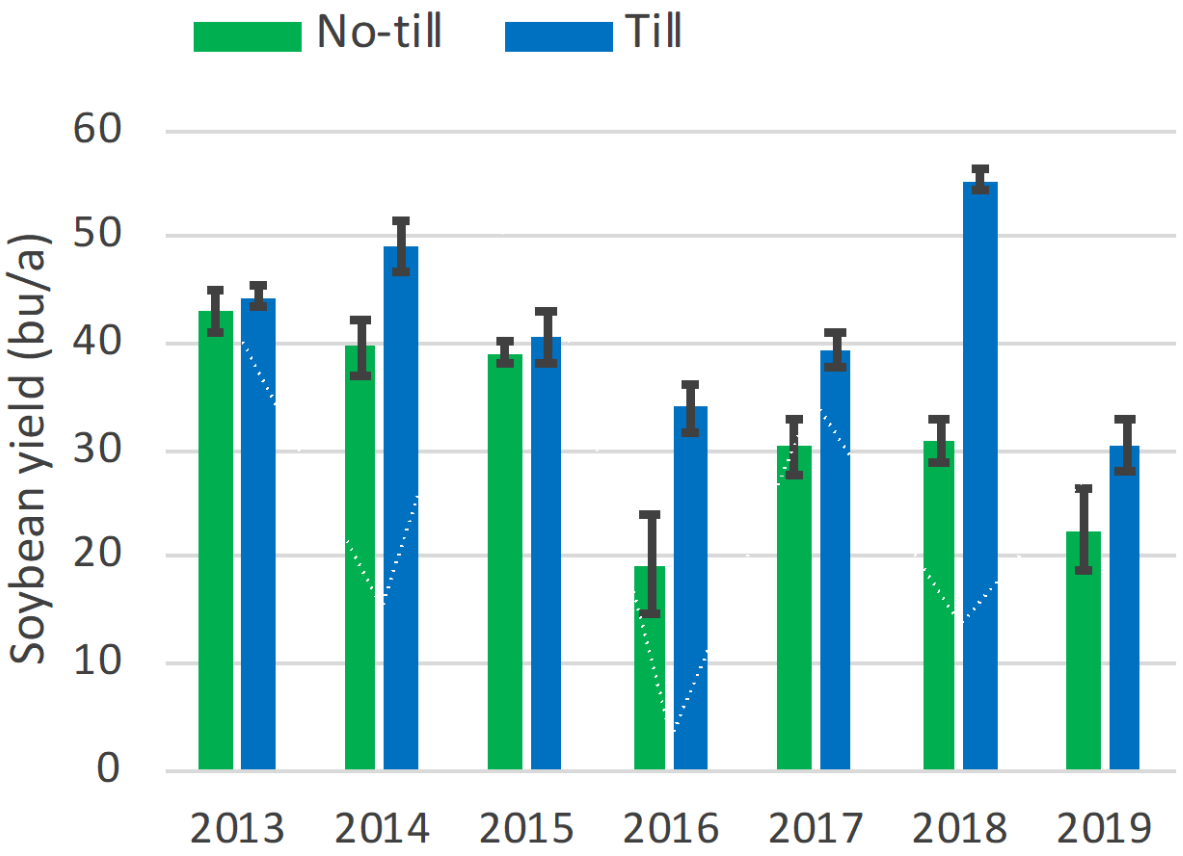
A few days before planting:
Is there adequate soil moisture and/or rain in the forecast?

- **No** — Harvest cereal rye for grain.
- **Yes** — Proceed with rolling cover crop at anthesis and no-till planting soybeans.



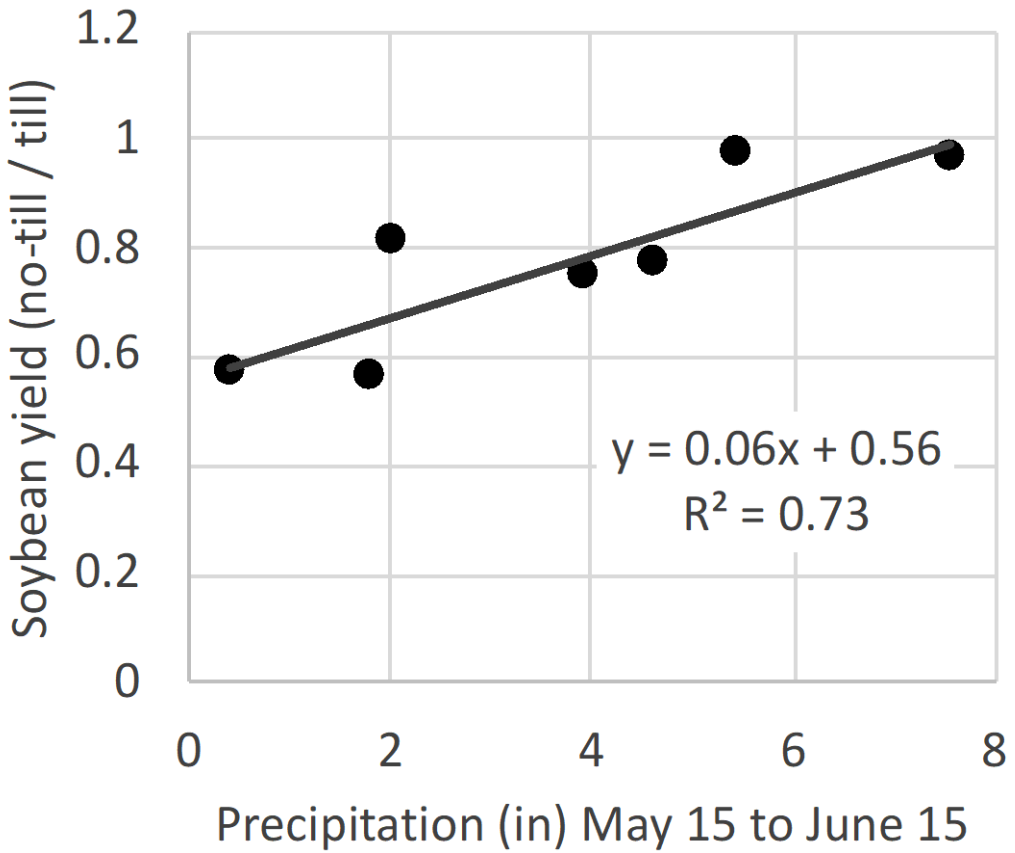
Soybean yield in no-till vs. tilled plots over 7 years

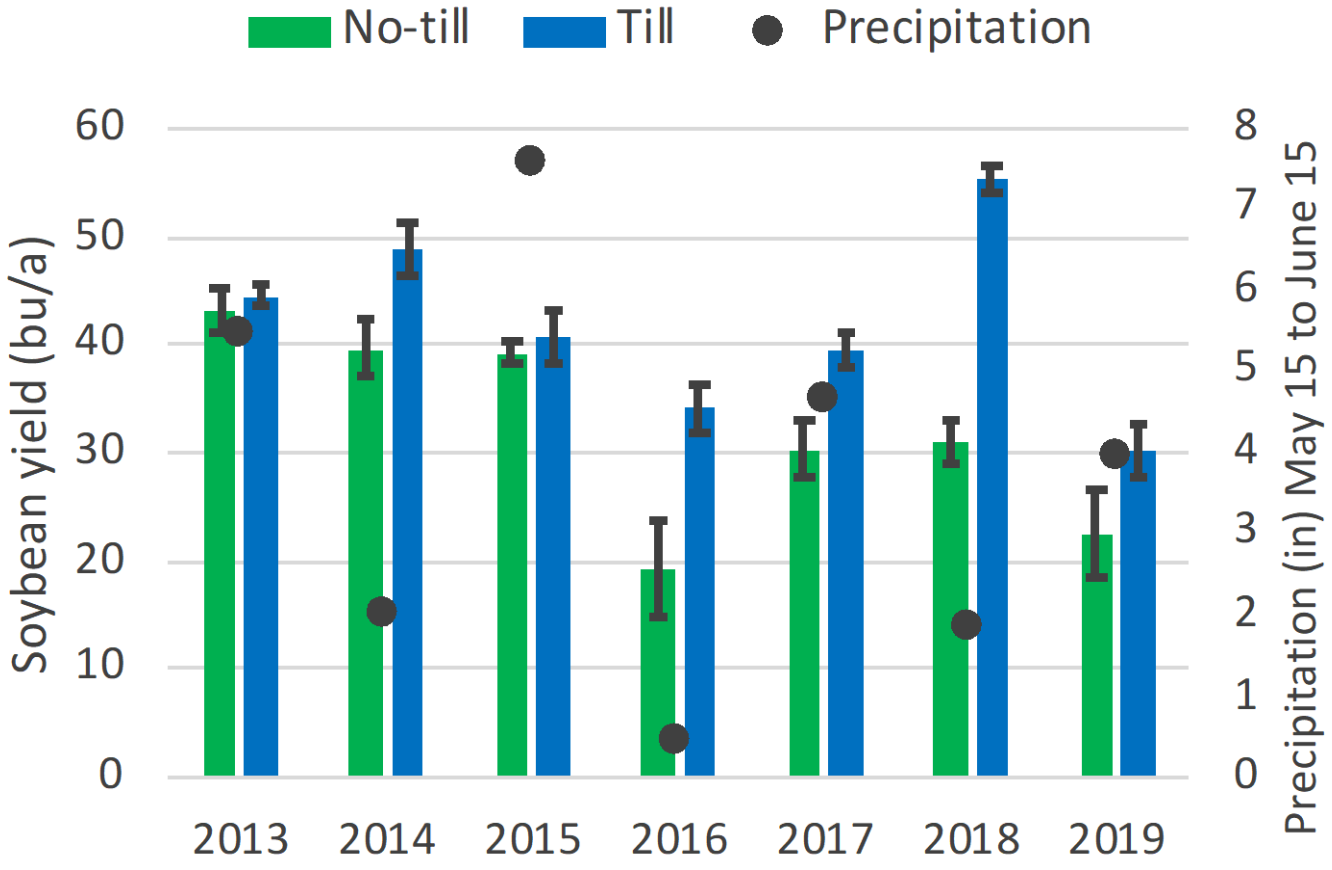
Large yield gap in some years but not others

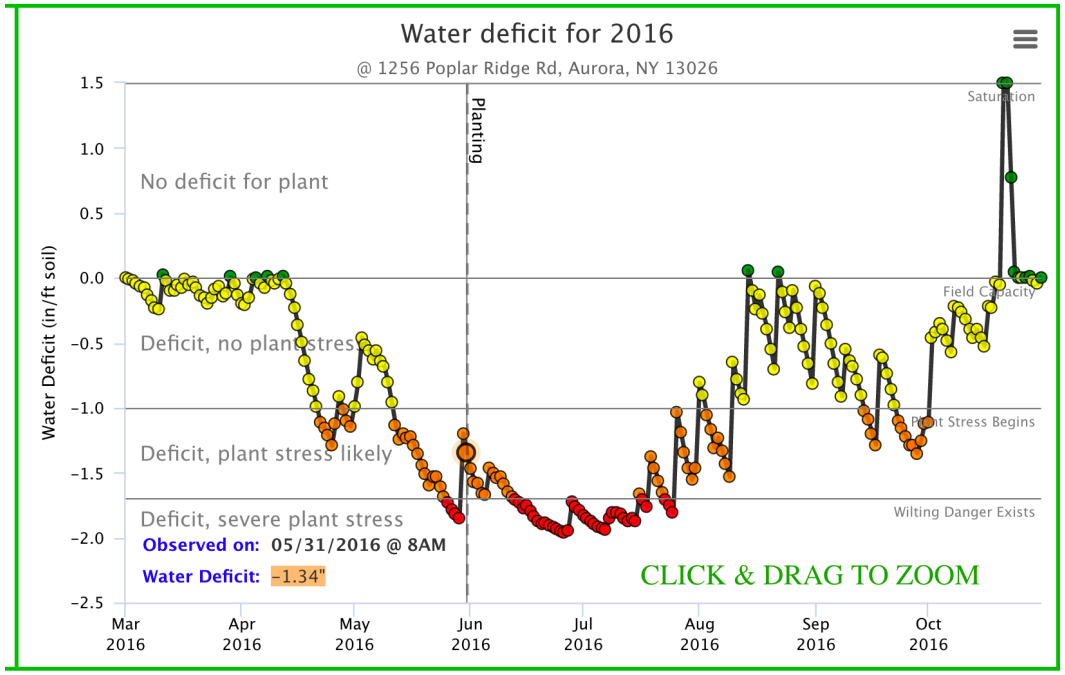


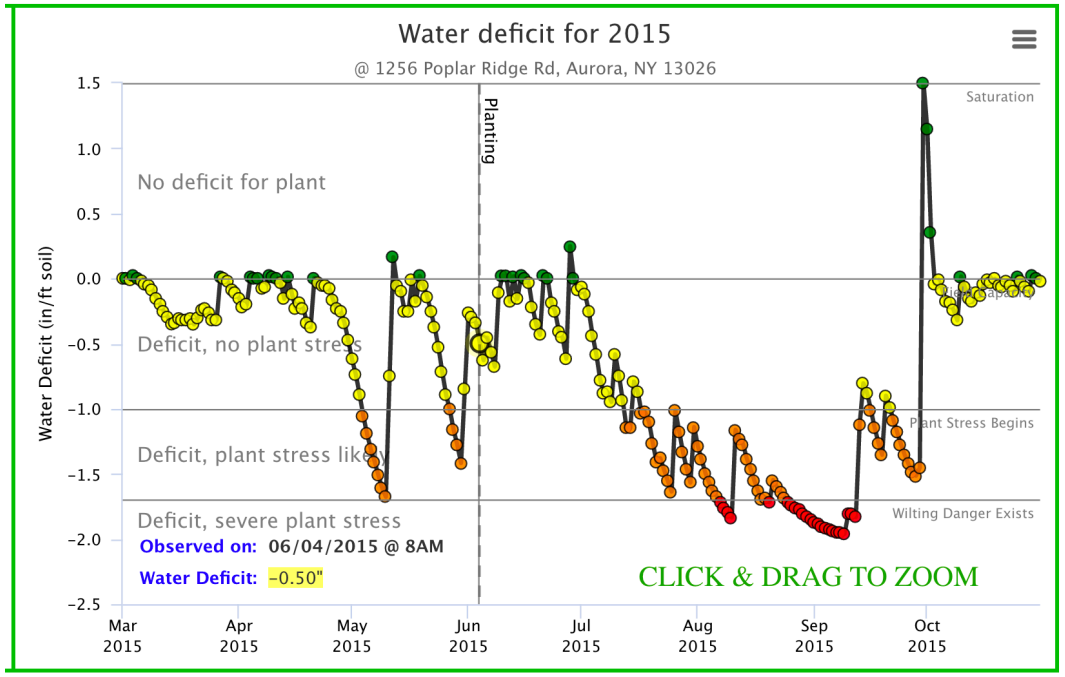
Data from research farms in central NY

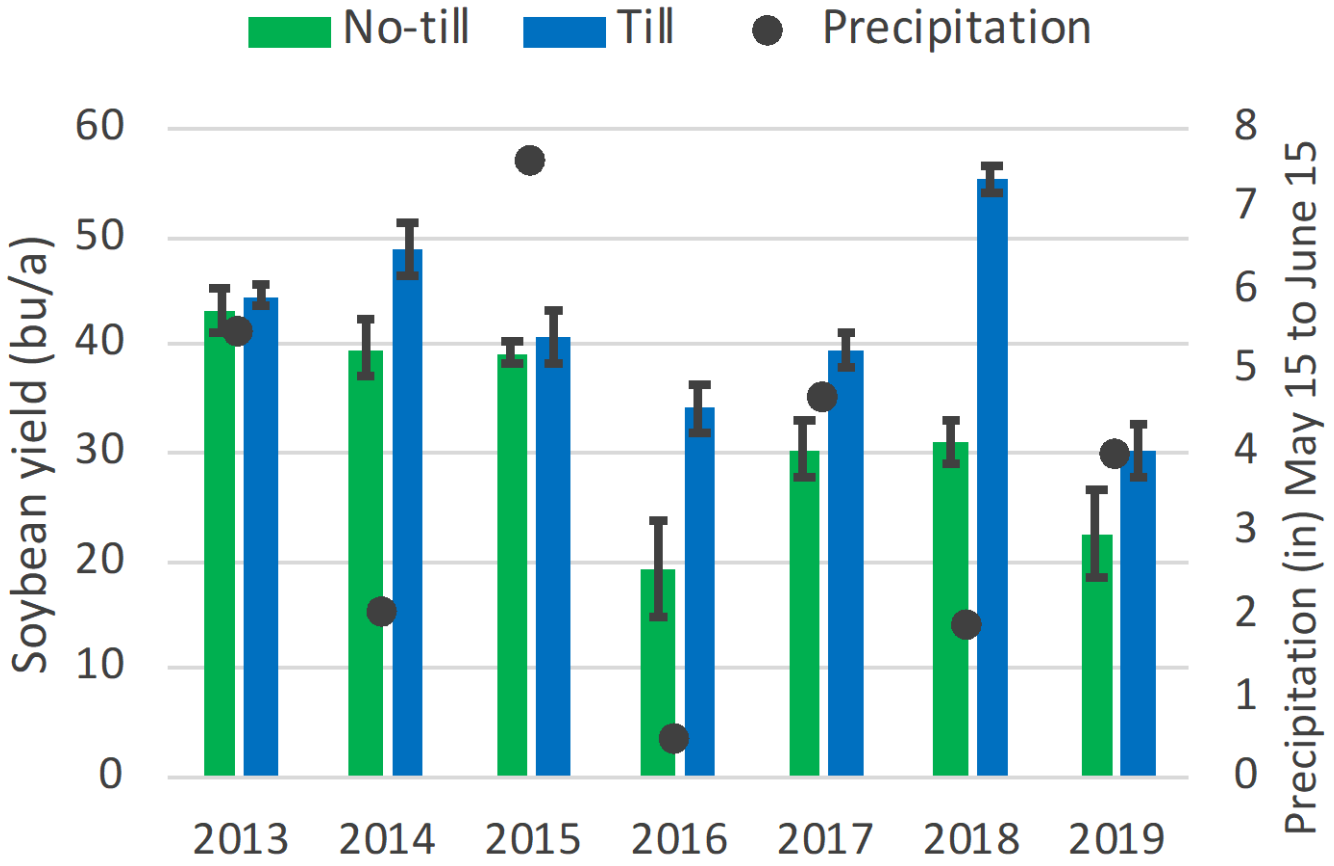
Spring rain important for matching yields of soybean planted into tilled soil





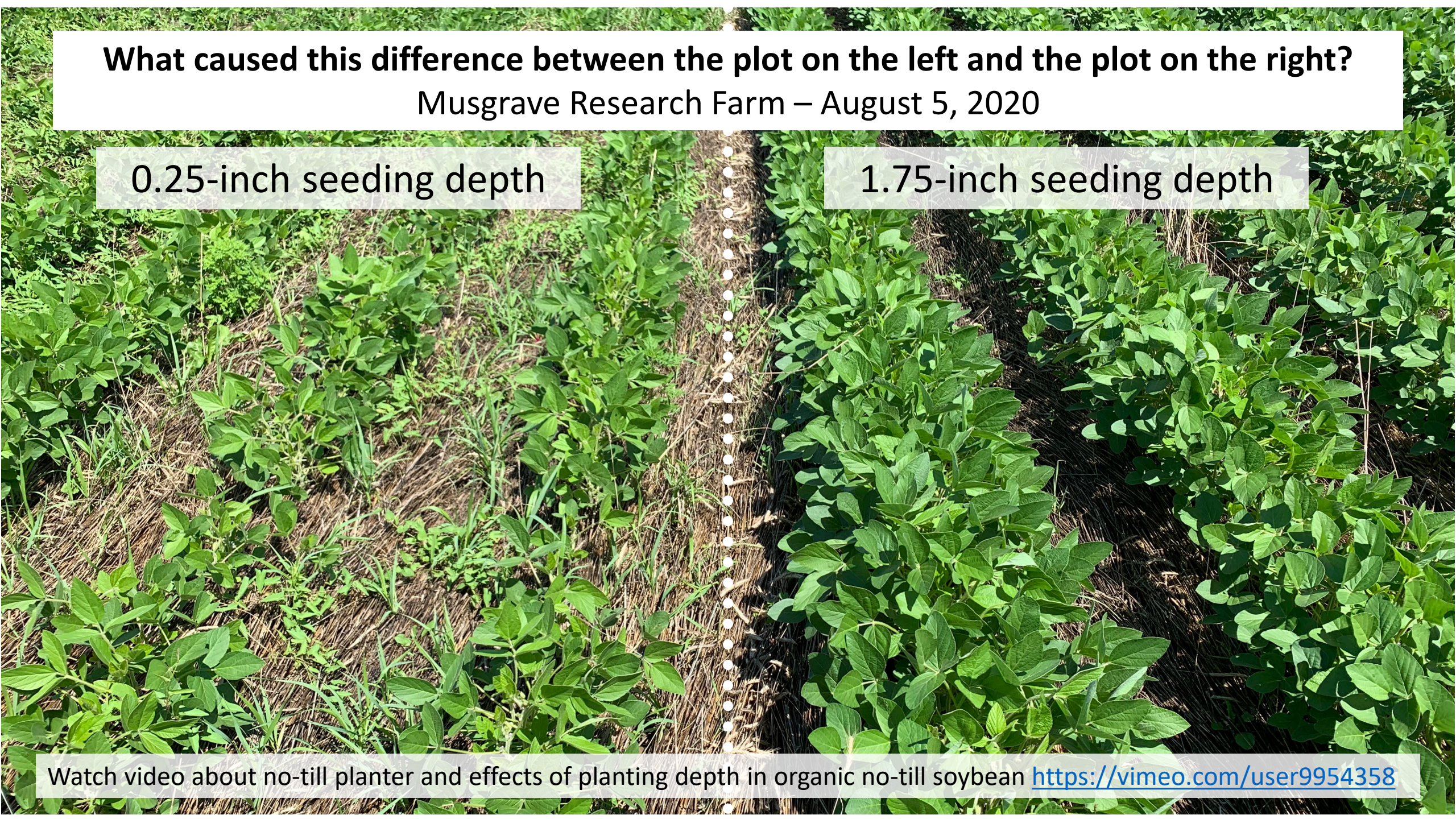






http://climatesmartfarming.org/tools/csf-water-deficit-calculator/


What caused this difference between the plot on the left and the plot on the right?
Musgrave Research Farm – August 5, 2020


What caused this difference between the plot on the left and the plot on the right?
Musgrave Research Farm – August 5, 2020
0.25-inch seeding depth
1.75-inch seeding depth
Watch video about no-till planter and effects of planting depth in organic no-till soybean https://vimeo.com/user9954358

*Proper distancing was maintained by presenter and videographer during filming

New research

- Suppressing white mold with rolled rye in soybean and dry bean
- Inter-row mower and weed zapper for supplemental weed control
- No-till wheat and sunflower into rolled-crimped cover crops

https://www.youtube.com/watch?v=08GEqkrfhdU&feature=youtu.be

Rolled-Crimped Cover Crops for Organic No-till Wheat

Matthew R. Ryan, Terry J. Rose, Sandra Wayman and Christopher J Pelzer

Southern Cross University

Cornell CALS
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Soil and Crop Sciences Section

Why wheat?

- Research on organic no-till grain production focused on no-till planting corn and soybean into rolled-crimped winter cover crops
- Often tillage is moved from before summer cash crops to before winter cover crops as part of a rotational approach
- Limited research on other grain crops that can be no-till planted into rolled-crimped cover crops
- Success with wheat could lead to extended sequences of organic no-till


JOHN DEERE
1590
O'HARA MACHINERY
Auburn, NY
Yetter
farm equipment
JOHN DEERE

Objective

Evaluate seedling emergence, weed suppression, and grain yield in organic wheat no-till drilled into rolled crimped cover crops

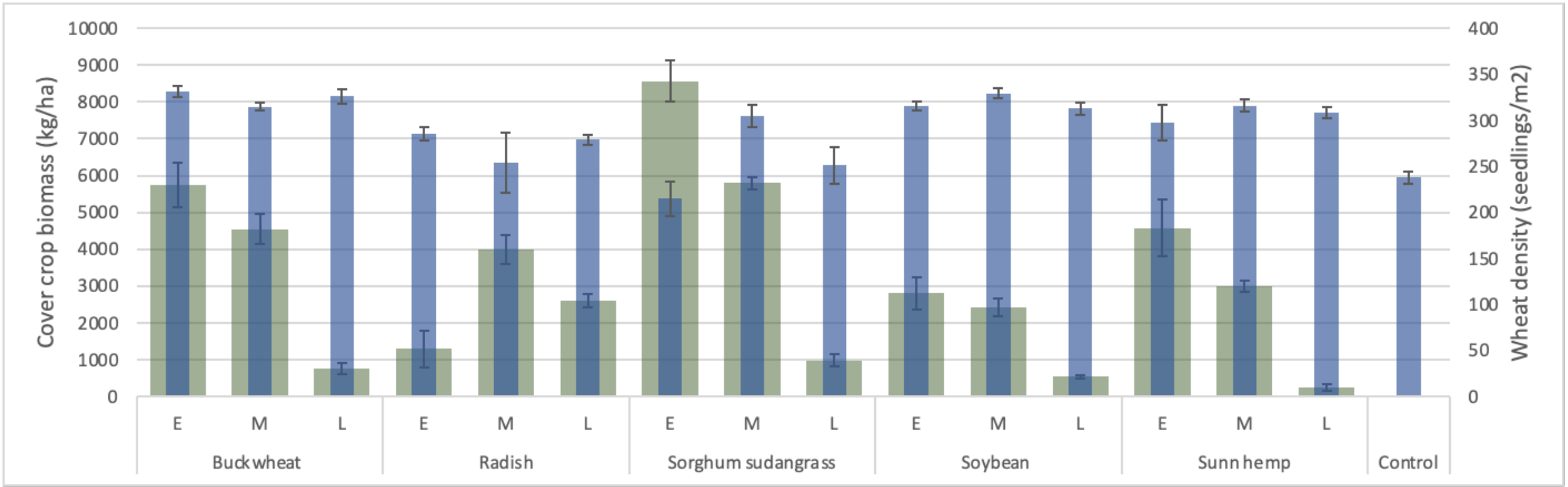
Methods

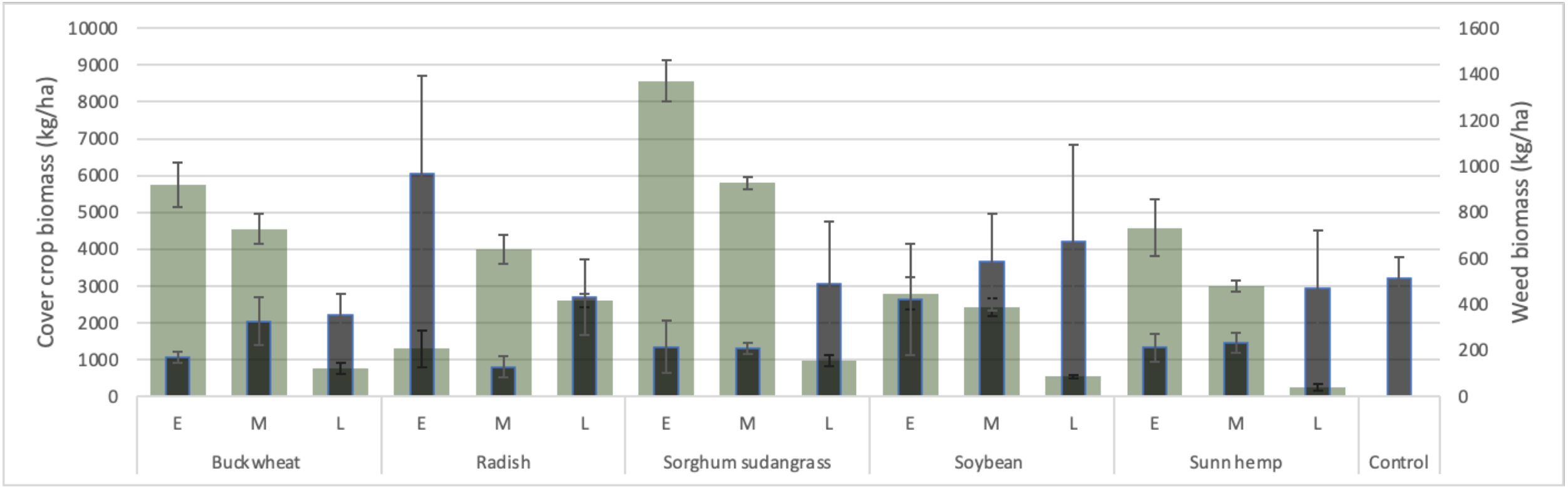
- Cornell Musgrave Research Farm in Central NY

- 5 cover crops were seeded on July 12, July 30, and August 20 in 2019
  - Buckwheat (variety not stated) at 64 kg pure live seeds ha^{-1}
  - Radish ('Daikon') at 12 kg pure live seeds ha^{-1}
  - Sorghum sudangrass ('ADV S5501') at 56 kg pure live seeds ha^{-1}
  - Soybean ('Viking O.1518N') at 72 kg pure live seeds ha^{-1}
  - Sunn hemp (variety not stated) at 40 kg pure live seeds ha^{-1}

- Cover crops were terminated with a roller-crimper and winter wheat ('SY Wolf') was drilled at 3.2 million pure live seeds ha^{-1} September 29

- Wheat was harvested with a plot combine July 21 in 2020


Cover crop biomass (kg/ha)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Wheat density (seedlings/m2)
400
350
300
250
200
150
100
50
0
E
M
L
Buckwheat
Radish
Sorghum sudangrass
Soybean
Sunn hemp
Control


Cover crop biomass (kg/ha)
Weed biomass (kg/ha)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1600
1400
1200
1000
800
600
400
200
0
E
M
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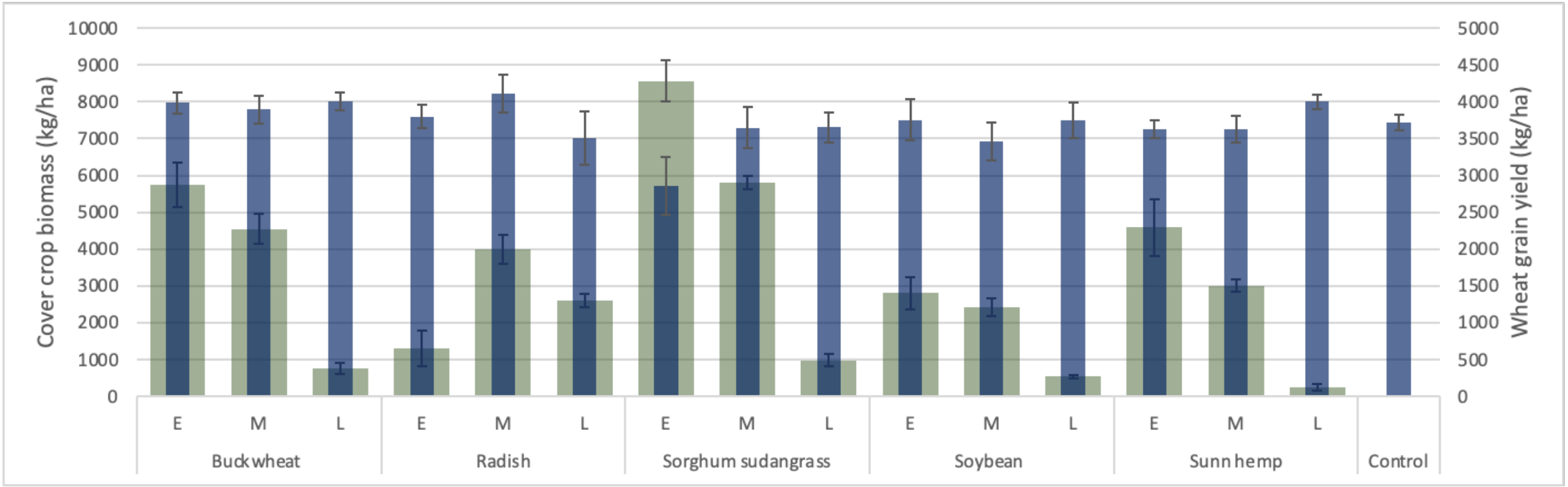
Buckwheat
Radish
Sorghum sudangrass
Soybean
Sunn hemp
Control


Cover crop biomass (kg/ha)
Wheat grain yield (kg/ha)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
5000
4500
4000
3500
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Soybean
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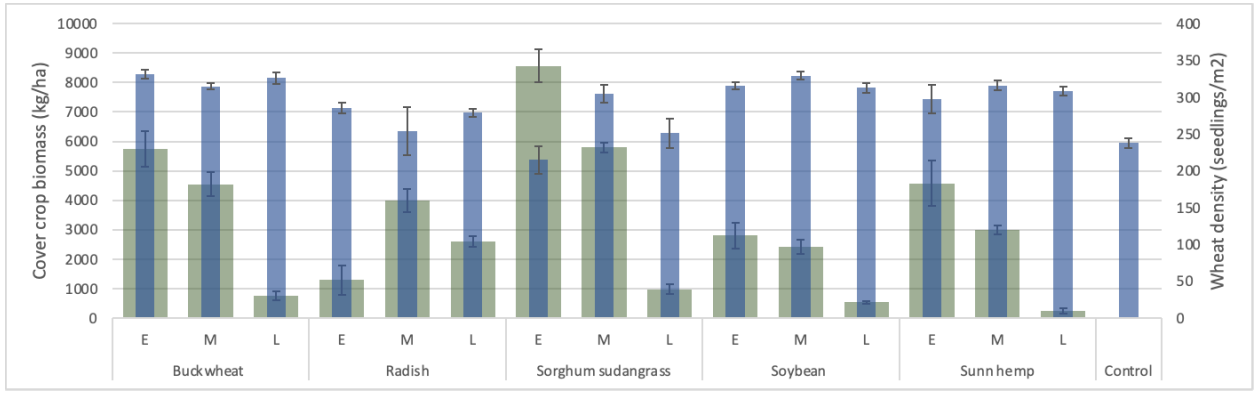
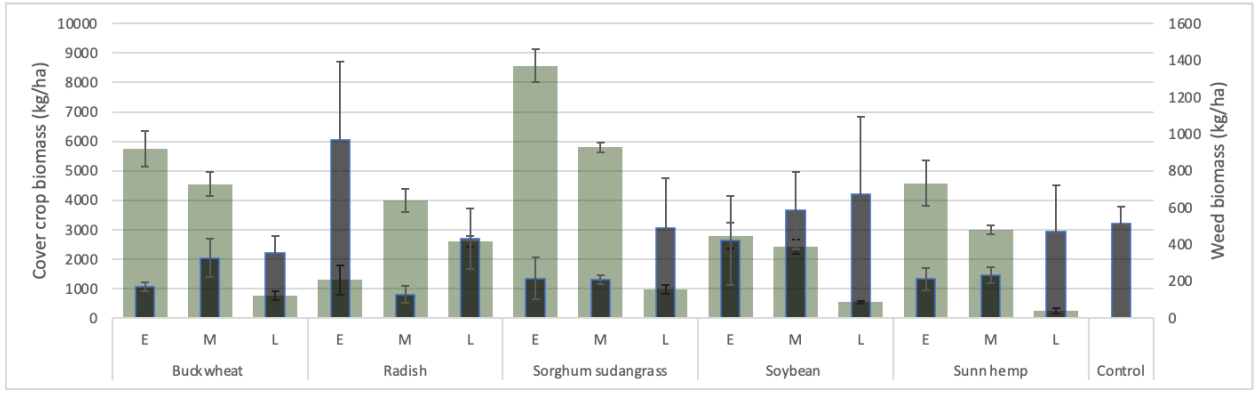
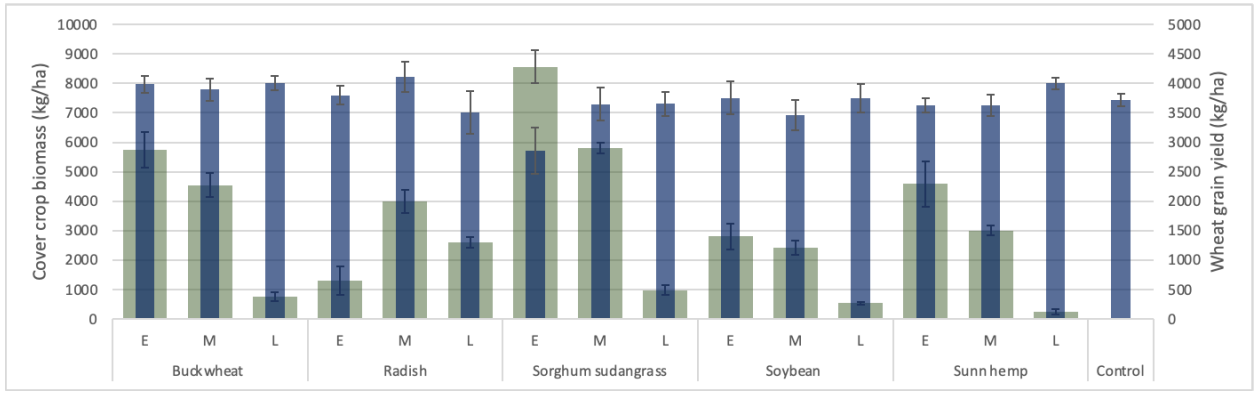






Results show that cover crop biomass in 2019 affected wheat emergence, weed suppression, and wheat grain yield

Buckwheat suppressed weeds but not wheat emergence or yield

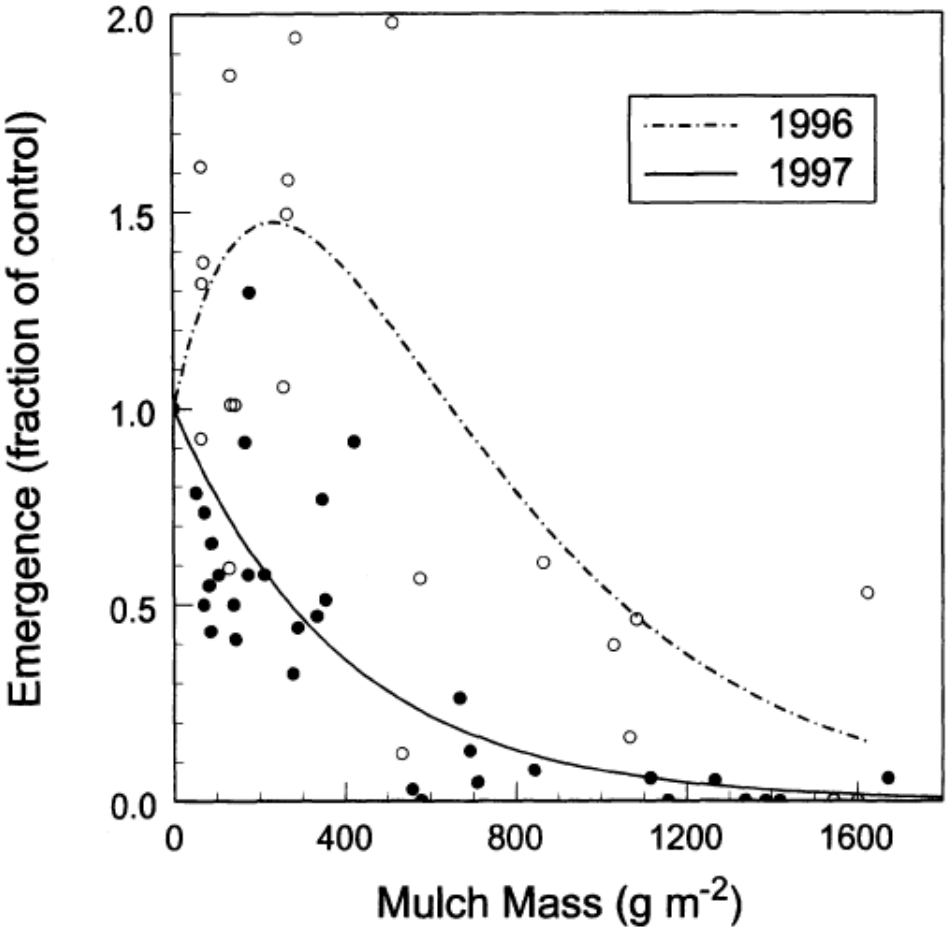
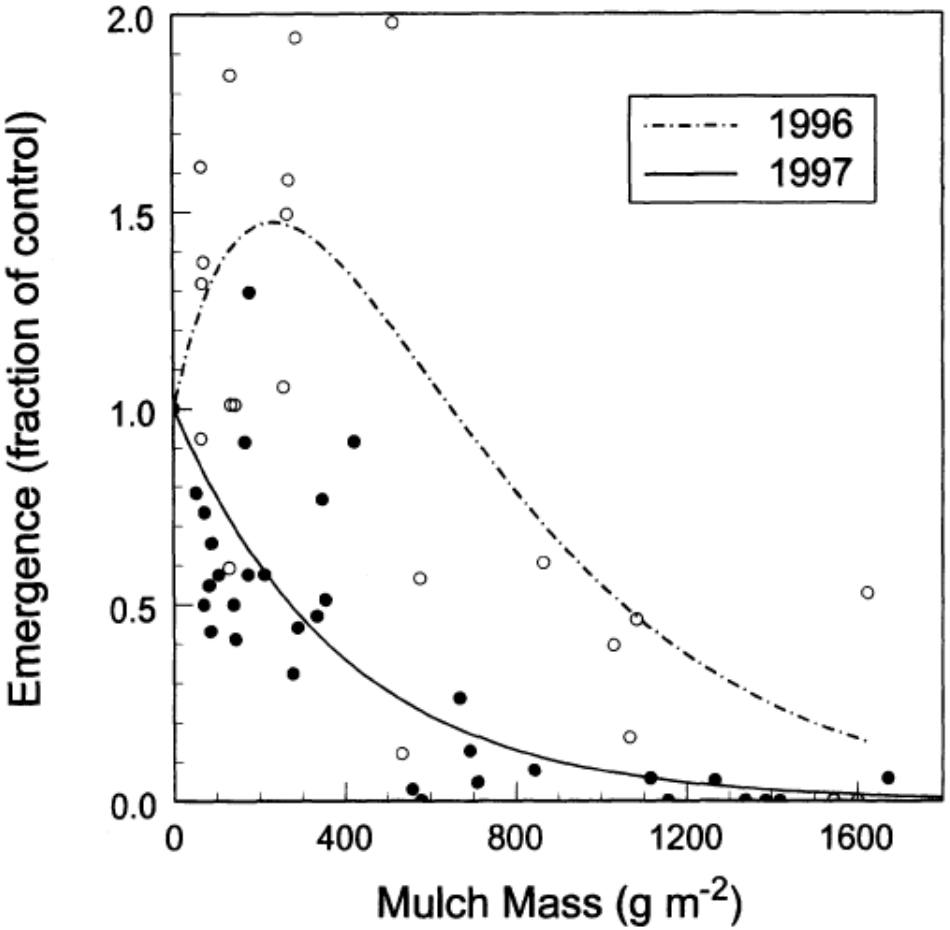


FIGURE 1. *Amaranthus retroflexus* emergence (E) as a function of mulch mass (M). Models were $E = (1+0.00778 \cdot M) \cdot \exp(-0.00277 \cdot M)$ for 1996 ($R^2 = 0.43$) and $E = \exp(-0.00255 \cdot M)$ for 1997 ($R^2 = 0.59$). The coefficients in the 1996 model were significantly different than 0 indicating that the stimulation of emergence at low mulch rates was significant. Data for *Trifolium incarnatum* and *Vicia villosa* mulches were pooled for presentation because responses to mulches separately were not significantly different according to 95% confidence intervals.

Teasdale, J.R. and Mohler, C.L., 2000. The quantitative relationship between weed emergence and the physical properties of mulches. *Weed Science*, *48*(3), pp.385-392.

Expected similar relationship between mulch and wheat emergence as what has been shown for mulch and weed emergence



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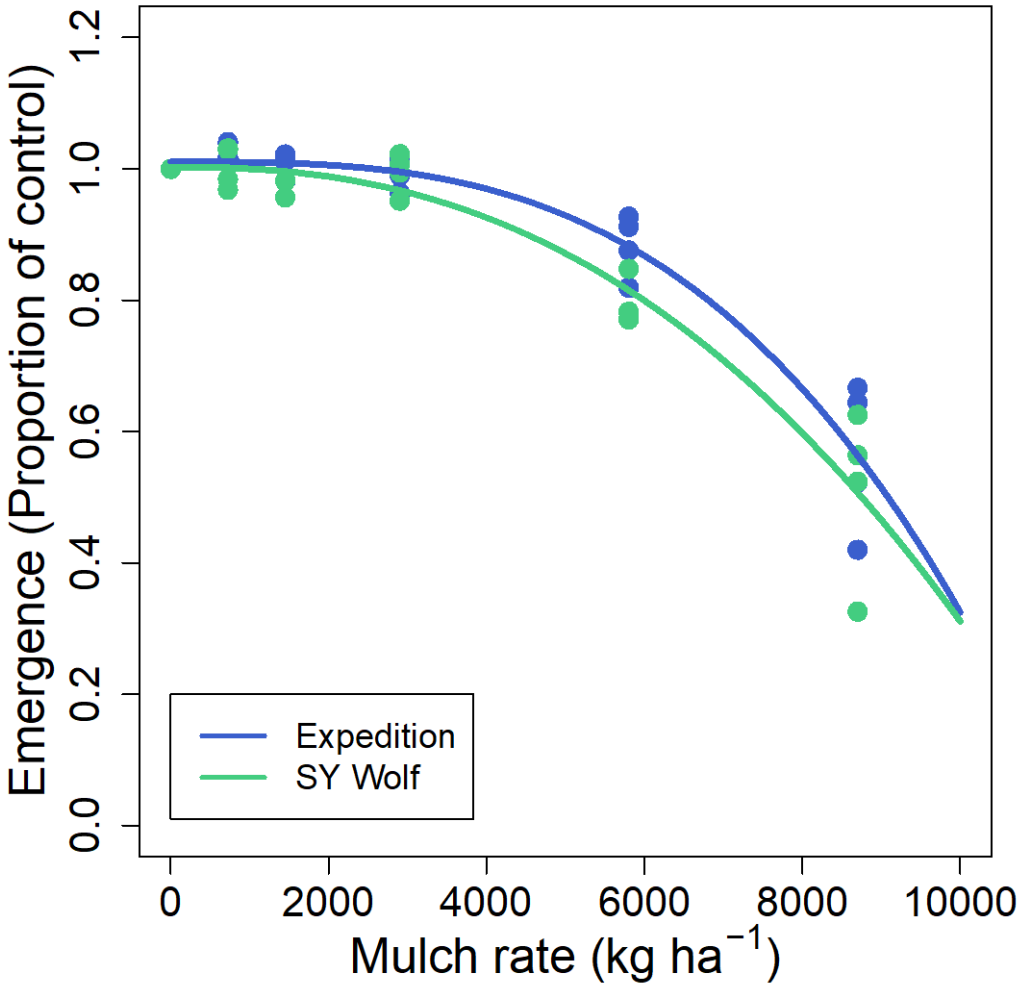
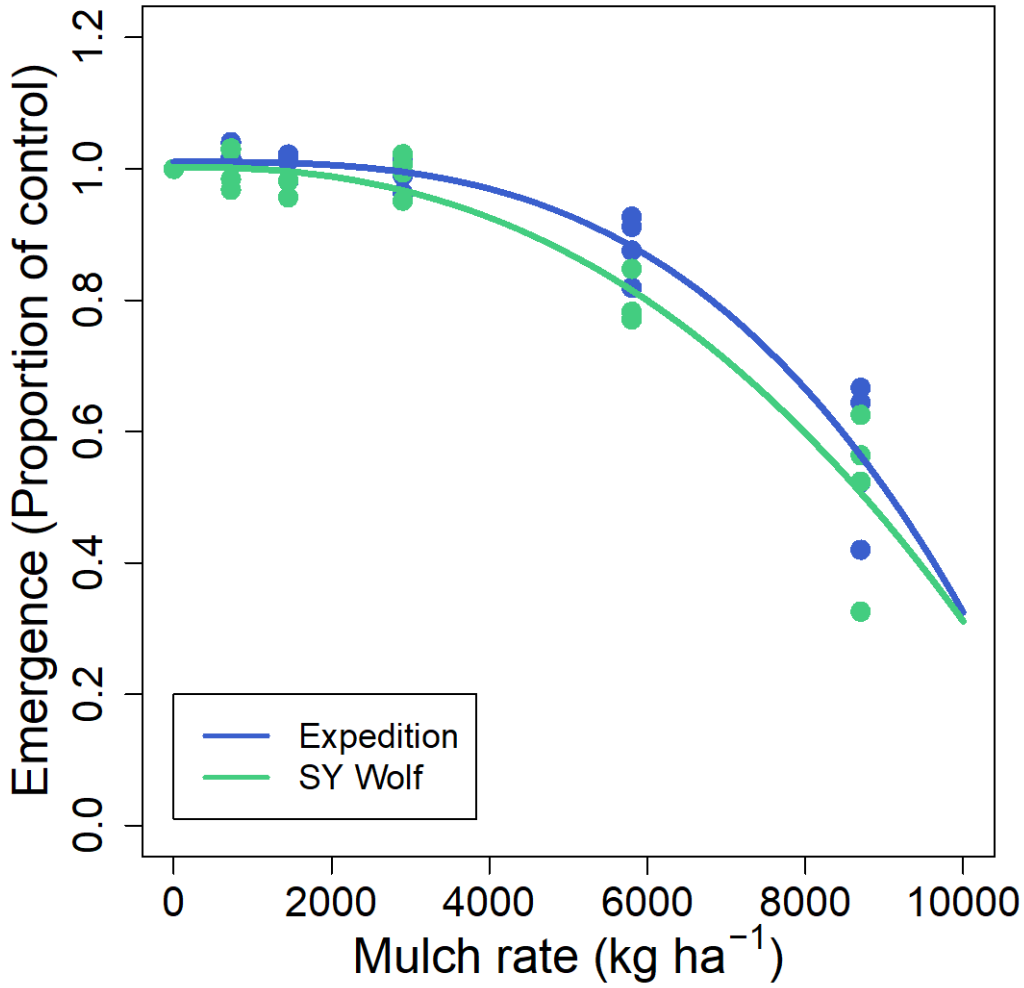


Teasdale, J.R. and Mohler, C.L., 2000. The quantitative relationship between weed emergence and the physical properties of mulches. *Weed Science*, *48*(3), pp.385-392.

Results show that wheat seedling emergence was relatively tolerant to increases in mulch

Likely due to trait differences between wheat and the small seeded broadleaf weed species that were studied previously



Conclusions

- Wheat can be no-till drilled into rolled crimped cover crops, expanding crop rotation options for organic farmers who want to minimize soil tillage

- Ability to tolerate and emerge through moderate levels of mulch

- Buckwheat is a smother cover crop that can produce large biomass over a short period and facilitate no-till wheat production

Acknowledgements and funding

- James Cagle
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- Uri Menalled
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Funding: OECD Co-operative Research Program, the USDA National Institute of Food and Agriculture, Hatch Project 2016-17-252, and the New York State Environmental Protection Fund for the New York Soil Health Initiative, administered through the New York State Department of Agriculture and Markets Contract No. C00178GS-802 3000000

Southern Cross University