Environmental and Agronomic Efficiency of Phosphorus in No-Tillage Corn-Soybean Rotation with Cover Crops

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Image Credit: Jerry Ting

Image Credit: Junction City Post

Objectives

1. How does application method of P fertilizer influence P loss and use?
2. Can cover crops be used to alter P loss and use?
3. Can different agricultural management strategies be used to create a more efficient system?

Aerial Photo of Field Site

Field Site

Methods

- No-tillage Corn-Soybean Rotation
  - 2016: Soy
  - 2017: Corn
- 3 P Fertilizer treatments
  - 0 kg/ha P
  - 23.6 kg/ha P fall broadcast
  - 23.6 kg/ha P spring injected
- 2 Cover crop
  - No cover crop
  - Winter wheat & triticale/rapeseed

Runoff and Loss Methods

- Each plot fitted with 0.46 m H-Flume and automated sampler

- Flow-weighted composite sample collected for each rain event
  - Total P, dissolved P, & total suspended solids

P Uptake & Removal Methods

2016

- Measured total P uptake of entire plant at R7
- Measured P removed in grain

2017

- Measure total P uptake of stalks at R6
- Measured P removed in grain

Efficiency Calculations

Term	Calculation*
Agronomic Nutrient Use Efficiency, ANUE	$ANUE = (Y-Y_0) / F$
Partial Productivity Factor, PPF	$PPF = Y / F$
Fertilizer Recovery Efficiency. FRE	$FRE = (P_{uptake} – P_{uptake,control}) / F$
Partial Nutrient Balance, PNB	$PNB = P_{removal} / F$
Environmental Efficiency, EE	$EE = Y / P_{loss}$

Y = yield

Y_0 = yield with out fertilizer applied

F = amount of nutrient applied

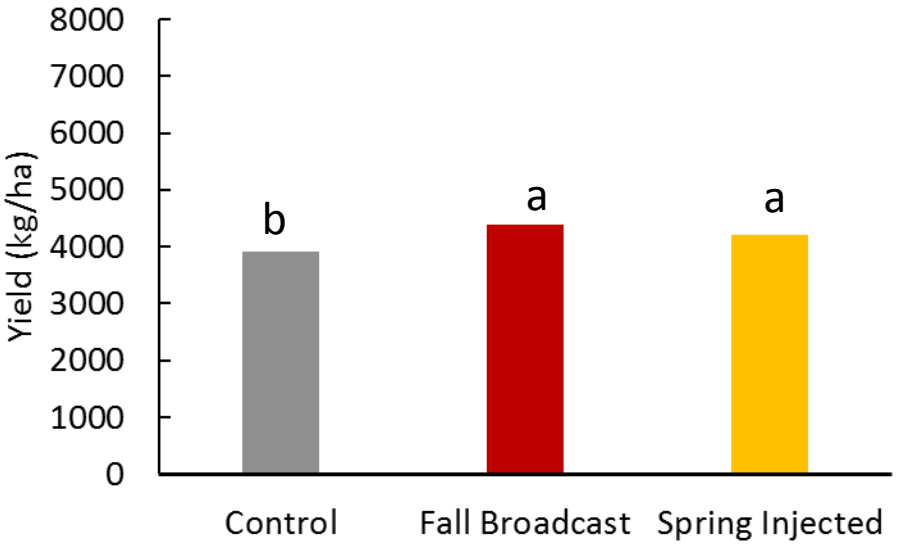
ANOVA Table

	Yield	P Uptake	P Removal	Partial Nutrient Balance	Partial Productivity Factor	Total P Loss	Dissolved P Loss	Sediment Loss	Environmental Efficiency (total P)	Environmental Efficiency (dissolved P)
2016										
Fertilizer	*	**	***	*	NS	**	***	NS	***	***
Cover	NS	NS	NS	NS	NS	NS	**	***	NS	NS
Fert*Cover	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
2017										
Fertilizer	NS	**	*	NS	NS	***	***	NS	*	***
Cover	*	*	NS	NS	*	NS	***	**	NS	NS
Fert*Cover	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

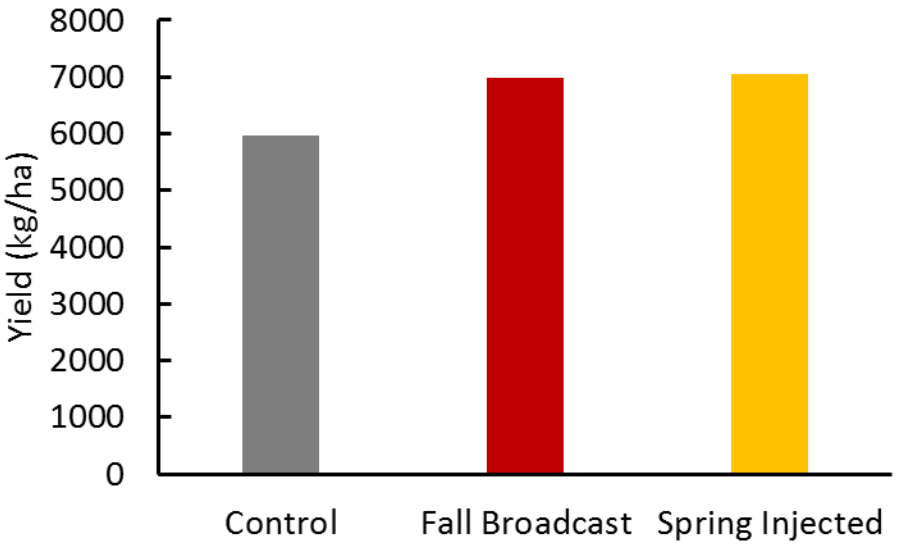
* = significant difference at α=0.05; ** = significant difference at α=0.01; *** = significant difference at α=0.001; NS = not significant

Crop Yield

2016 Soybean 10%

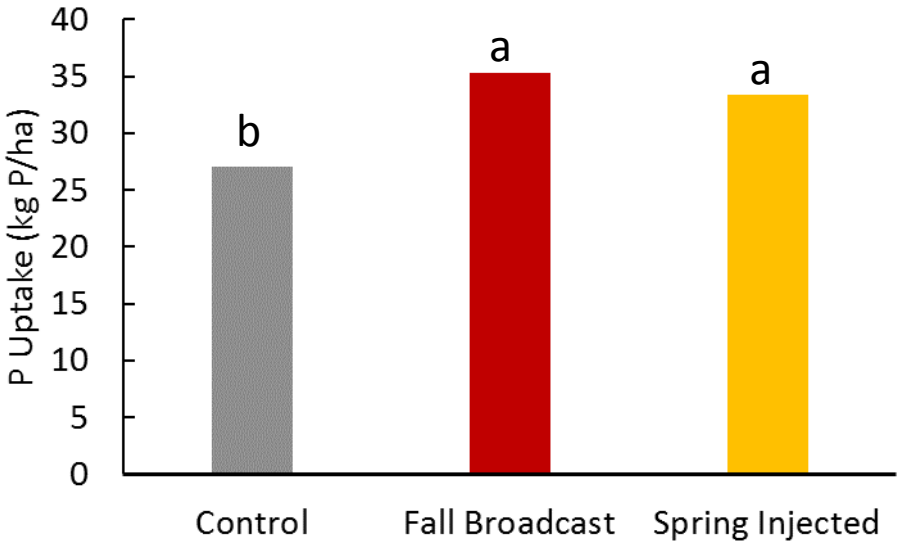


2017 Corn NS

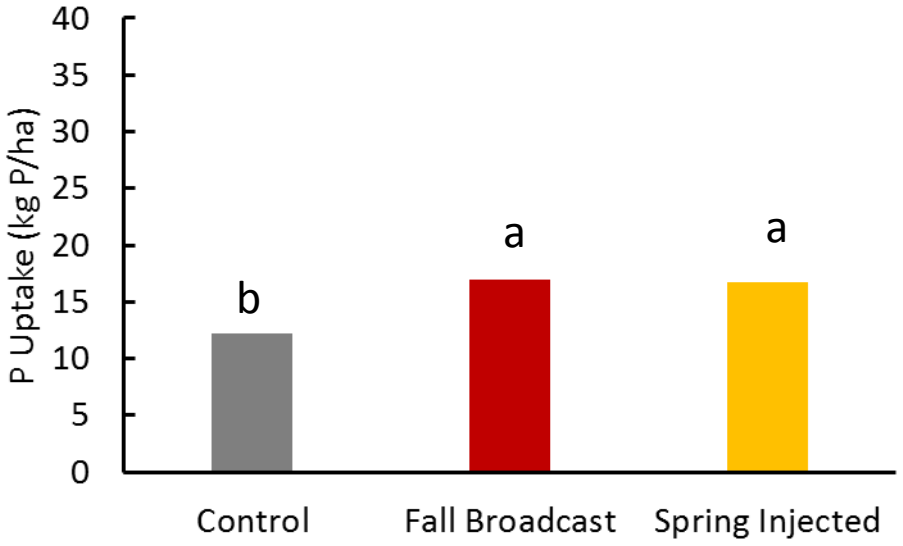


P Uptake

2016 Soybean 27%

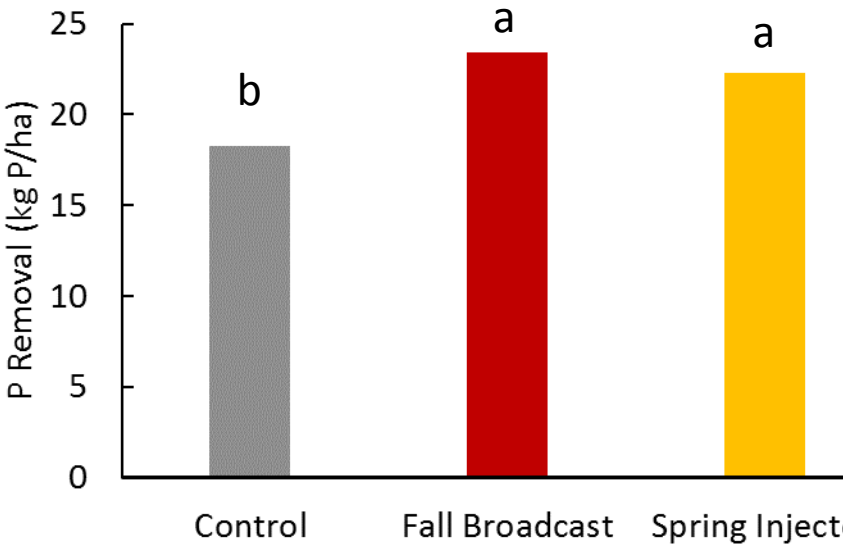


2017 Corn 37%

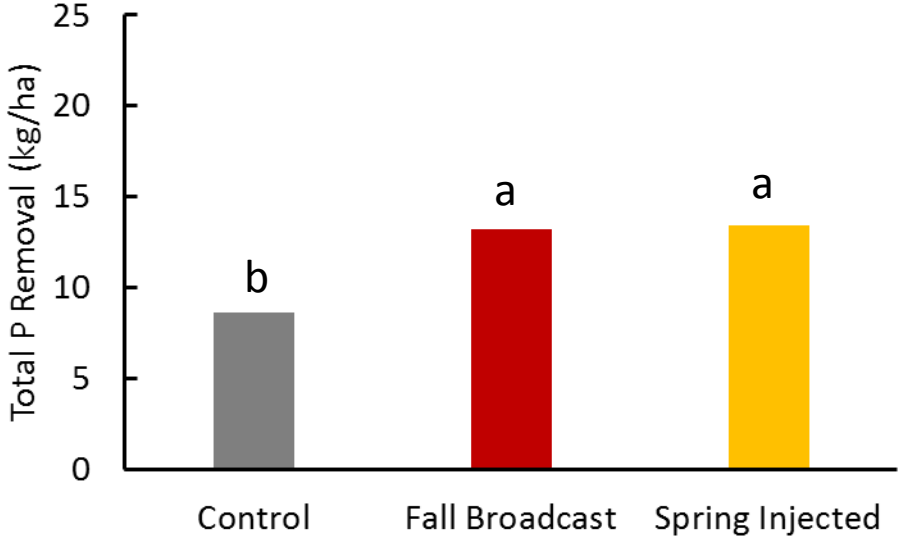


Total P Removal in Grain

2016 Soybean 25%



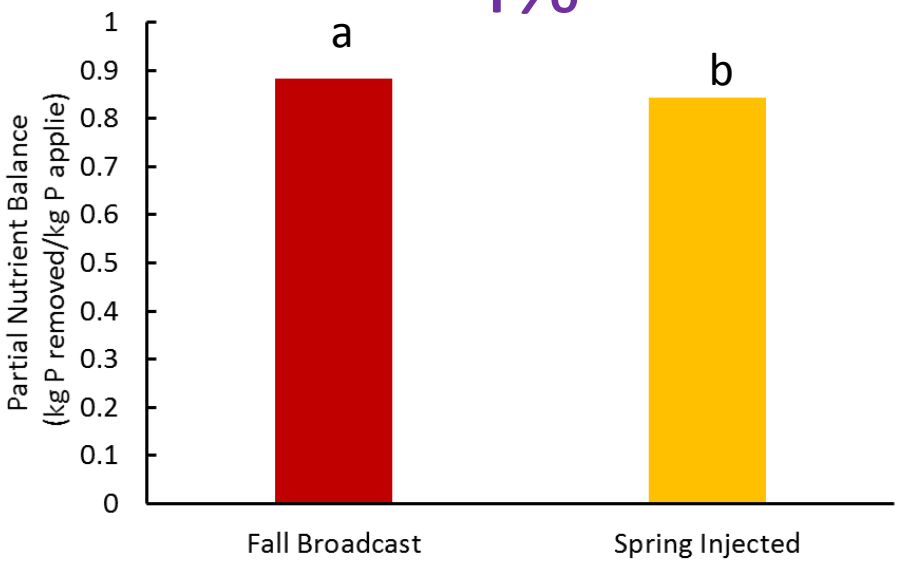
2017 Corn 50%



Partial Nutrient Balance

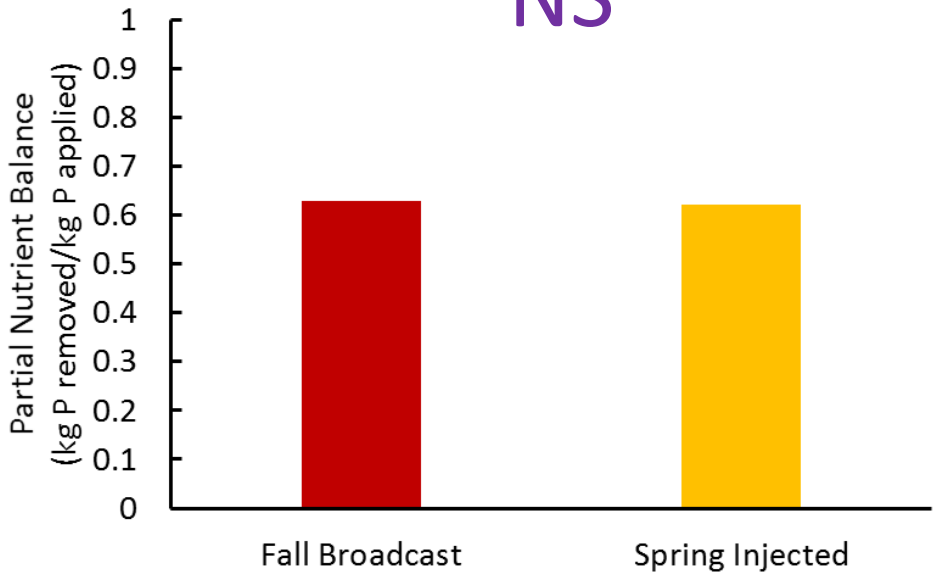
2016

4%



2017

NS

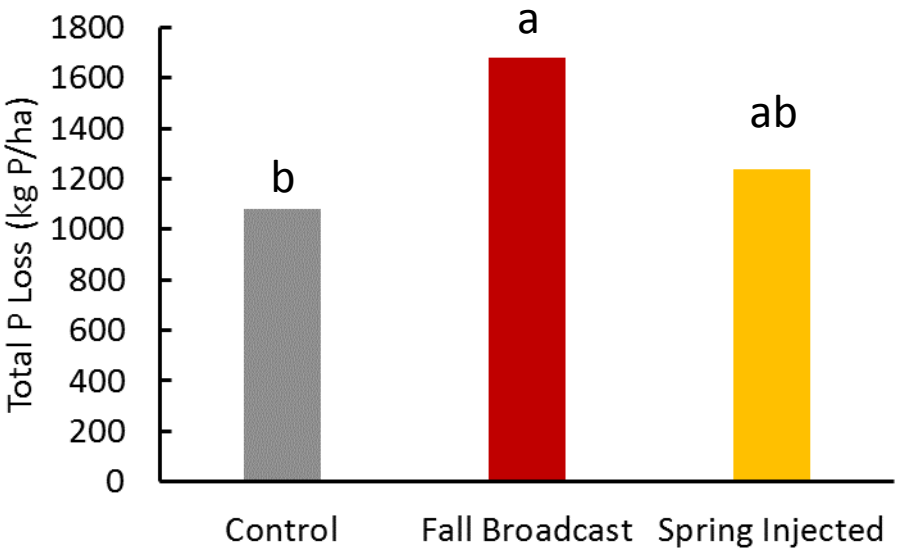


$$PNB = (P_{removal})/F$$

Total P Loss

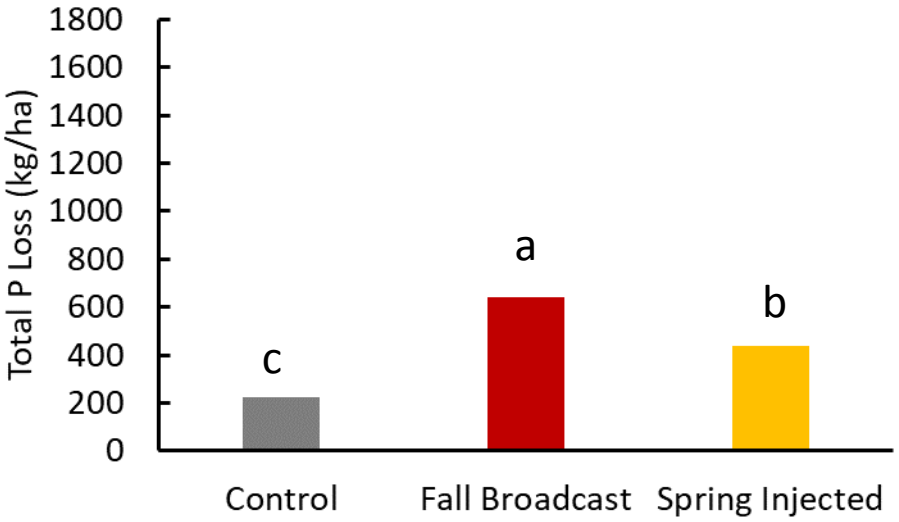
2016

1.5X



2017

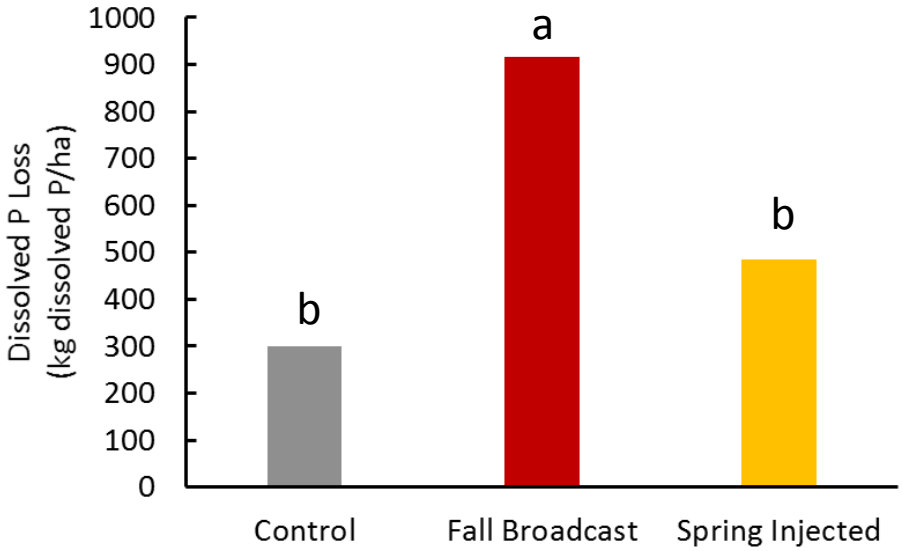
3X & 2X



Dissolved P Loss

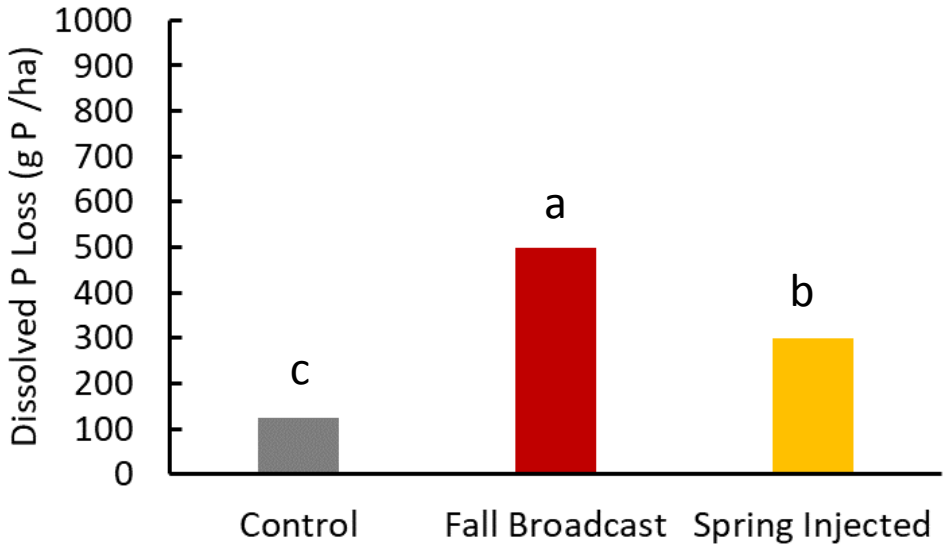
2016

3X & 2X



2017

6X & 3X

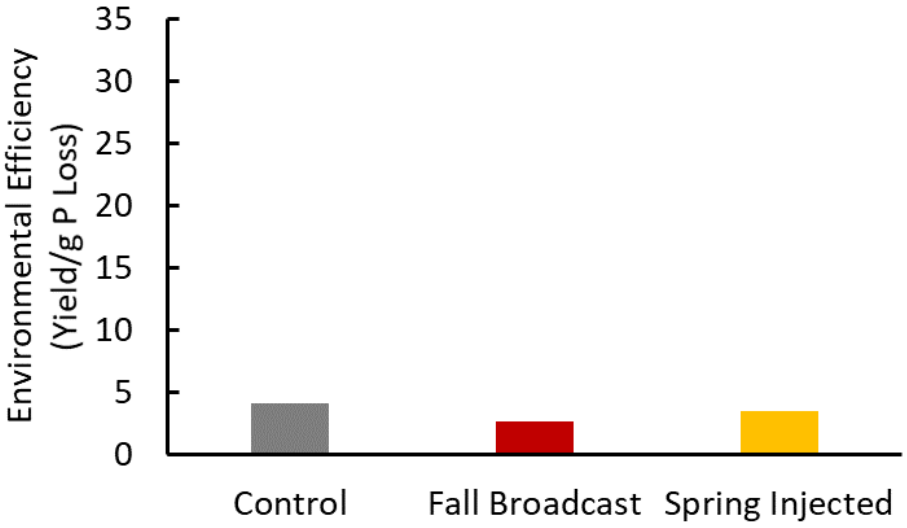


Environmental Efficiency

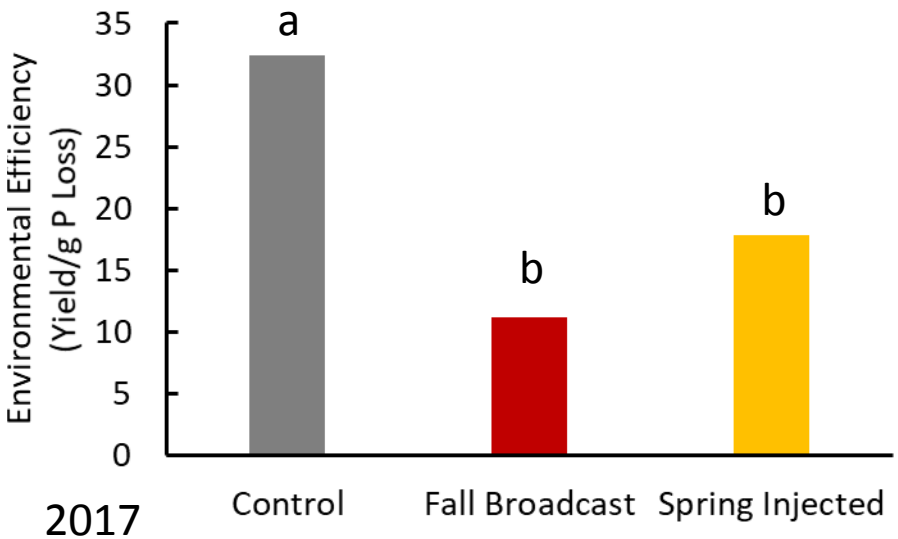
NS

-65% & -45%

2016



2017



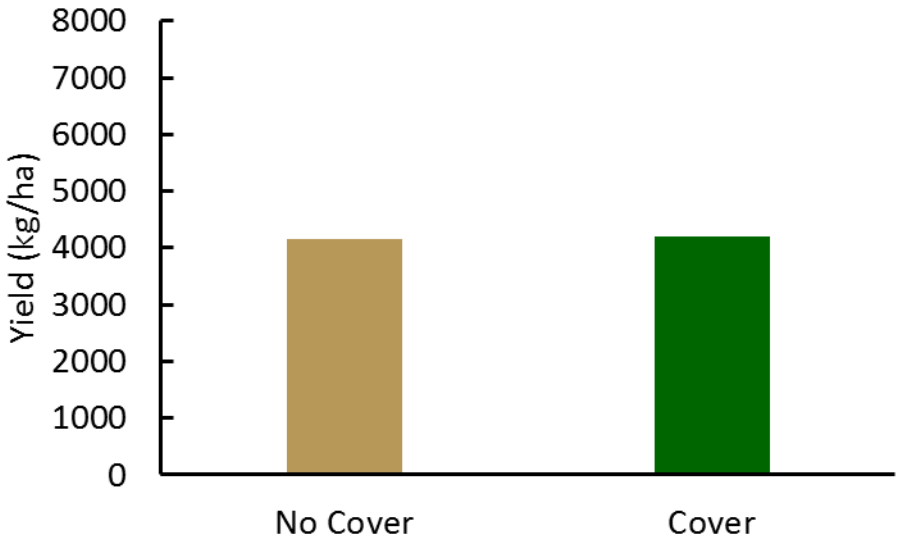
2017

$$EE = Yield / P_{loss}$$

Crop Yield

2016

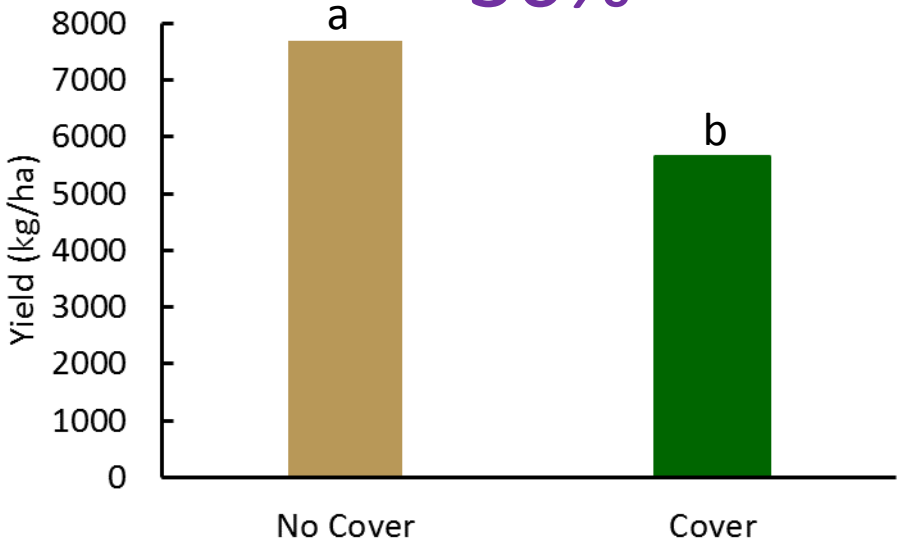
NS



2016

2017

-36%

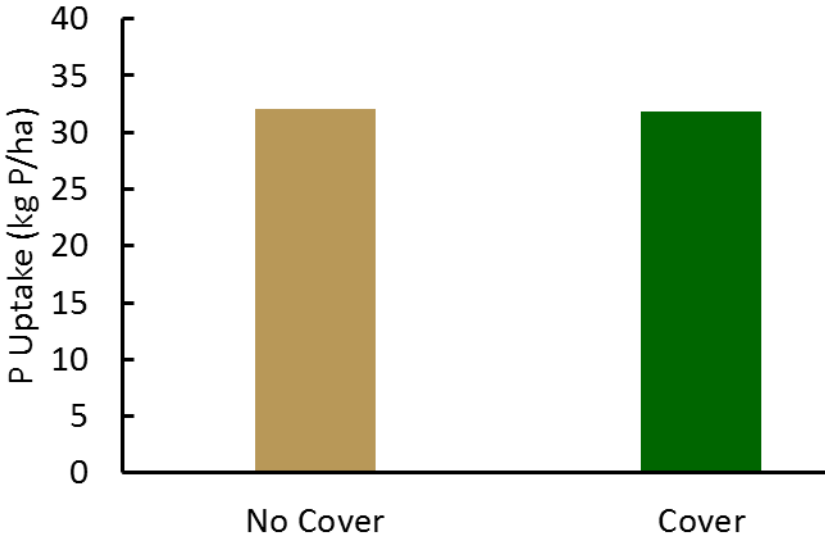


2017

P Uptake

2016

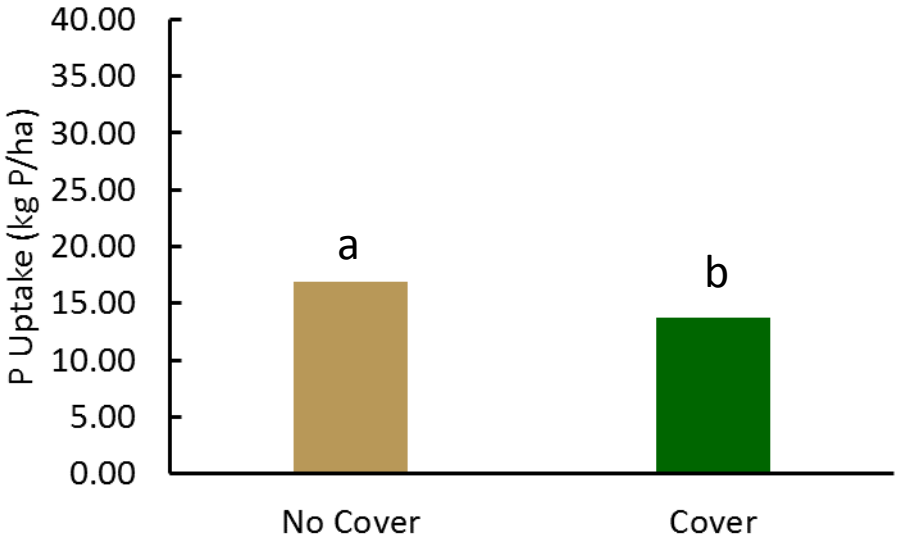
NS



2016

2017

-23%

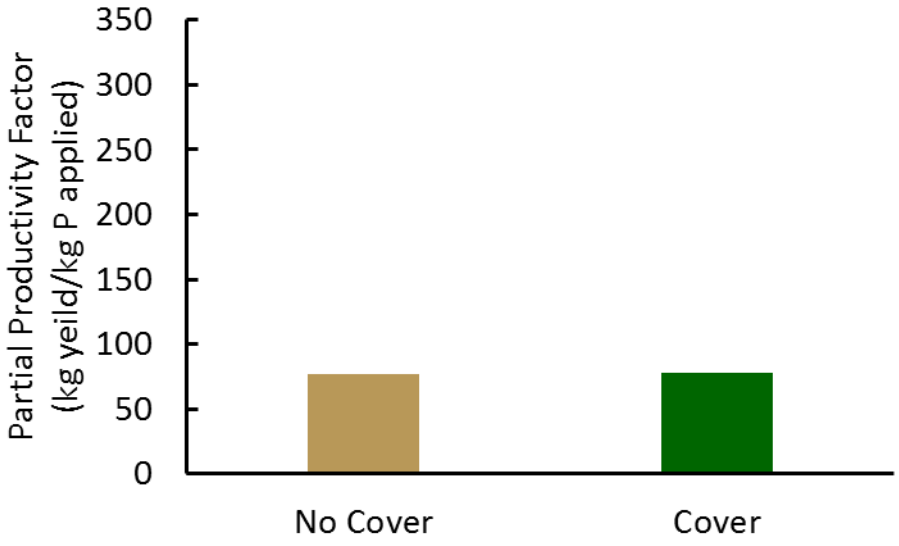


2017

Partial Productivity Factor

2016

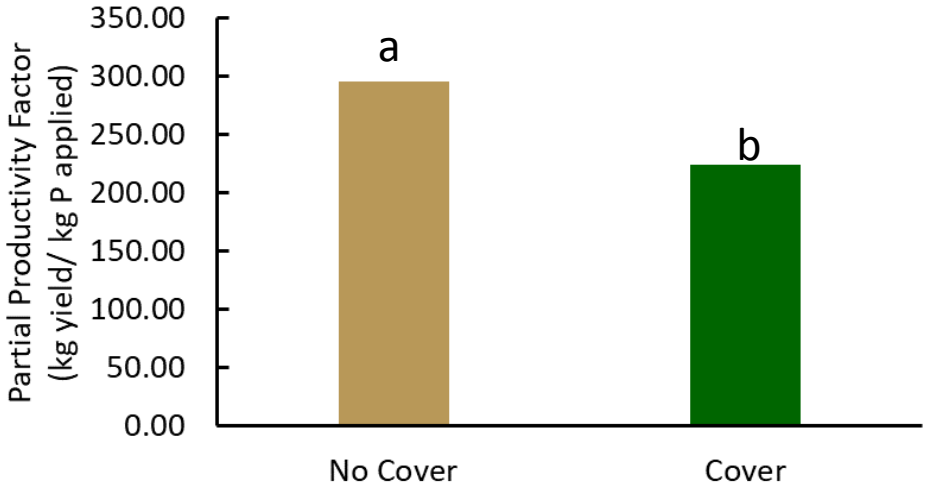
NS



2016

2017

32%



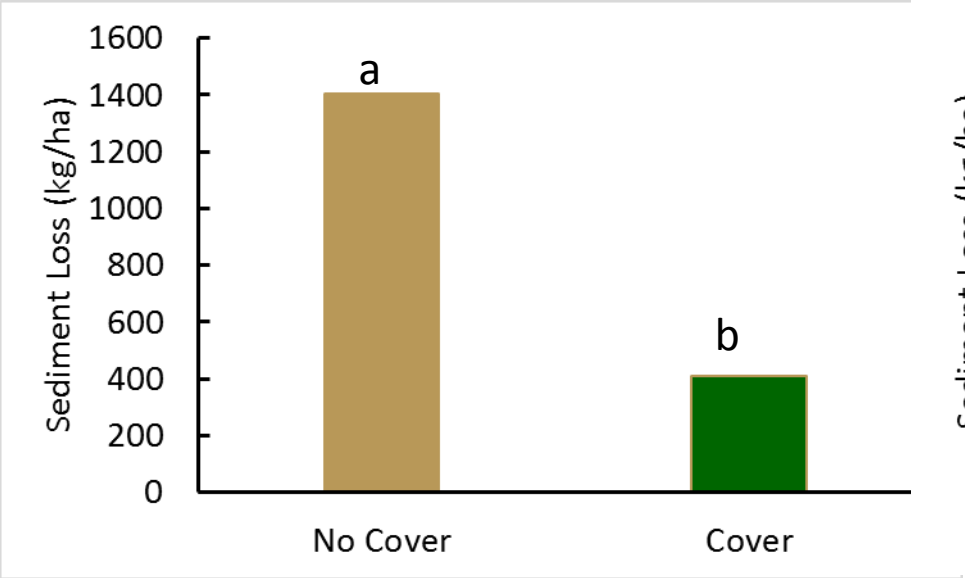
2017

$$PPF = (Y)/F$$

Sediment Loss

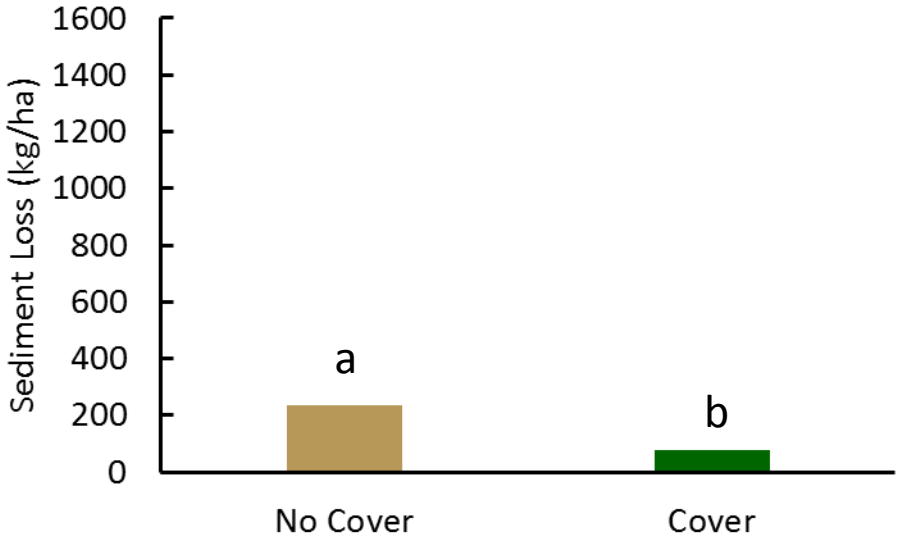
2016

-70%



2017

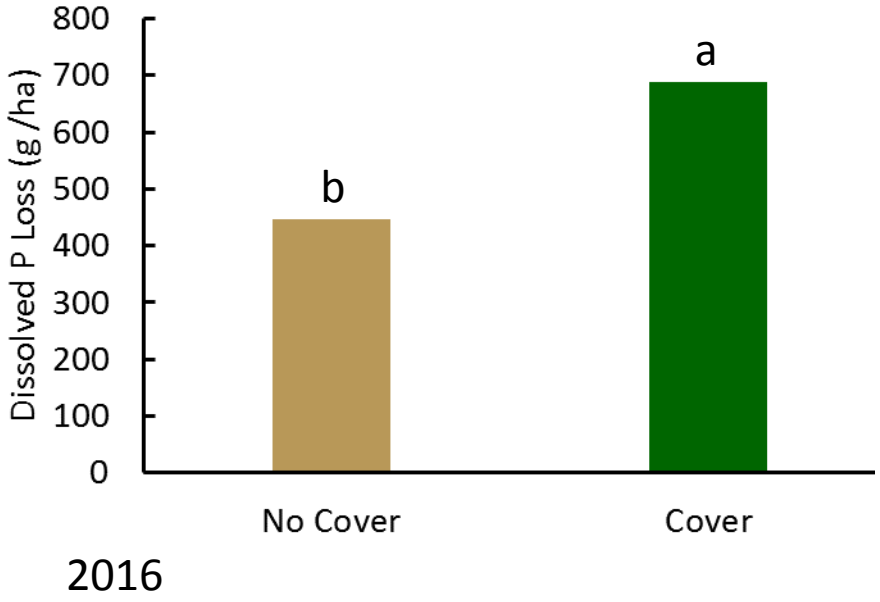
-70%



Dissolved P Loss

2016

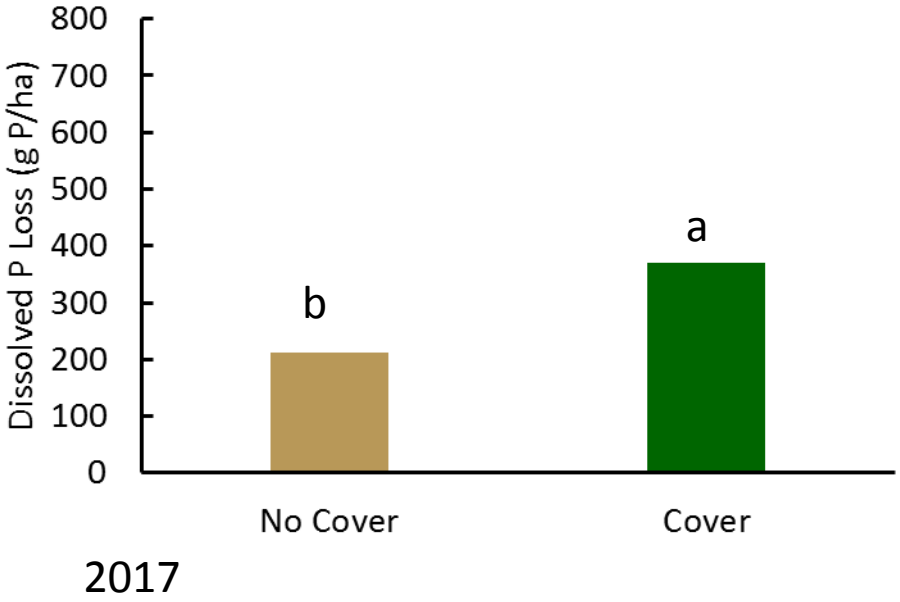
54%



2016

2017

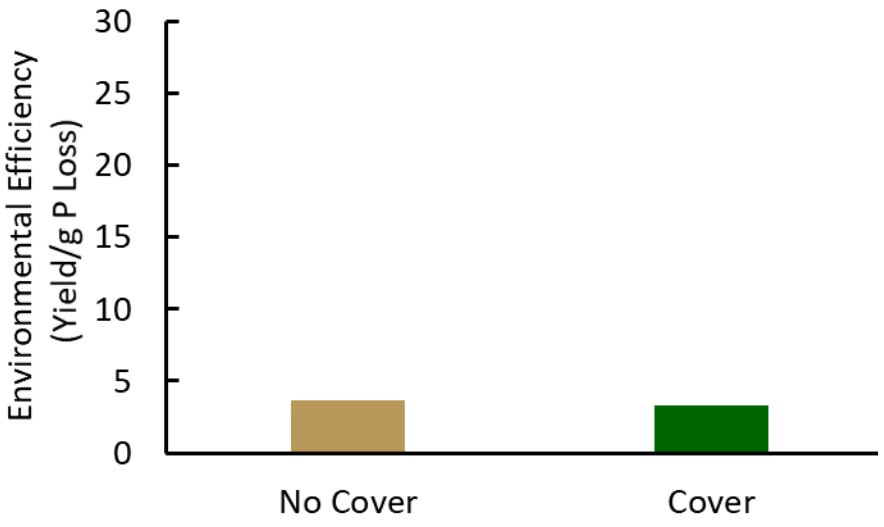
75%

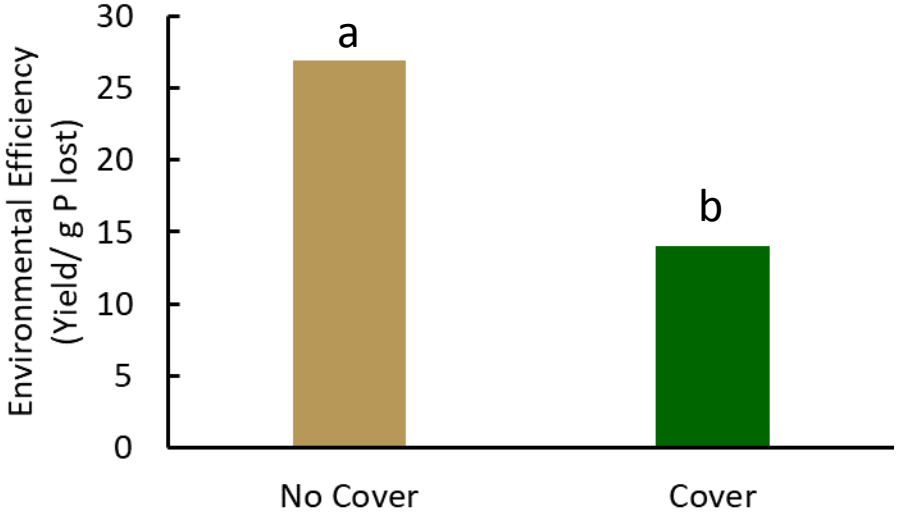


2017

Environmental Efficiency

2016 NS **2017** -50%





$$EE = Yield / P_{loss}$$

Conclusions

- P fertilizer increased yield of soybean regardless of application method
- Use of P fertilizer influenced P uptake, P removal and both total and dissolved P loss
- Cover crops decreased sediment loss
- Cover crops increased dissolved P loss
- Application method of P fertilizer influenced environmental efficiency

Research Made Possible By

Acknowledgments

- **Research Team:** Connor Kijowski, Tara Wilson, Cassandra Schnarr, Laura Starr & Luciano Menezello De Souza
- **Farm Staff:** Dustan Ridder, Russell Dille & Kevin Ascher
- **Kansas State Soil Testing Lab**

Questions?