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## INTRODUCTION

The soybean crop provides one of the best opportunities to include a cool season cover crop ahead of planting. Combining P fertilizer with cereal cover crop seeds will place the fertilizer below the soil surface and combine two operations (cover crop planting and fertilizer application). Other benefits include eliminating the environmental risk of P fertilizer runoff and potentially creating a synergistic benefit.

## OBJECTIVES

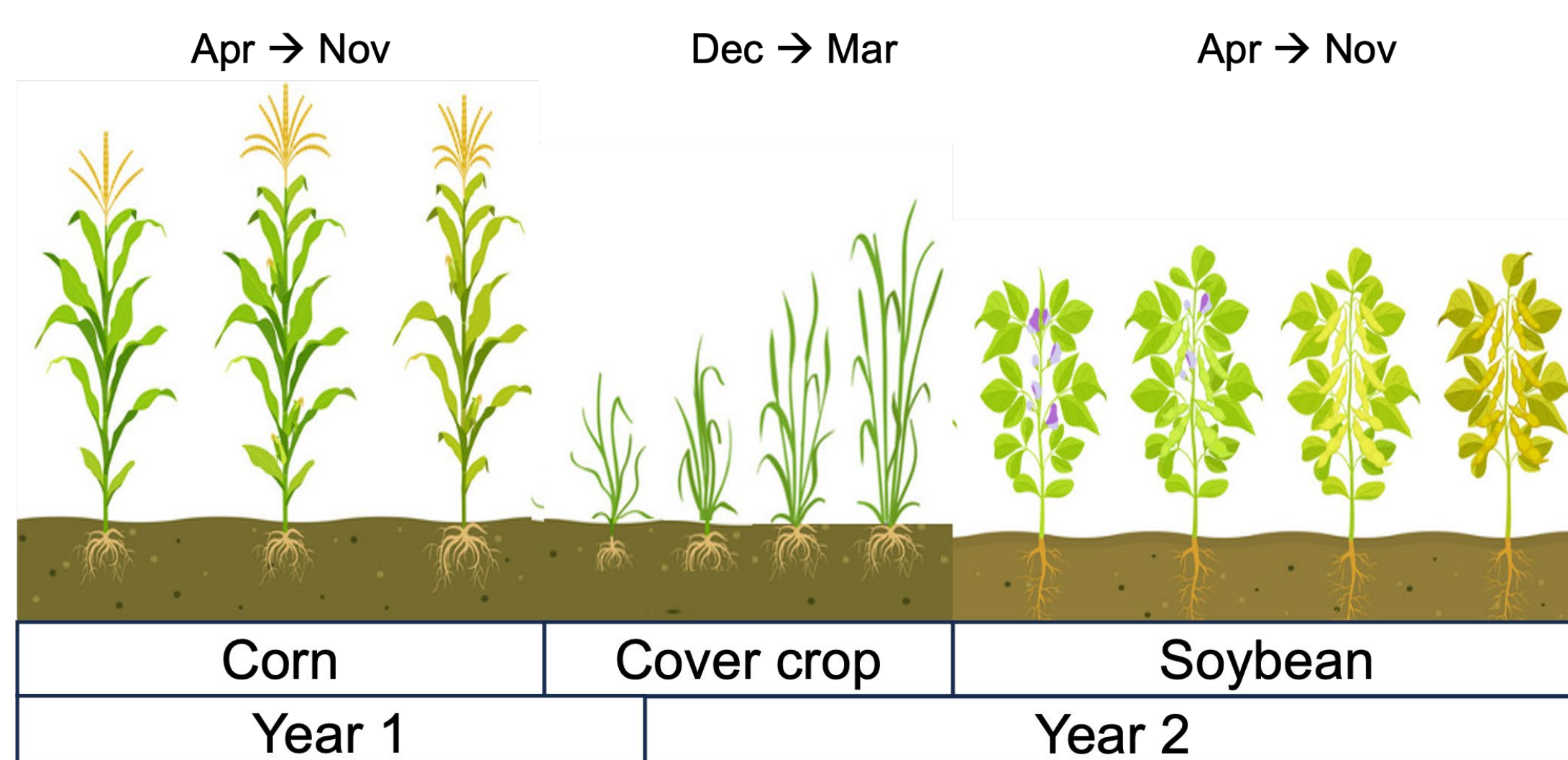
This study aims to maximize phosphorus use efficiency by the soybean crop by using cover crop planting as a window of opportunity for better P fertilizer placement and timing.

## MATERIALS AND METHODS

- Nine sites were established, with five locations (3, 4, 7, 8, and 9) under supplemental irrigation and four rainfed locations.
- Treatments included a control with no P application and a P rate of 40 Kg P<sub>2</sub>O<sub>5</sub>/ha, using mono-ammonium phosphate (MAP).
- Rates and cover crops were arranged in a factorial combination of treatments.
- Soil samples were collected 0-15 cm before treatment application, composite by blocks.
- The plant tissue samples were digested using nitric-perchloric acid digestion and analyzed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES).

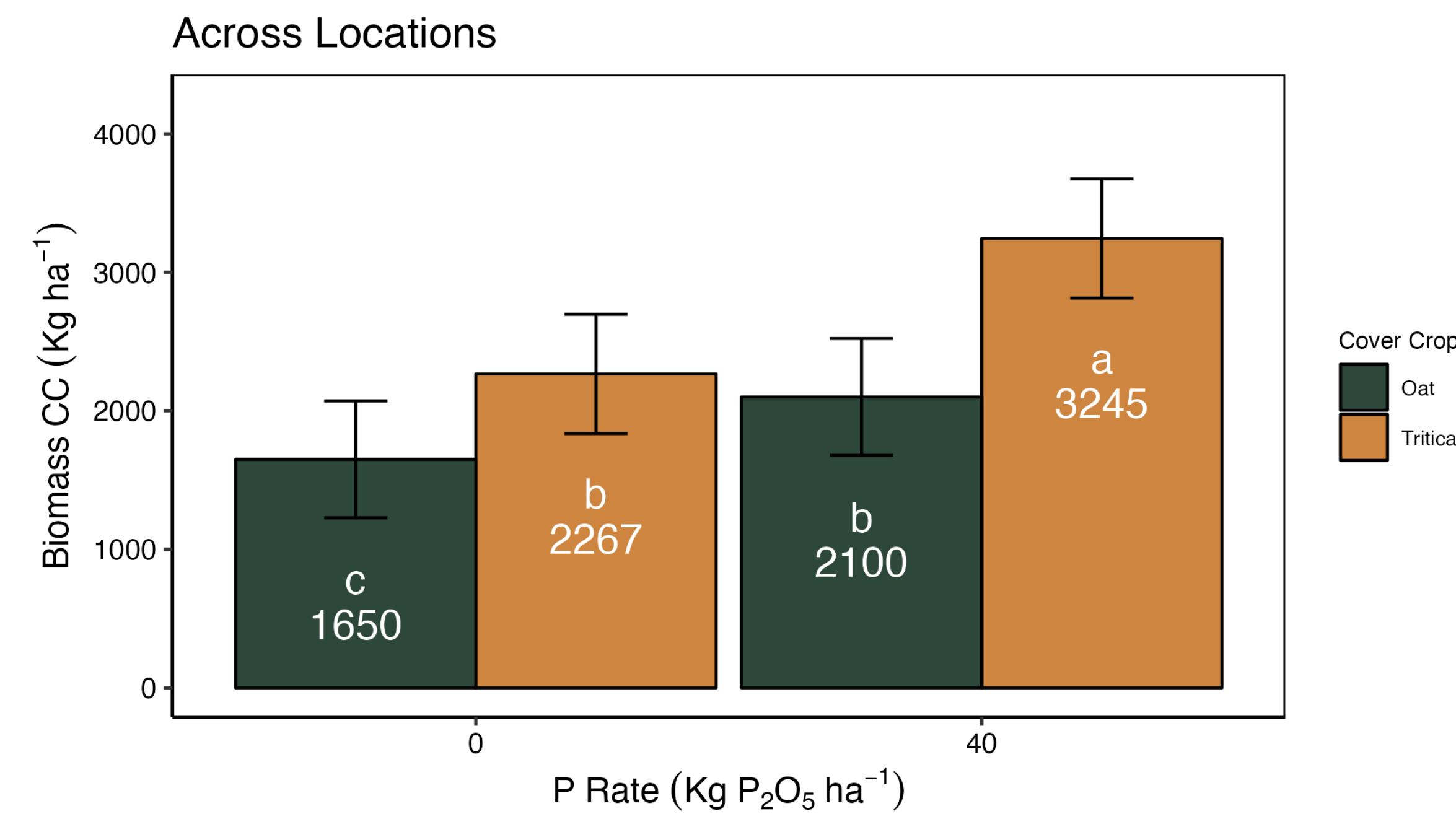
**Table 1:** Average soil test P, pH, and organic matter (OM) by location.

Site	Year	Soil test values			
		STP-M3	STP-B1	pH	OM
		----- mg kg <sup>-1</sup> -----			
1	2022	79	84	5.3	33
2	2022	17	19	5.7	27
3	2022	3	6	5.8	37
4	2023	10	18	6.5	16
5	2023	5	13	6.0	31
6	2023	9	14	7.1	22
7	2023	3	8	6.1	33
8	2023	7	14	5.9	25
9	2023	18	30	6.8	19

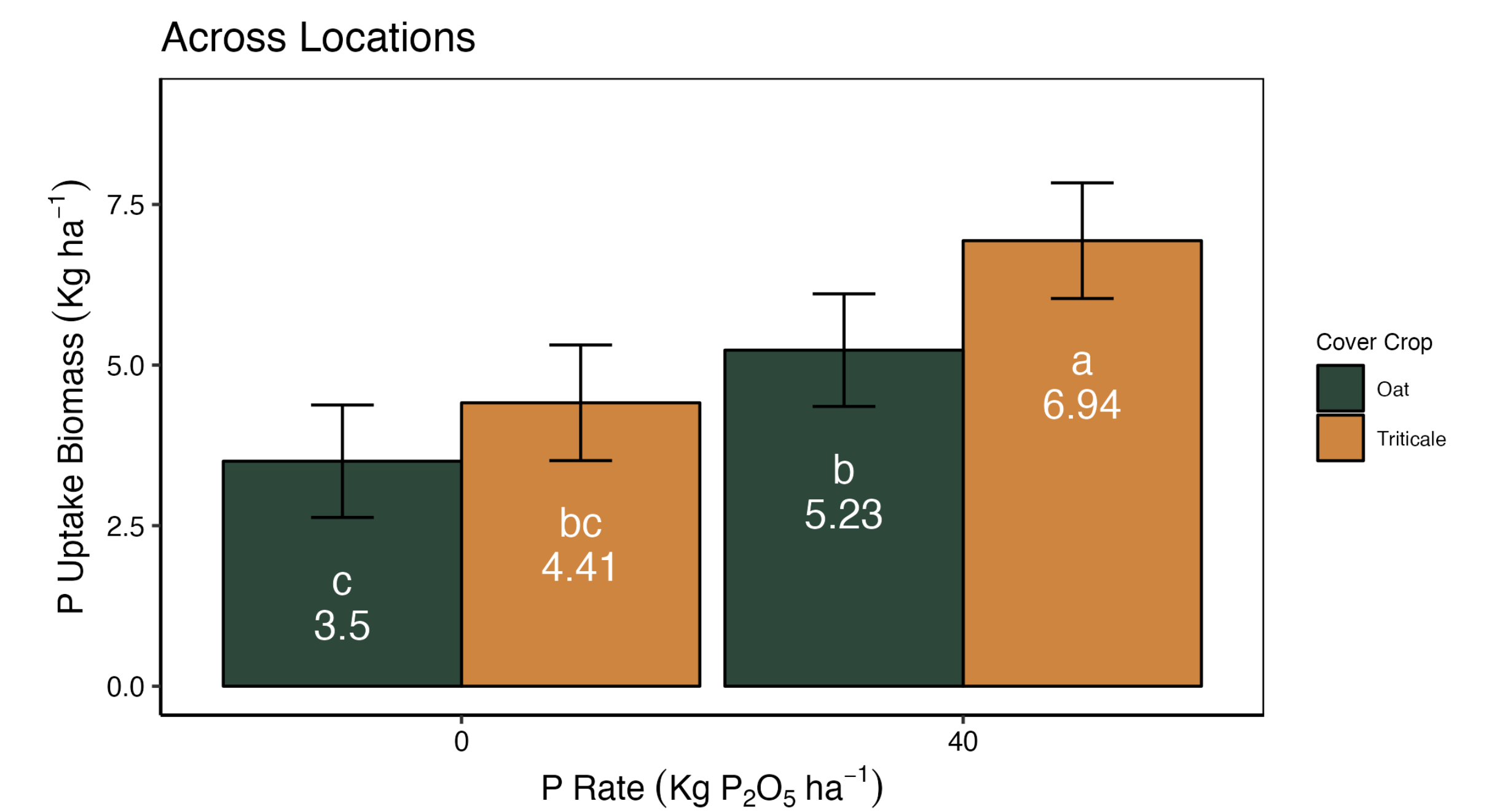


**Figure 1:** Window of opportunity a cover crops in a corn-soybean cropping system.

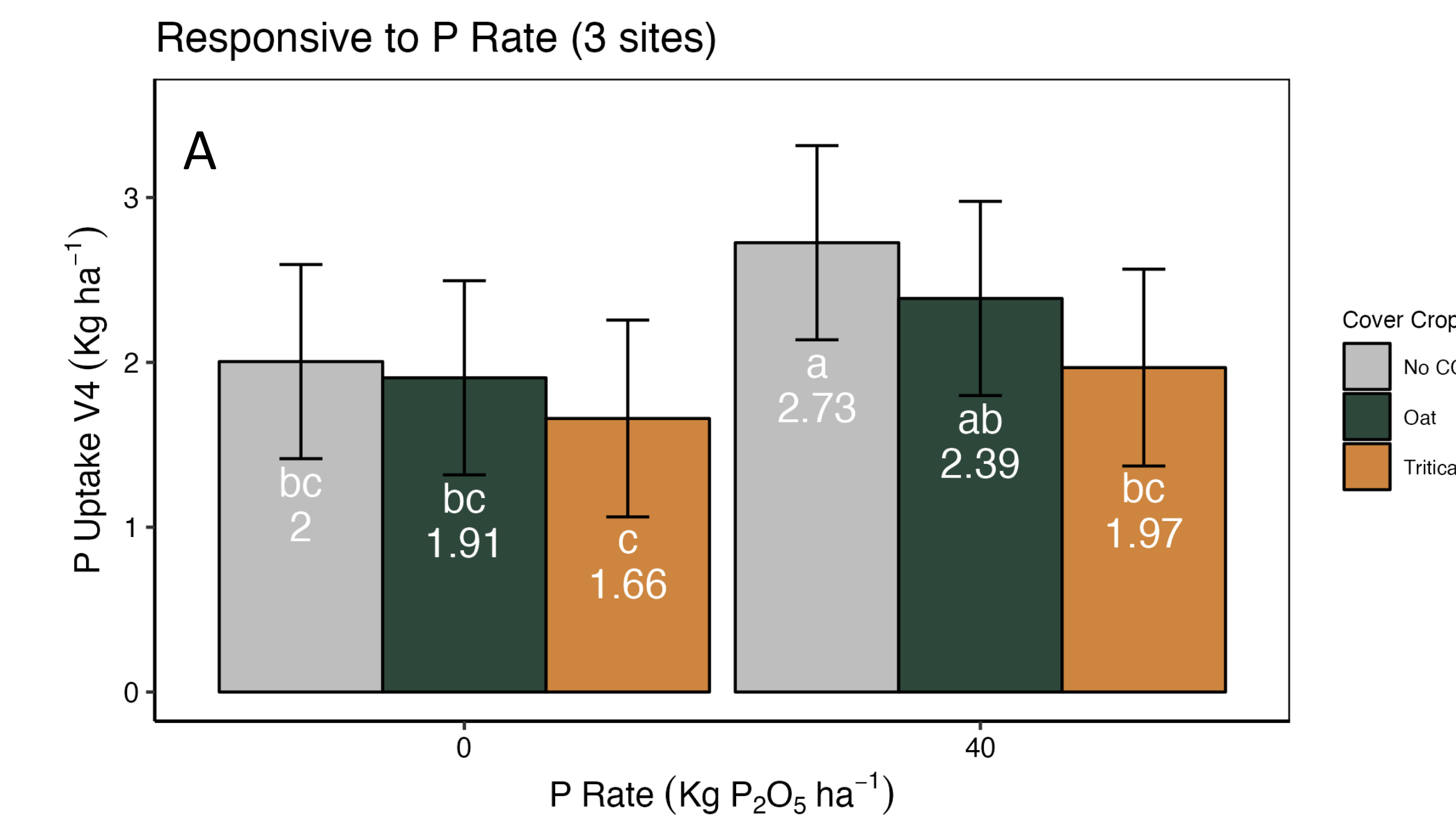
## RESULTS



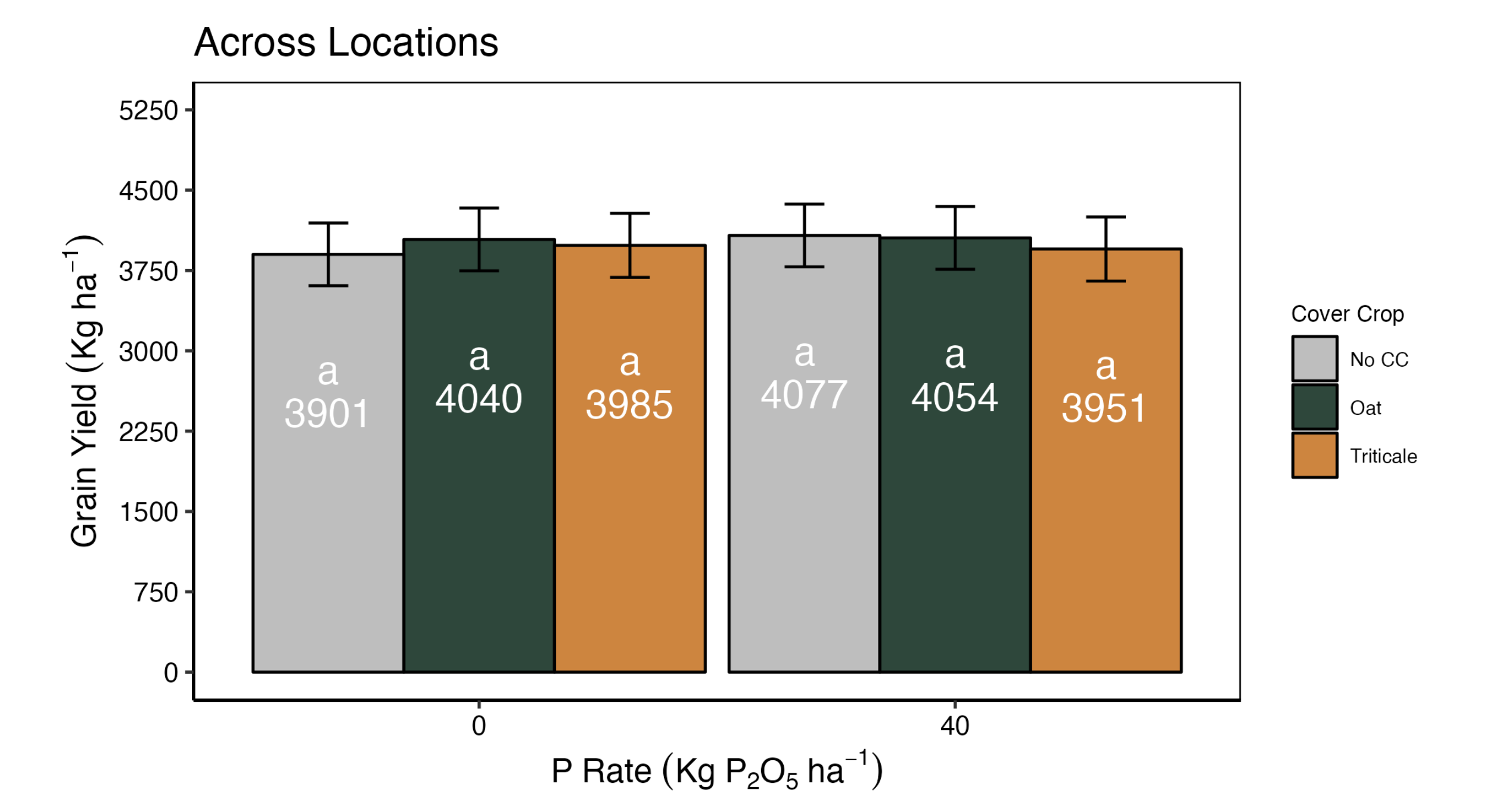
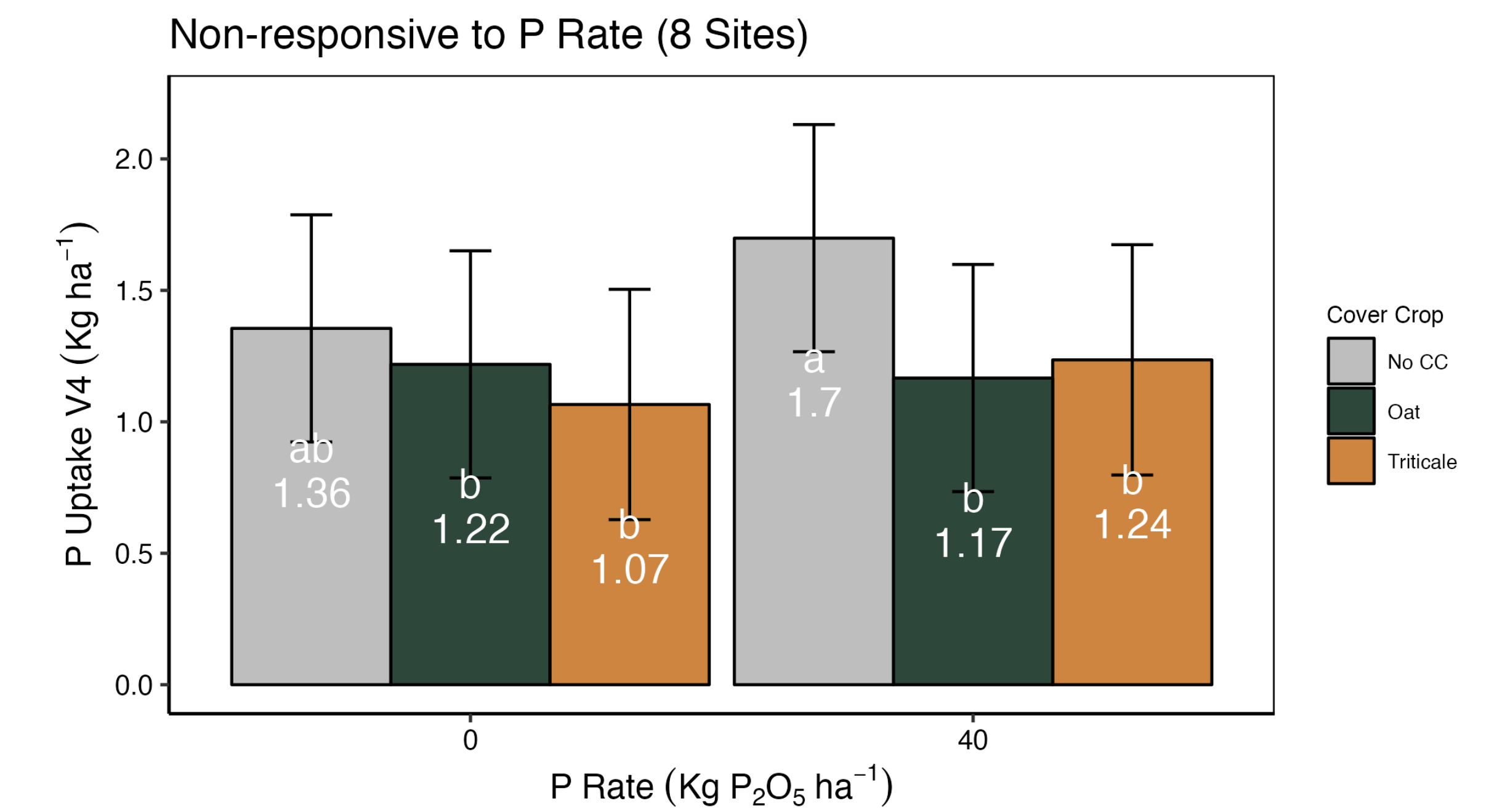
**Figure 2:** Cover crop biomass (Kg ha<sup>-1</sup>) as affected by different P rates and cover crop species across 9 locations.



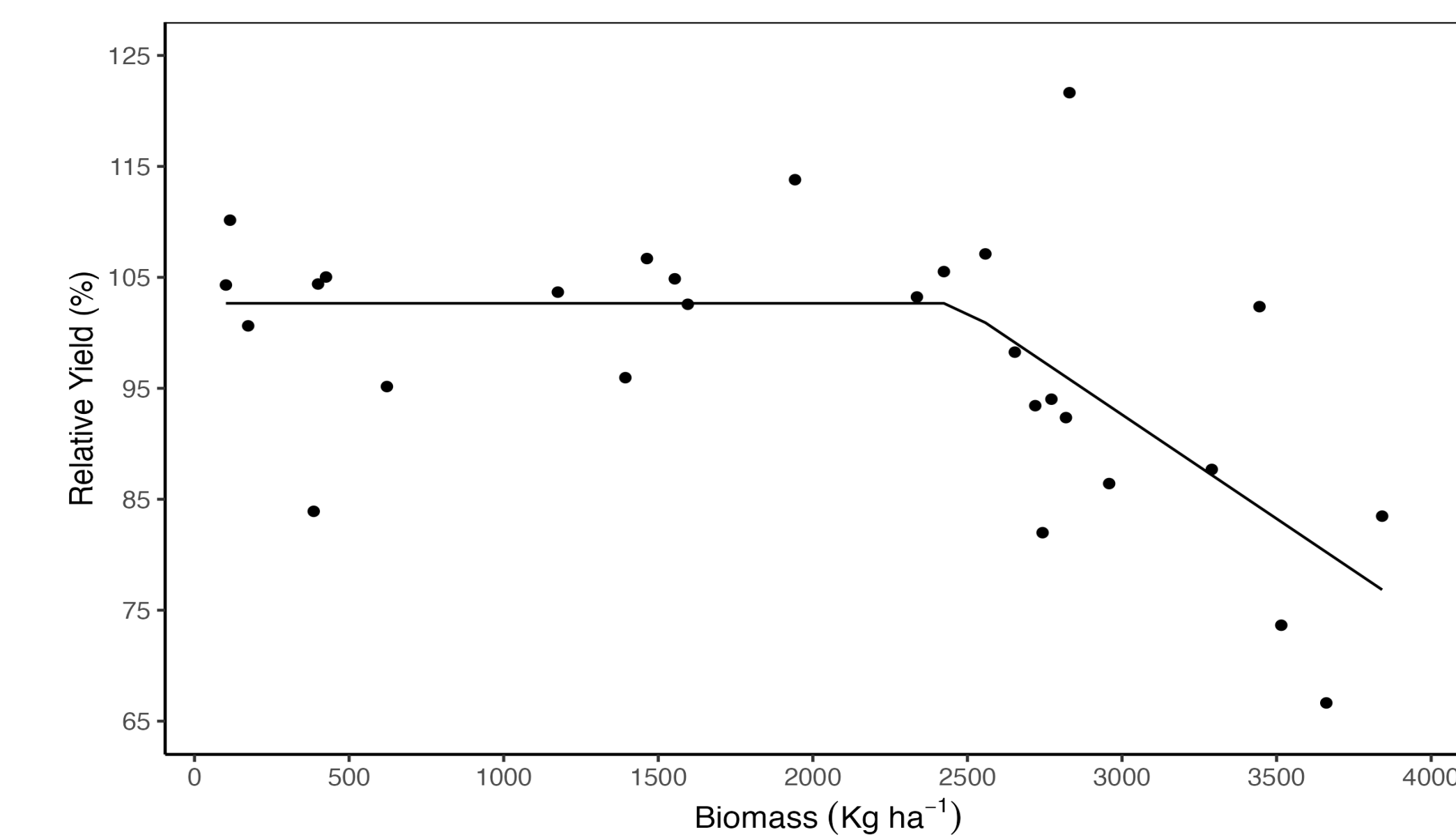
**Figure 3:** Cover crop P Uptake (Kg ha<sup>-1</sup>) as affected by different P rates and cover crop species across 9 locations.



**Figure 4:** Phosphorus uptake (Kg ha<sup>-1</sup>) as affected by different P rates and cover crop species in responsive (A) and non-responsive (B) locations to P fertilizer application at the V4 growth stage.



**Figure 5:** Grain yield (Kg ha<sup>-1</sup>) as affected by different P rates and cover crop species.



**Figure 6:** Relative yield (%) as affected by cover crop biomass (Kg ha<sup>-1</sup>) across 6 locations.

Parameters	PR	(CC)	PR x CC	p > F	
				Site 1	Site 2
V4 P Uptake	<0.001	<0.001	0.209	0.424	0.001
Grain Yield	0.168	0.047	0.430	0.549	0.002
CC Biomass		0.826			0.101
CC P Uptake		0.300			0.108
				p > F	
				Site 3	Site 4
V4 P Uptake	0.764	0.115	0.818	0.509	0.051
Grain Yield	0.218	0.069	0.531	0.227	0.627
CC Biomass		0.101		0.293	<0.001
CC P Uptake		0.166		0.012	0.372
				Site 5	Site 6
V4 P Uptake	0.006	0.042	0.460	0.133	0.353
Grain Yield	0.347	0.548	0.193	0.619	0.417
CC Biomass	<0.001	<0.001	0.001	0.094	<0.001
CC P Uptake	<0.001	<0.001	0.105	0.024	<0.001
				Site 7	Site 8
V4 P Uptake	0.164	0.030	0.380	0.005	0.188
Grain Yield	0.216	0.081	0.707	<0.001	0.080
CC Biomass	0.051	0.117	0.226	<0.001	<0.001
CC P Uptake	0.083	0.124	0.480	<0.001	0.192
				Site 9	
V4 P Uptake	0.153	0.003	0.027		
Grain Yield	0.334	0.313	0.411		
CC Biomass	0.034	0.053	0.115		
CC P Uptake	<0.001	0.109	0.080		

**Figure 7:** Significance of F values for fixed effect of P fertilizer application rates, placement, and rates:placement on phosphorus uptake, and grain yield.

## SUMMARY

- At the early growth stage, there is a penalty in soybean P uptake when adding a cover crop to the system in locations responsive and non-responsive to P fertilization.
- There was no difference in yield across locations by adding cover crop to the system or by applying P fertilizer.
- Excessive CC biomass seems to negatively affect soybean growth and yield, suggesting the need for timely termination of the cover crop. In dryer Kansas environment, it is conceivable that water utilization by cover crops is affected.