Using cover crops to adapt to climate change

Jason Kaye, with Charlie White, Mary Barbercheck, Armen Kemanian, William Curran, and Dave Mortensen
Can cover crop species selection and cover crop mixtures increase resilience of yield and water quality to warming, drought, and intense precipitation?
We planted 0, 1, 3, 4, & 6 cover crop species in PA.

- Clover
- Canola
- Cereal Rye/Triticale
- Austrian Winter Pea
- Forage Radish
- Oats
Winter cover crops reduce sediment and nutrient pollution

But cold fall/winter temperatures limit their impact

Critical time for leaching to subsoil
Warming will make it easier to establish cover crops in autumn.
We can use planting date as an analogue for climate change

Canola planting dates:

- August 24
- October 5
- August 2
- Sept 13
Warming will also increase soil N mineralization

Enhanced cover crop growth
Also enhanced N mineralization

Critical time for leaching to subsoil

Month

Cover Crop Growth potential

Future climate
Current climate

Wheat
Silage
Soy
Corn Grain
Corn
With current climate, we can grow diverse mixtures after wheat but not after corn.
Mixtures are sensitive to soil and climate conditions: can we use this as an adaptation tool?

Rye dominated

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Canola dominated

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- Red clover
- Pea
- Canola
- Cereal rye

Shorter season

 Longer season
Summary: Warming will likely increase cover crop growth and species options

- Larger fall cover crops will have co-benefits, like reduced erosion potential, C inputs, and weed suppression
- Higher fall mineralization may increase need for cover crops for N retention
- In some windows/regions double cropping may replace cover cropping
- Species selection can be used to adapt to warming.
  - Eg. Deep rooted species
  - Mixtures provide insurance that some species will thrive
Drought may have a larger impact on cash crop growth than cover crop growth.

Plant water stress not common.

Future climate vs. Current climate.
Some farmers worry that cover crops will reduce water availability to cash crops.
Some farmers worry that cover crops will reduce water availability to cash crops. Warming may exacerbate this problem. But precipitation increases could ameliorate it. Either way, cover crops can be used to adapt.

Kill date choices
Leaving residues as mulch.

Winter kill species
Soils mulched by cover crops have more soil moisture during cash crop season

- Not our results but others have found:
  - Increased infiltration
  - Decreased evaporation from soil
- Species election: After radish or canola diminish compaction, corn yields increases due to greater access to deep water (Chen and Weil 2011)
Integrated soil fertility management considering fertilizer, soil and cover crop residues may provide more adaptive capacity for yield resilience than cover cropping alone.

We found that the main effect of cover crops was through N: More N from cover crops increased corn root growth and yields with and without drought.
Summary: Cover crops can help adapt to drought via...

1. Integrated nutrient management that promotes early season cash crop root growth
2. Managing kill date or using winter kill species
   • Need local research
3. Increasing infiltration (radish)
4. Mulching soil (needs local research)
5. Other soil health aspects? Need research
Intense rain events are increasingly common in the Northeast, especially September-October.

Most Extreme Events Occurred Recently

- Top 10 Rain Events, Central PA:
  - Events since 2000: 7
  - Events 1990-2000: 2
  - Events 1948-1990: 1

9 of the top 10 Rain Events in a 71-year Central PA record occurred since 1990.

Most Extreme Rain Events occurred between July & October

- # of top 10 Rain Events, Central PA:
  - April: 1
  - June: 1
  - July: 2
  - September: 4
  - October: 2

Mid-summer through fall is a peak time for these events.
Rainfall intensity: Cover crops can reduce erosion from high intensity events....but only if we get them planted in time.
Interseeding may be an important strategy to beat the fall rains
Before harvest cover crops are already established

- Also a common practice in wheat
- Species interactions are important:
  - If radish dominates then poor spring cover
  - Which species best reduce erosion in fall? (current research)
Intensity summary

• Cover cropping could become challenging if extreme rain events are synchronous with planting or killing cover crops
  – Interseeding can reduce this risk
• If we get them planted, cover crops will certainly reduce sediment losses
  – How do species differ?
  – Are mixtures better than monocultures?
Using cover crops to adapt to climate change

• Fall N leaching from soil may increase with warming
  – cover crops can help
• Fall rain intensity may increase sediment and P losses
  – cover crops can help if we can get them planted
  – interseeding can help but adoption is low, research needed
• Integrated N management may increase drought resilience of corn yield
• Species selection is an important lever
  – Which species best reduce erosion from extreme events?
  – How does species selection affect spring soil moisture?
• Cover crop mixes add insurance
There are often tradeoffs between N retention services and N supply.
Mixtures don’t change services, but they diminish dis-services.