



Minimizing Phosphorus Loss with 4R Practices & Cover Crops

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Why do producers surface-apply P fertilizer in the fall?

- Surface applications are faster, more convenient
- There is a large window of time for fall applications
- Agronomic efficacy may not be much different from sub-surface applications...

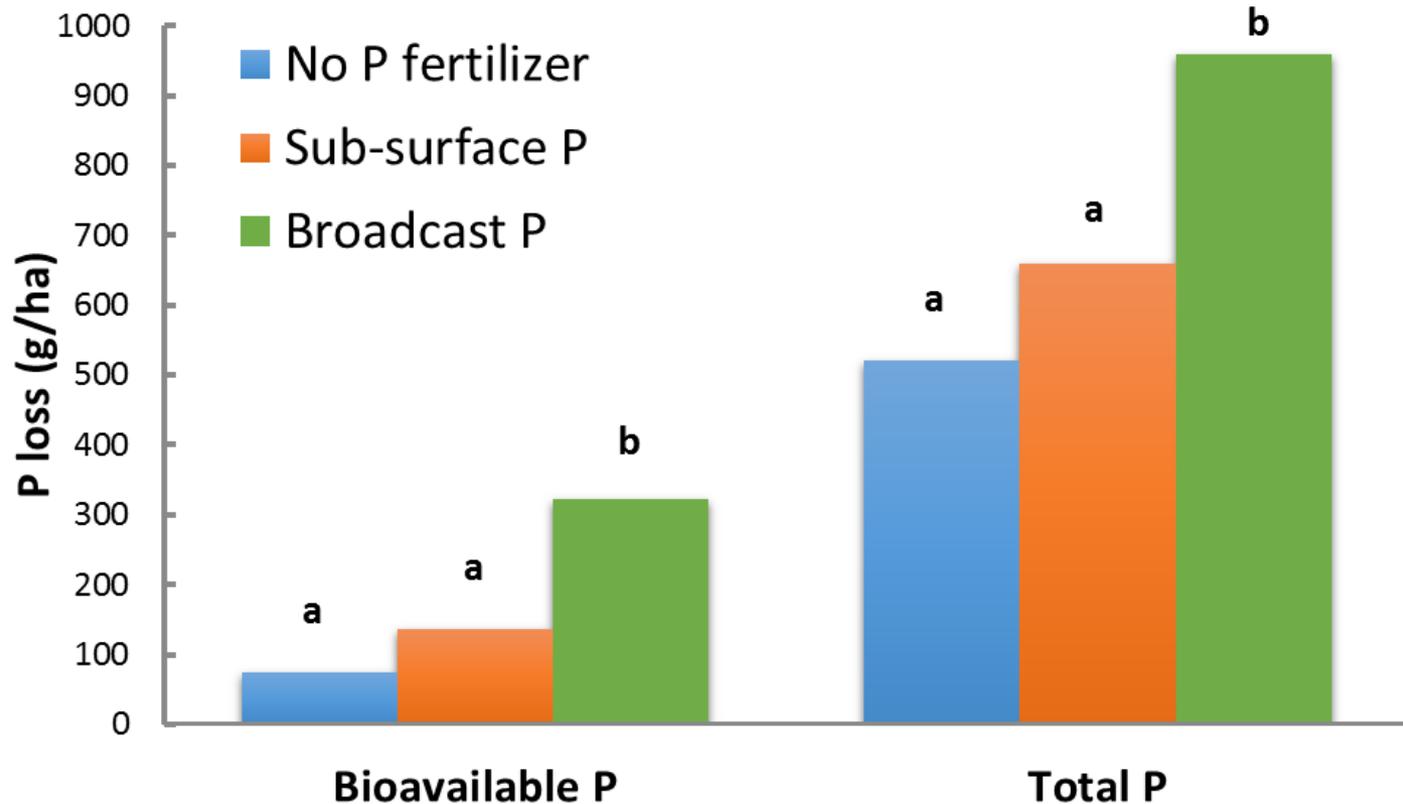
*Is this the
right place?*



Surface-broadcast fertilizer can increase risk of P loss

P loss from Grain Sorghum in 1998

(Kimmell et al., 2001)



Is this the right place?

Can we develop best management practices for surface-applied P fertilizer?

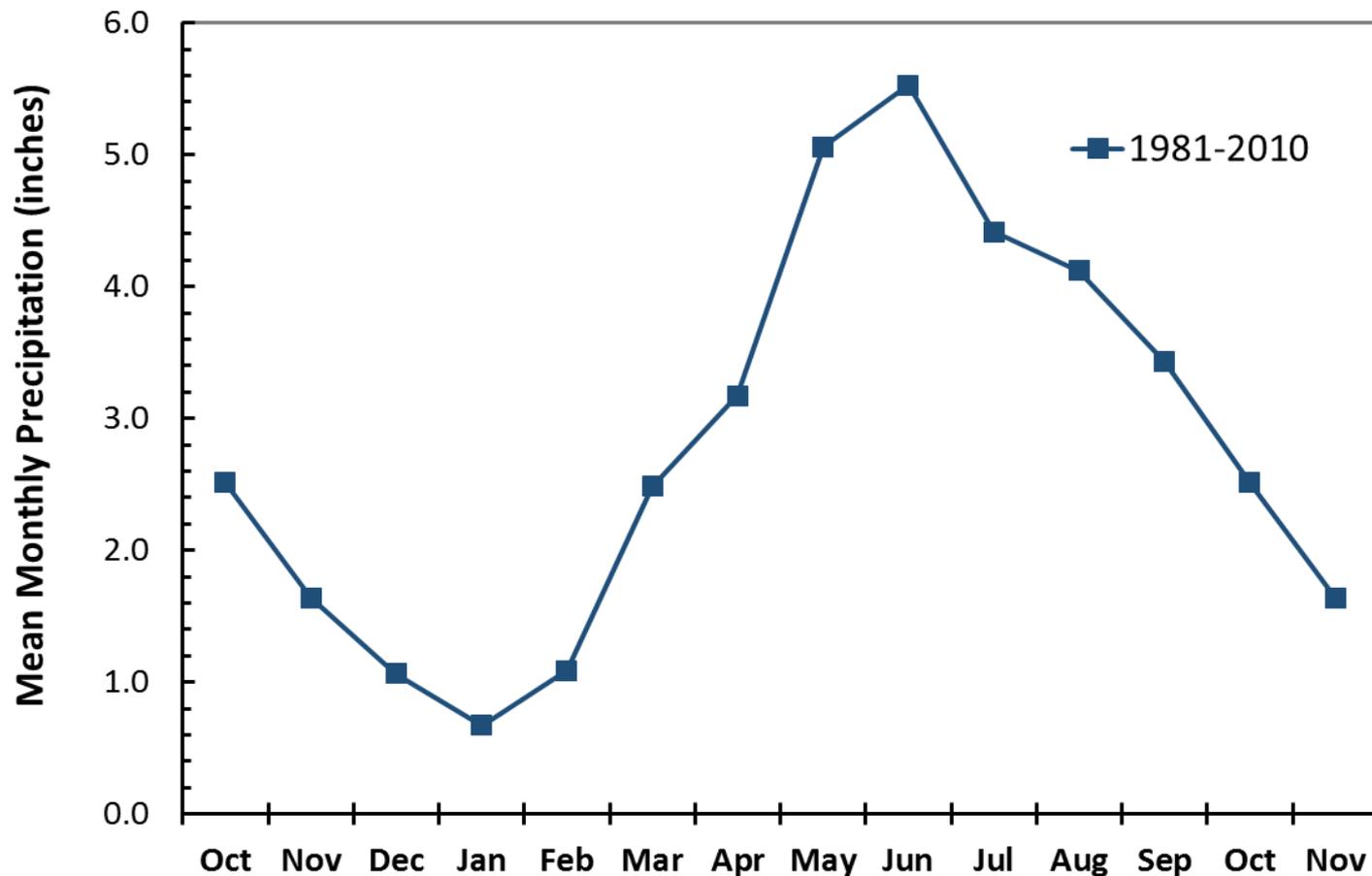
If this is the place, then what is the right time?

- *Is this influenced by climate?*
- *Is this influenced by cropping system?*

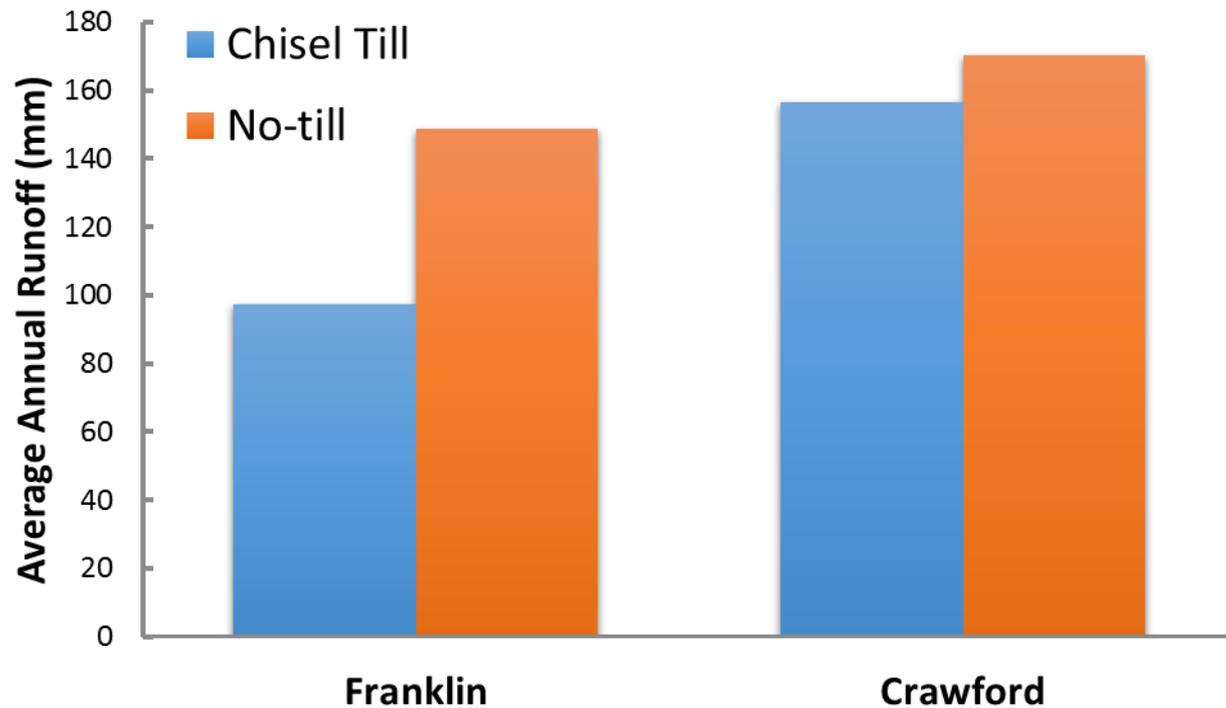
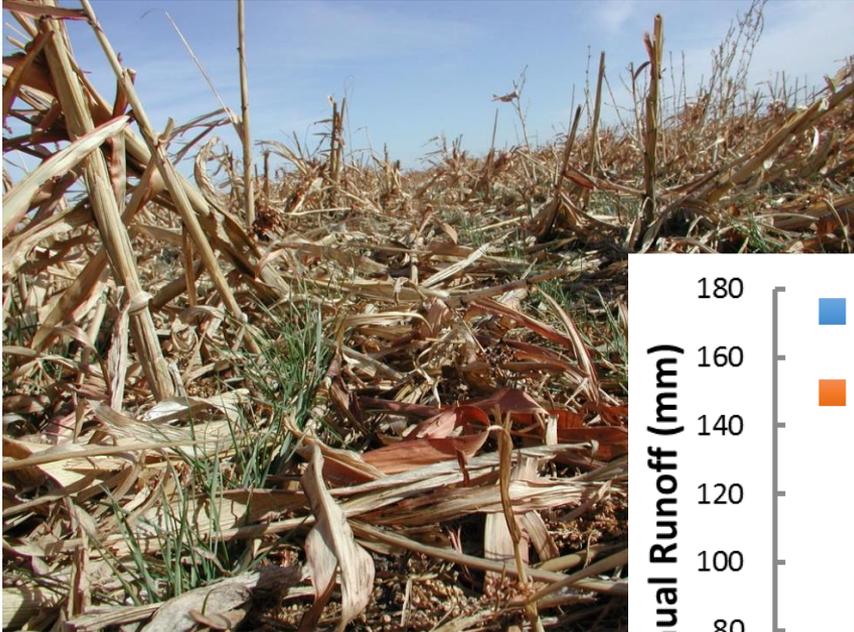


Is Fall the right “time” for surface-broadcast P fertilizer?

30-yr average monthly precipitation at Manhattan, KS



No-till reduces erosion, but can increase runoff.



4-yr average annual runoff in sorghum-soybean cropping systems (Zeimen et al., 2006)

Can cover crops reduce P loss from surface-applied fertilizer?

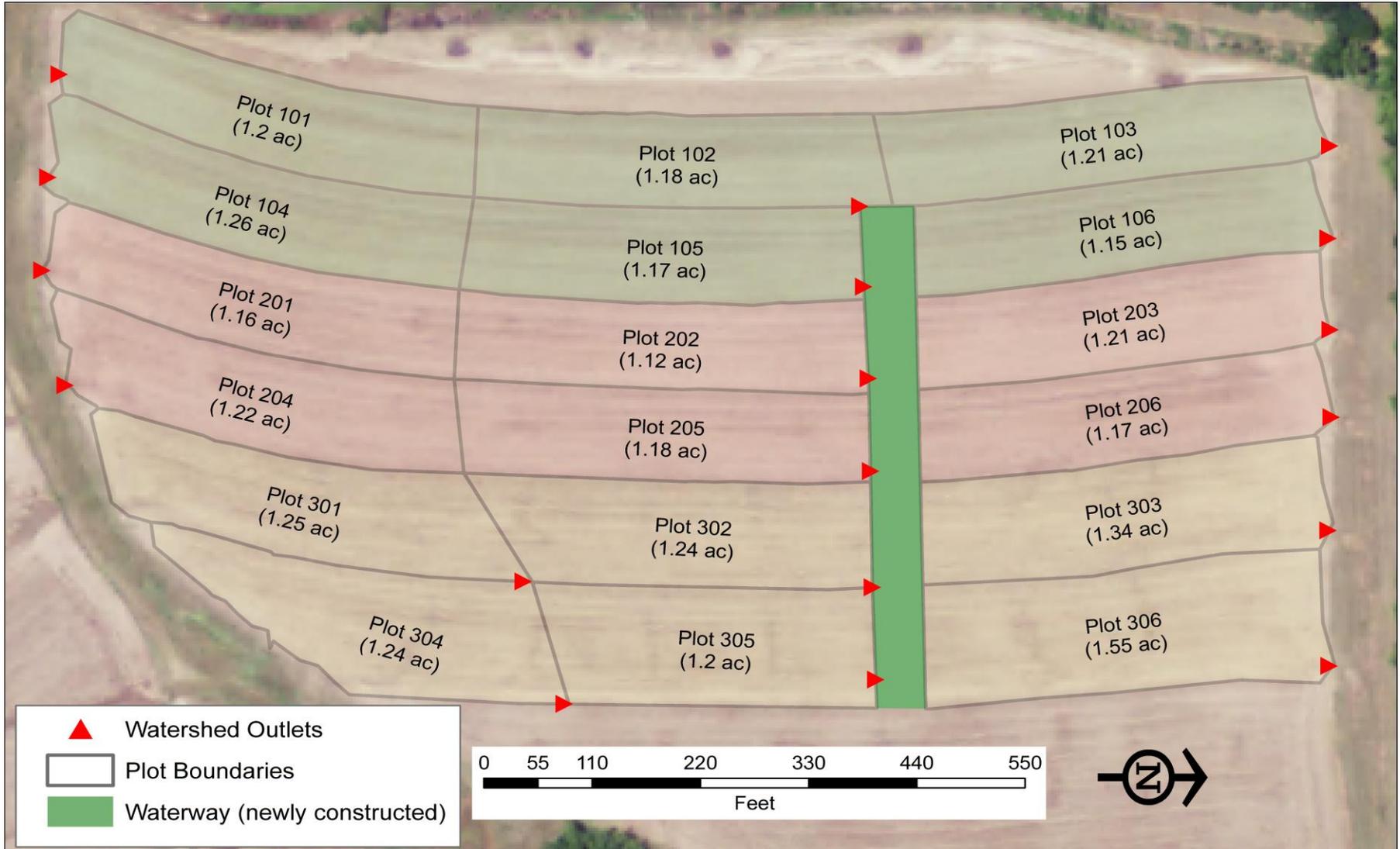


Research Questions (Objectives)

- How does P loss from fall surface-applied fertilizer compare to spring injected P fertilizer (current recommended BMP)?
 - How does this impact crop production, nutrient use efficiency, and profitability?
- Will cover crops reduce P losses?
 - What are the agronomic, environmental, and economic effects of winter cover crops in corn-soybean rotations?
- Will cover crops reduce P losses from fall surface-applied fertilizer?

KAW Field Lab

Kansas Agricultural Watersheds Field Lab



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Watershed Outlet



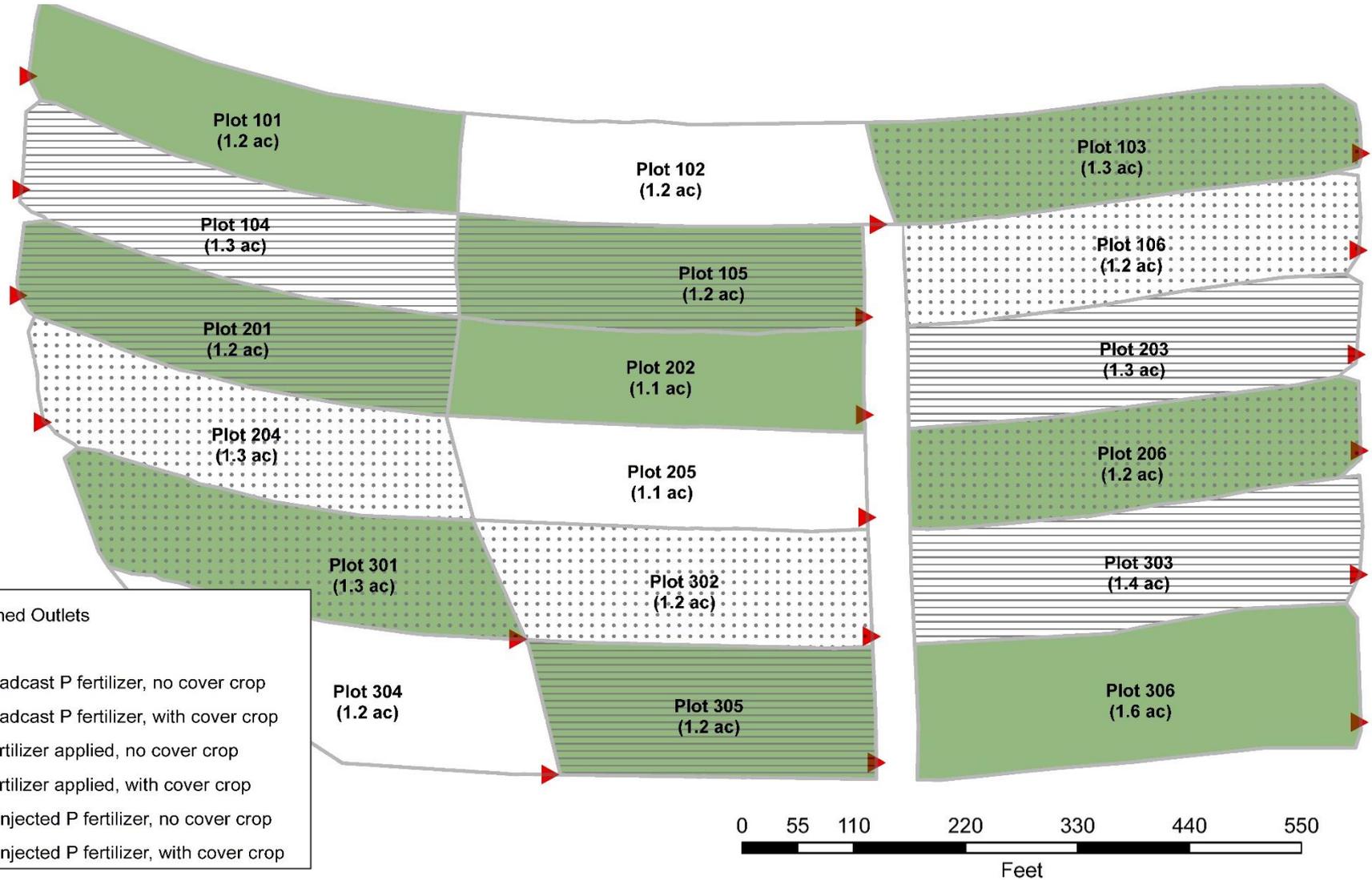
Methods

- Small watershed/field-scale study with natural rainfall
- No-till corn-soybean rotation (5 year duration)
 - Conventional-till corn in year 1 (2015)
- Factorial treatment structure
 - P fertilizer (2015)
 - 0 kg P₂O₅/ha
 - 82 kg P₂O₅/ha applied in 2x2 placement
 - 82 kg P₂O₅/ha broadcast in fall
 - With or without cover crop (2015 - winter wheat, hairy vetch, rapeseed)



KAW Field Lab

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Field Measurements

- Corn Yield (grain and stover)
- Water Loss (runoff)
- Sediment loss
- P loss
 - Dissolved
 - Total P
- N loss
 - NO_3 & NH_4
 - Total N



Field Measurements

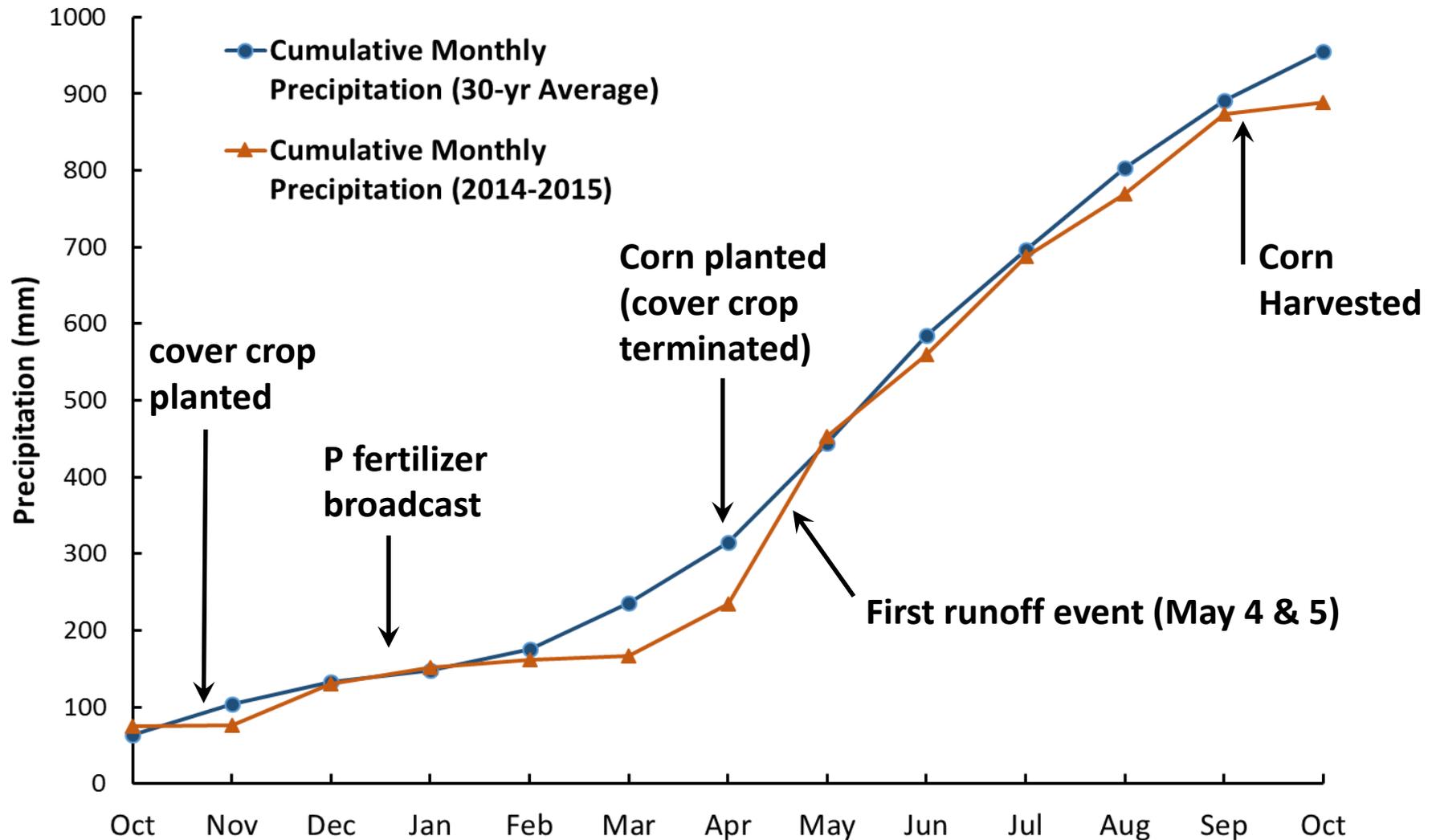
- Biomass production (crop and cover crop)
 - Nutrient content of biomass and grain
- Nutrient uptake (crop and cover crop)
 - Nutrient use efficiency – various computations
 - Environmental efficiency – (Nutrient loss/grain yield)
- Economic profitability



2015 - Data Analysis

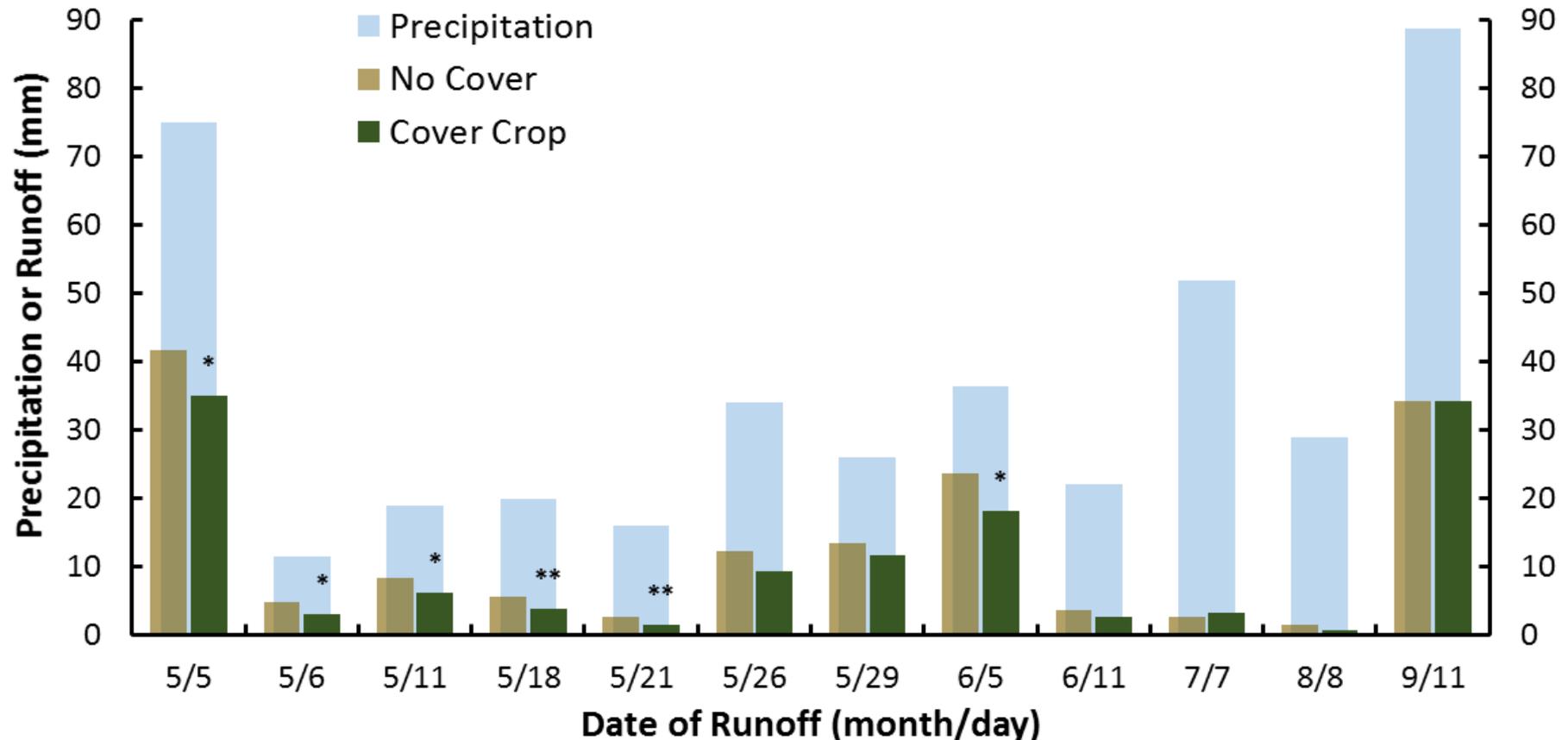
- Missing data from to complications with initial sampling plan (due to excess erosion)
 - 12 runoff events with 216 possible measurements (18*12)
 - 197 runoff values (9% missing)
 - 136 sediment, total P, and dissolved P concn. values (37% missing)
 - 131 sediment, total P, and dissolved P load values (39% missing)
 - Only 5 events with full data set allowing for factorial analysis of treatment effects on sediment and P loss.
- All data required transformation for statistical analysis
 - Runoff and dissolve P – Square root transformation
 - Sediment and total P – Log transformation

2014-2015 Precipitation



Cover Crop Effect on Runoff (2015)

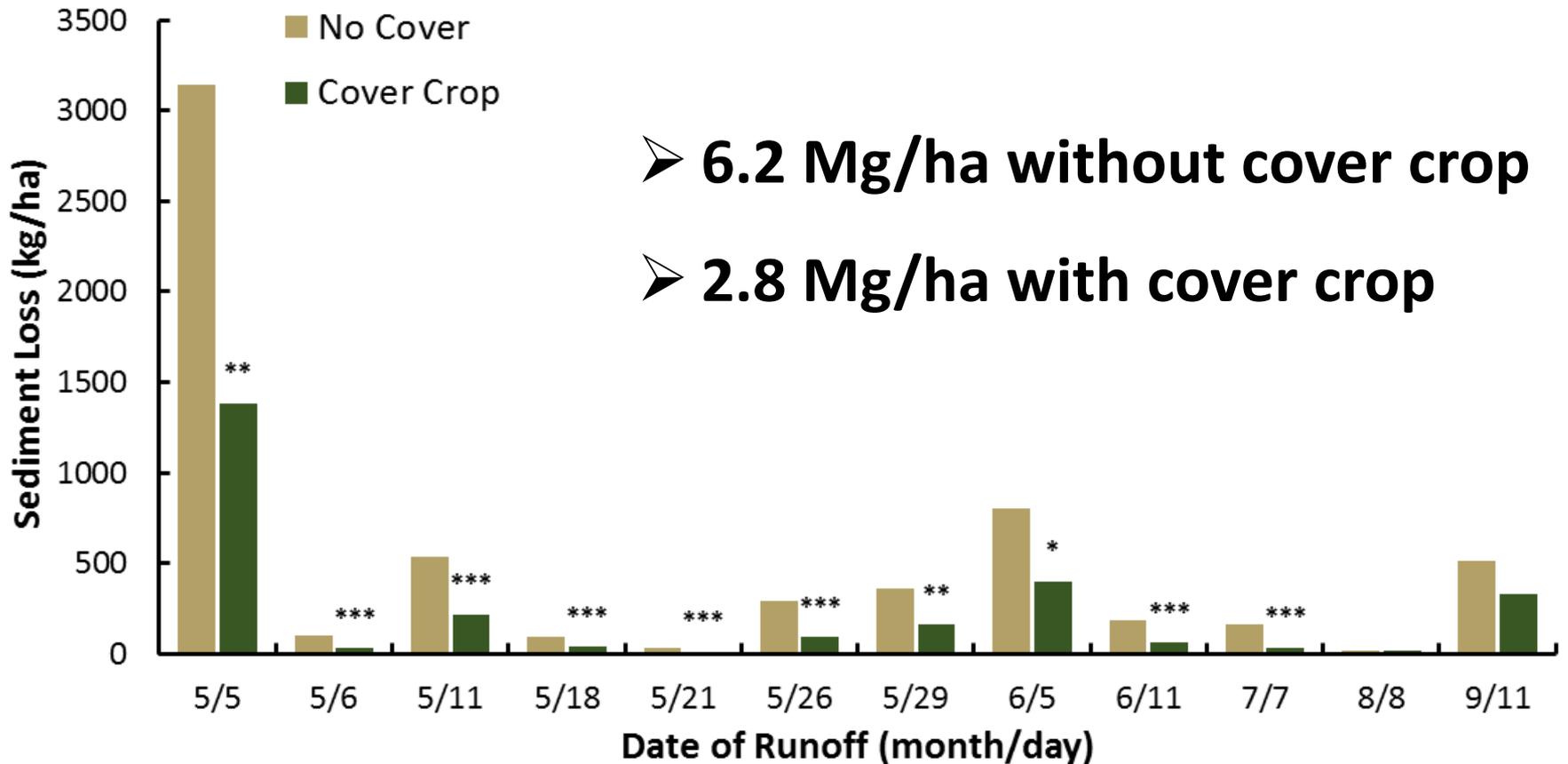
16% reduction in total runoff ($p=0.016$)



****, **, *** Indicates significant difference at $p<0.05$, $p<0.01$, $p<0.001$***

Cover Crop Effect on Sediment Loss (2015)

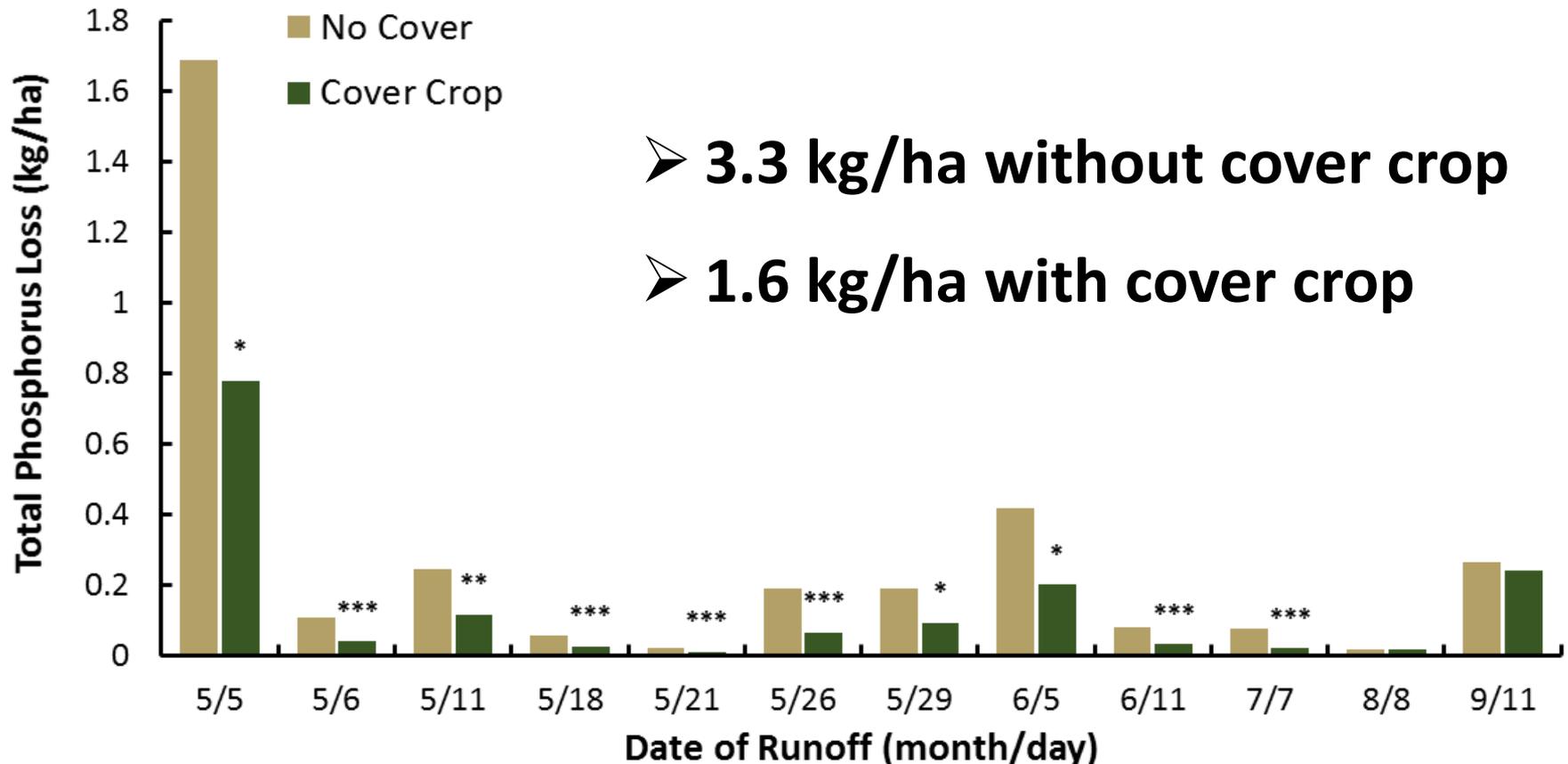
> 50% reduction in sediment loss ($p < 0.001$)



*, **, *** Indicates significant difference at $p < 0.05$, $p < 0.01$, $p < 0.001$

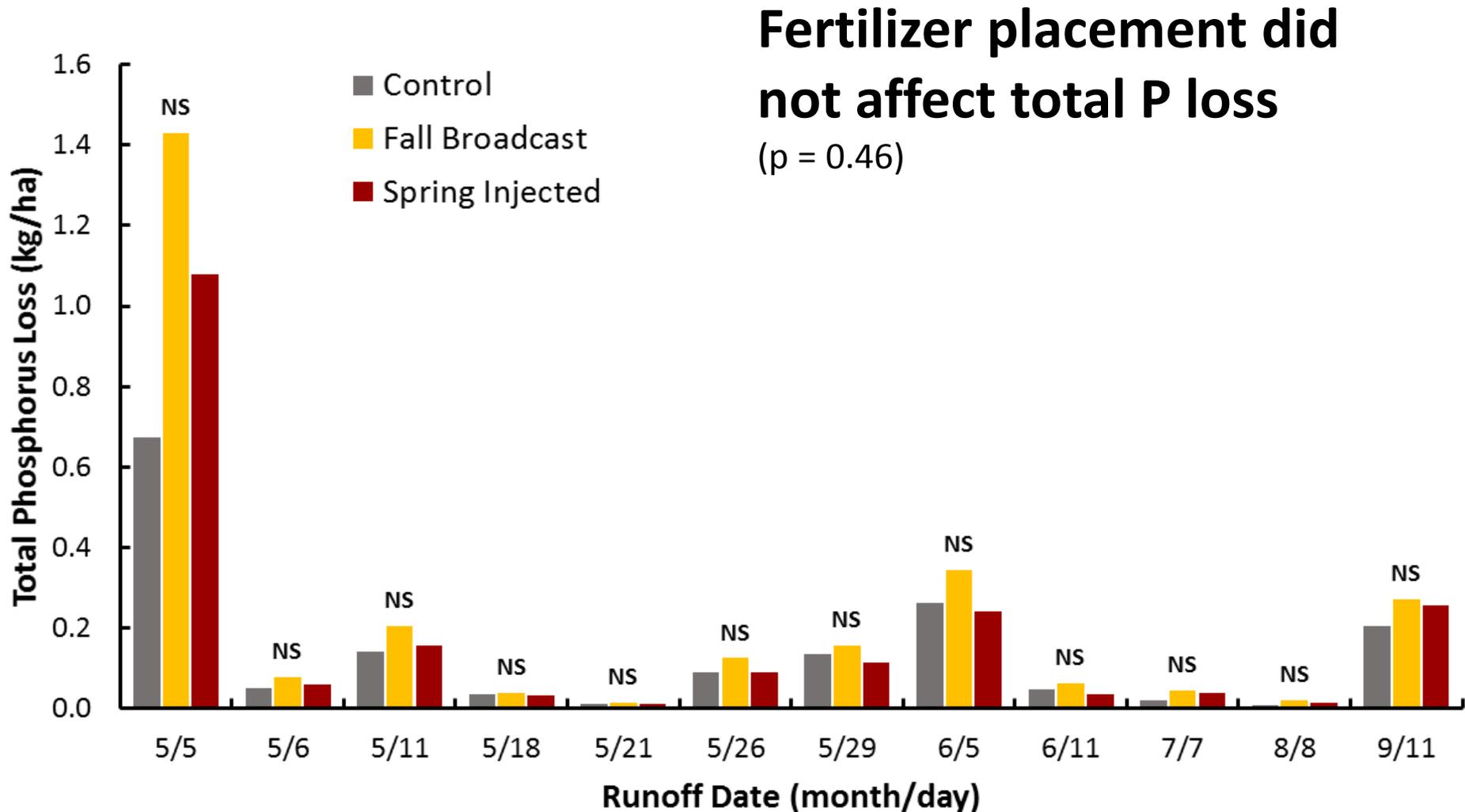
Cover Crop Effect on Total P Loss (2015)

> 50% reduction in total P loss ($p < 0.001$)

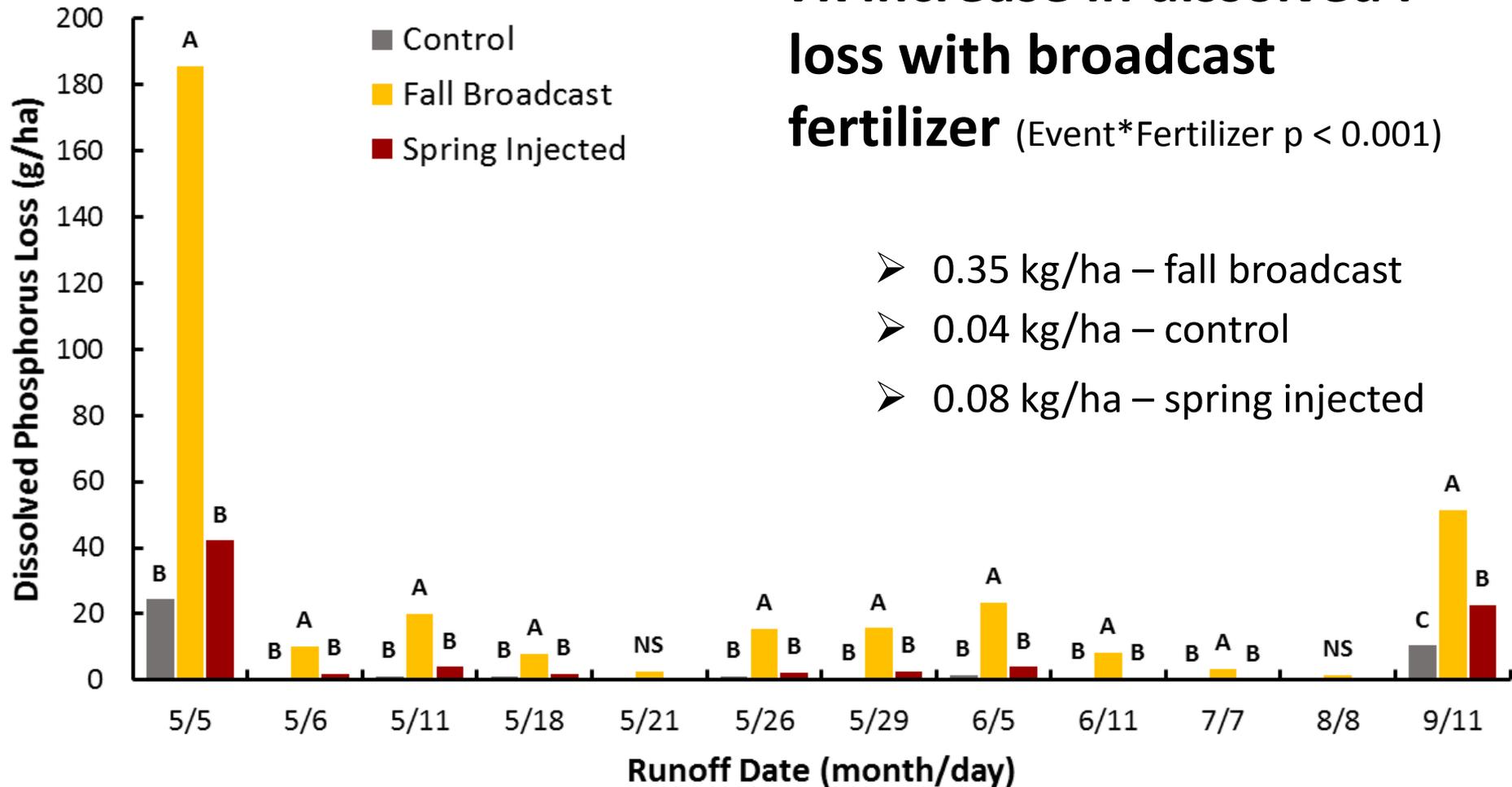


*, **, *** Indicates significant difference at $p < 0.05$, $p < 0.01$, $p < 0.001$

Fertilizer Placement Effect on Total P Loss (2015)

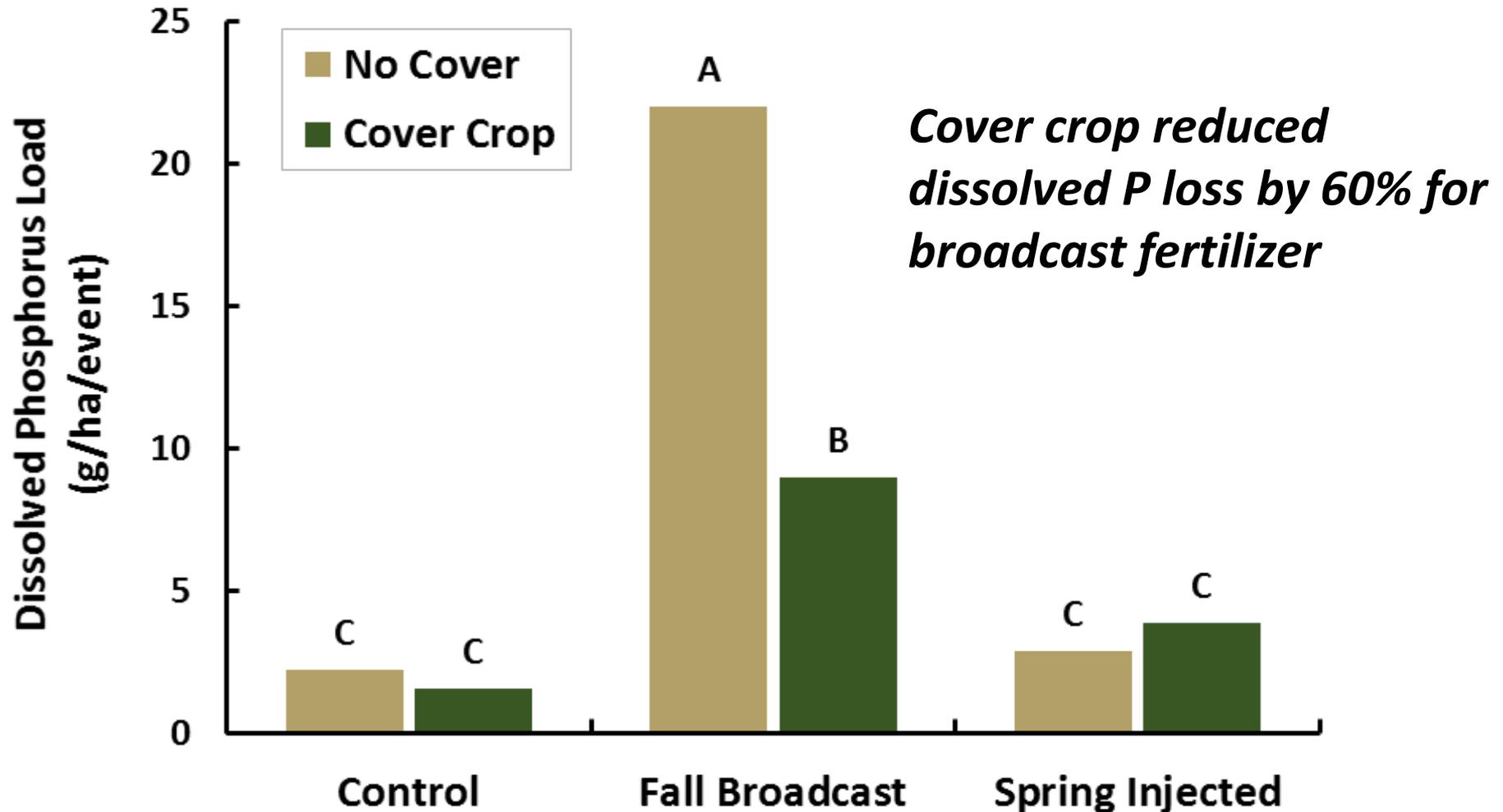


Fertilizer Placement Effect on Dissolved P Loss (2015)



Different letters indicate significant difference within event at $p < 0.05$

Fertilizer Placement by Cover Crop Interaction - Dissolved P



Different letters indicate significant difference at $p < 0.05$

Conclusions (for Year 1)

- Cover crop reduced runoff, sediment, total P, and dissolved P loss in conventional-till corn
- Broadcast P increased dissolved P loss (but not total P)
- Cover crop reduced dissolved P loss for surface-broadcast P fertilizer

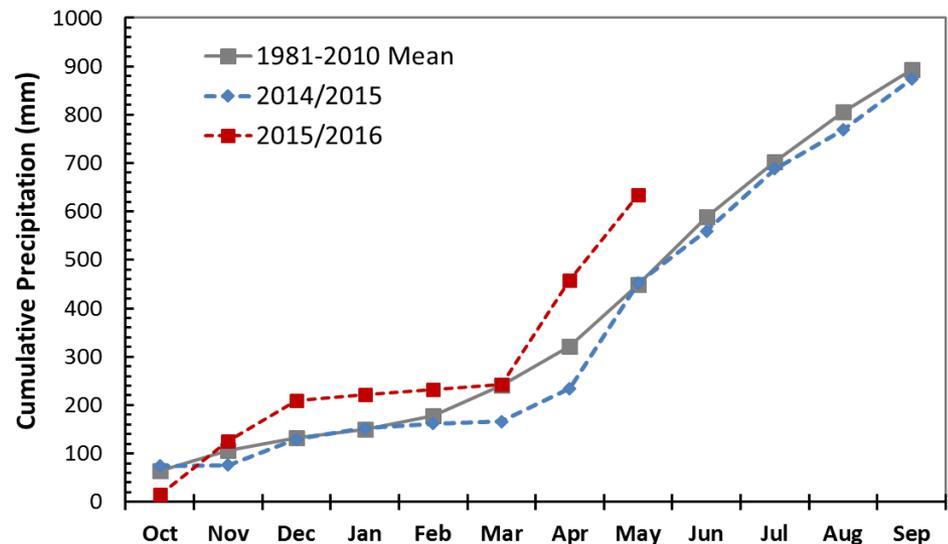
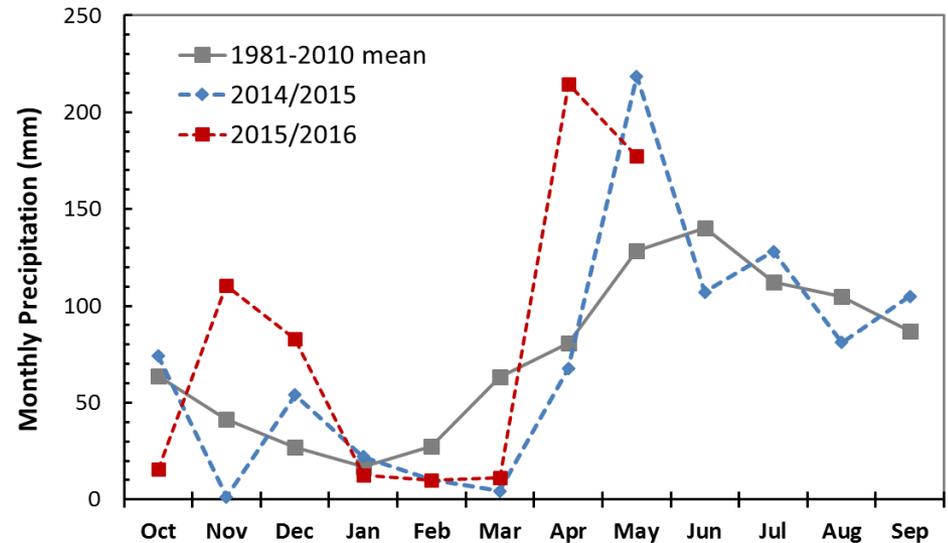


2015/2016 (Year 2)

- Cover crop of winter wheat
 - planted in Sept.
 - killed mid to late April
- Soybeans planted on June 6

- 13 runoff events so far
 - 3 within 30 days after fall fertilizer application
- 635 mm of precip with 130 mm of runoff (~20%)

- Appear to be more complex interactions over time
- Full statistical analysis of results not available at this time.



2015/2016 (Year 2)



Additional items that need investigation

- Cover crop effects on:
 - Soil health-related properties (aggregate stability, total C, carbon fractions, soil biology)
 - Time to initiation of runoff
 - Near surface soil moisture
- Dissolved P release from cover crops
- Use of process-based models
 - Use data at site to evaluate and improve model processes
 - Use validated models to extend project results to other locations.

Acknowledgements

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Questions?

➤ Visit our website <http://www.k-state.edu/kaw>

