Tile Drainage, Cover Crops and Nitrogen Interactions

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MinnesotaCorn

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Justification

- Previous research has shown subsurface drainage systems deliver nitrogen to surface waters and thereby degrade water quality.
  - How much: cropping system, weather, nitrogen management
- Row crop agriculture in Minnesota and throughout the Midwest is under scrutiny to reduce nitrogen concentrations and loads from drainage water.

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Nitrate reduction strategies

- Several strategies have been proposed to reduce nitrate losses from crop production systems including:
  - ***cover crops***
  - rate, timing and source of fertilizer N
  - drainage water management
    - in-field or edge-of-field

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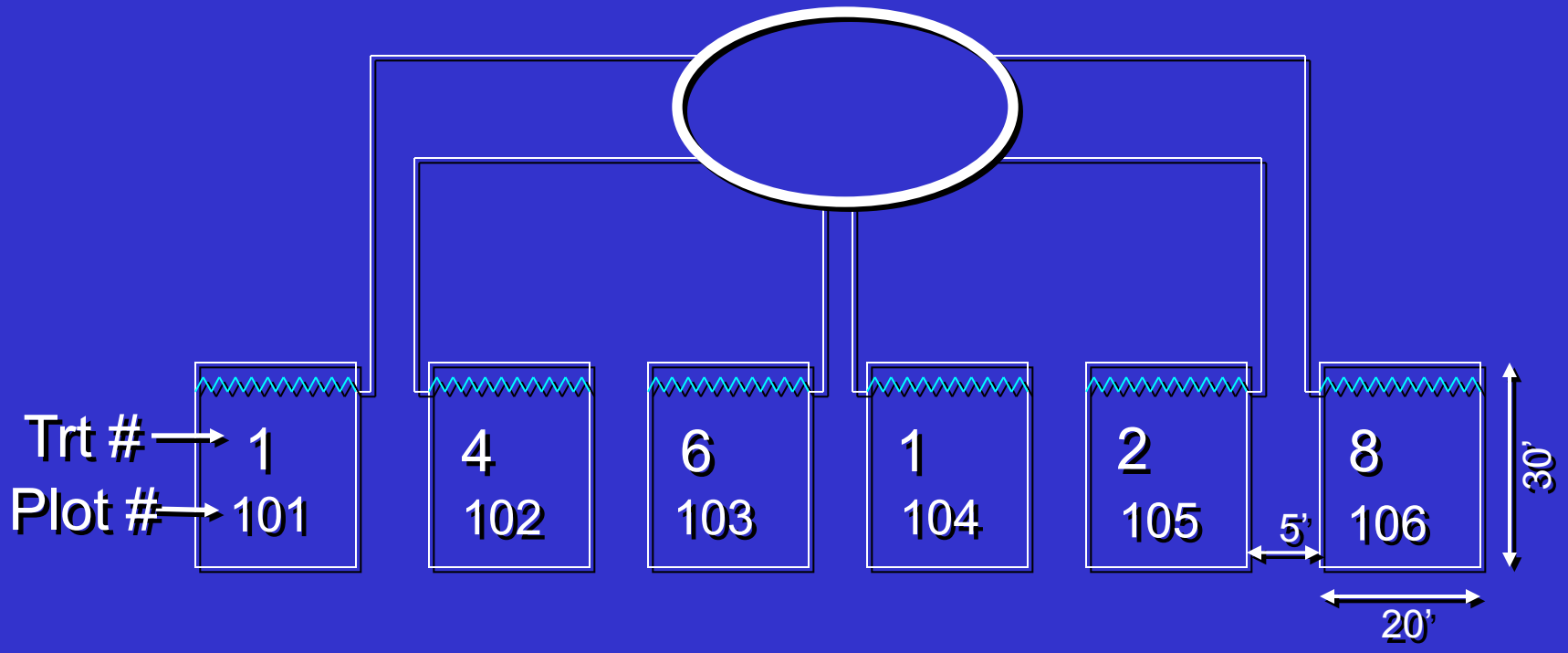
Research questions

- How does species selection of an overseeded cover crop and its termination date affect its ability to mitigate N loss from subsurface drainage?
- What effects and interactions do N rate, cover crop species and termination date have on corn and soybean productivity and N uptake and N use efficiency?

Experimental procedures

- Site: drainage research facility at Waseca
  - Canisteo-Webster clay loam (50-ft tile spacing)
  - 36 tile drained plots (20 ft × 30 ft), allows space for four replications of nine treatments.
- Nine treatments are comprised of a two-factor factorial with each factor at three levels.
  - **Cover crop**: none, cereal rye with spring termination and blend of annuals with winter termination (freezing)
  - **Nitrogen rate**: 3 (control), 120 and 150 lb N/ac for corn following soybean.

Drainage Research Facility at Waseca, SROC



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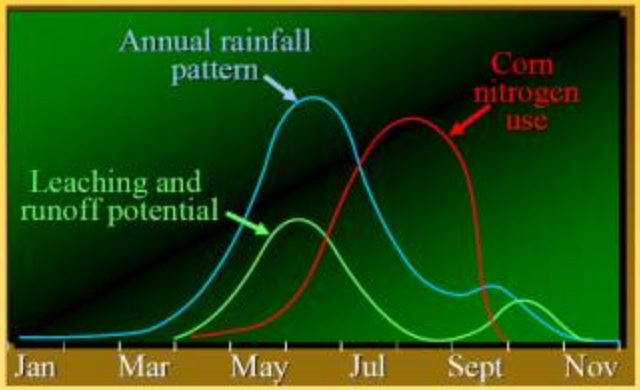
Treatments for corn in 2019.

Trt.	Cover Crop	Total N rate	N Timing^
		lb/ac	
1	None	3	3-lb at planting
2	None	120	Planting & V4
3	None	150	Planting & V4
4	Cereal rye with spring termination	3	3-lb at planting
5	Cereal rye with spring termination	120	Planting & V4
6	Cereal rye with spring termination	150	Planting & V4
7	Annual blend with fall termination	3	3-lb at planting
8	Annual blend with fall termination	120	Planting & V4
9	Annual blend with fall termination	150	Planting & V4

^ 30-lb N at planting as APP & UAN (May 6), urea+NBPT bdct. at V4 (June 10)



Sidedress time (late May-early June)

V3

10 lb N/ acre

4%

V6

22 lb N/ acre

10%

V12

68 lb N/ acre

30%

Silking

R1

135 lb N/ acre

60%

Milk

R3

180 lb N/ acre

80%

Physiological maturity

R6

225 lb N/ acre

100%

May Jun Jul Aug Sep

Driven to Discove

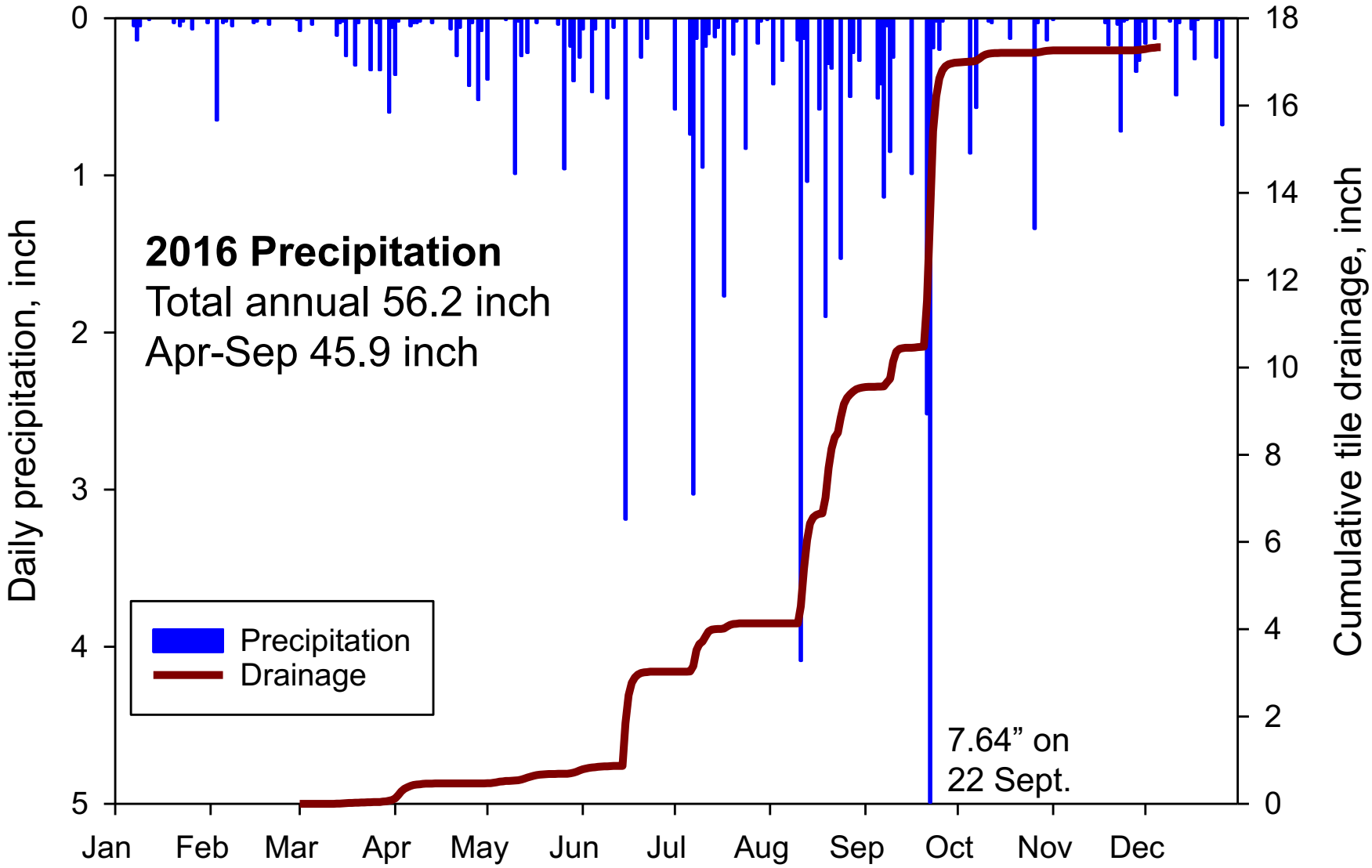
Methods

- Initiated study in 2016, corn-soybean rotation.
- Cover crops
  - Broadcast seeded by hand each year in early Sept. (R6 growth stage of soybean, R5 in corn)
    - Cereal rye (spring termination) 90 lb/ac seeding rate ($37/ac seed cost)
    - Blend (winter termination) annual rye 12 lb/ac, crimson clover 15-lb and radish 5-lb ($53/ac)
    - Aerial seeding $14-20/ac?
- Tillage system: fall strip-till after each crop
  - P and K fertilizer applied in strip-till band for corn and broadcast for soybean.

Measurements

- Corn, soybean and cover crop yield, N content in grain and biomass. Calculate N uptake and NUE.
- Tile drain flow, and nitrate-N concentration and loss.
- Soil inorganic N to a depth of 3-ft. in spring and fall.

Tile drainage and precipitation in 2016.



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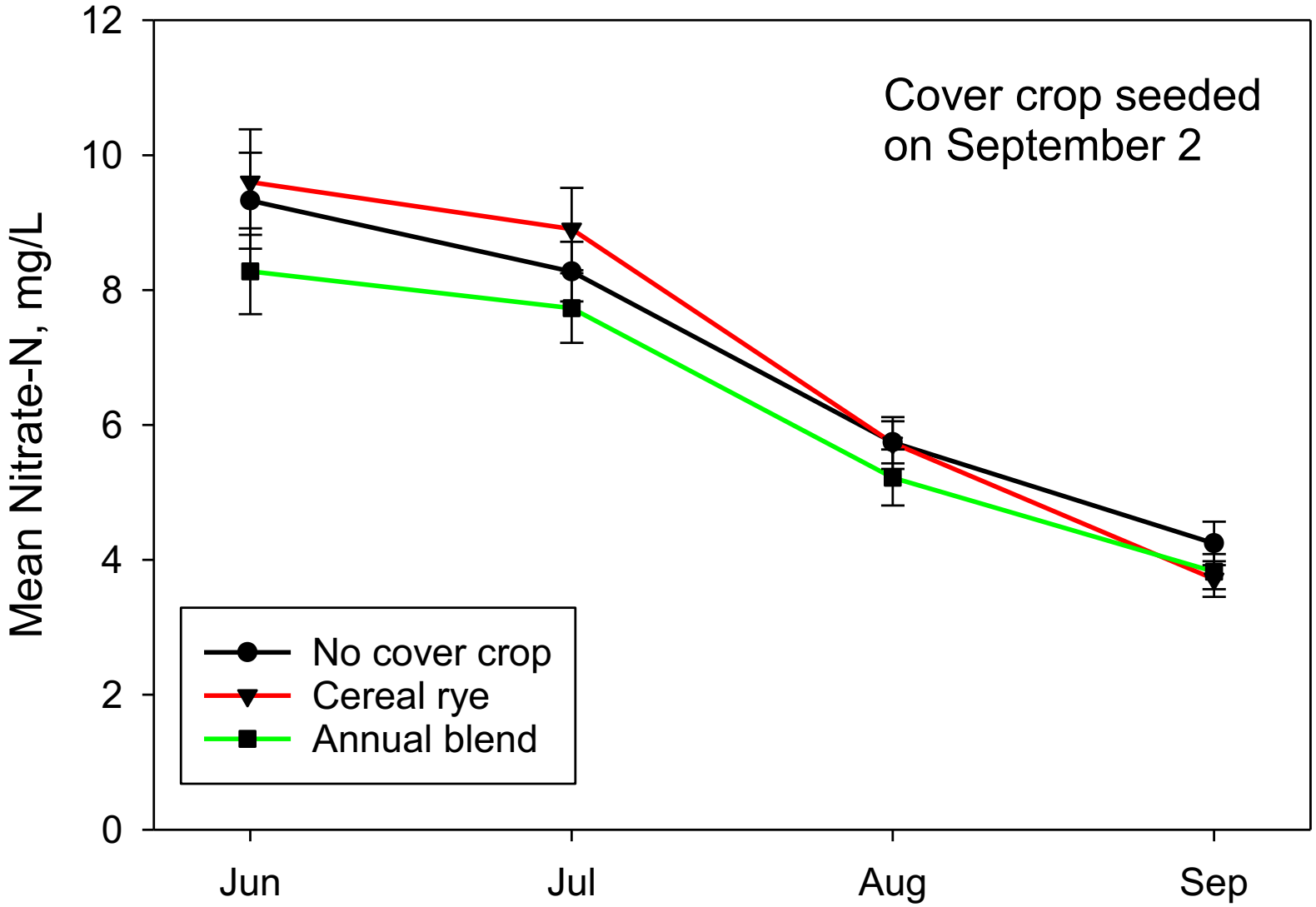
Nitrate-N concentration in tile water in 2016.



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Oct. 10, 2016
Vetsch et al. 2020


Oct. 10, 2016


Oct. 24, 2016
Orbit-Air
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Nov. 16, 2016
Vetsch et al. 2020


Nov. 16, 2016
Vetsch et al. 2020

April 17, 2017

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May 7, 2017
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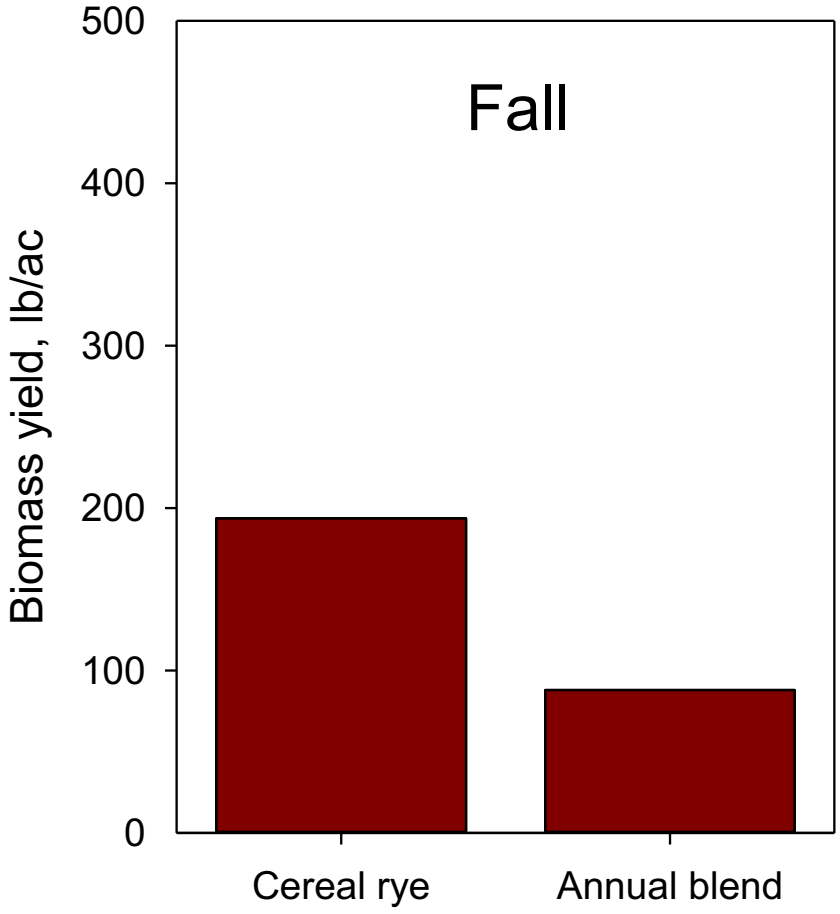
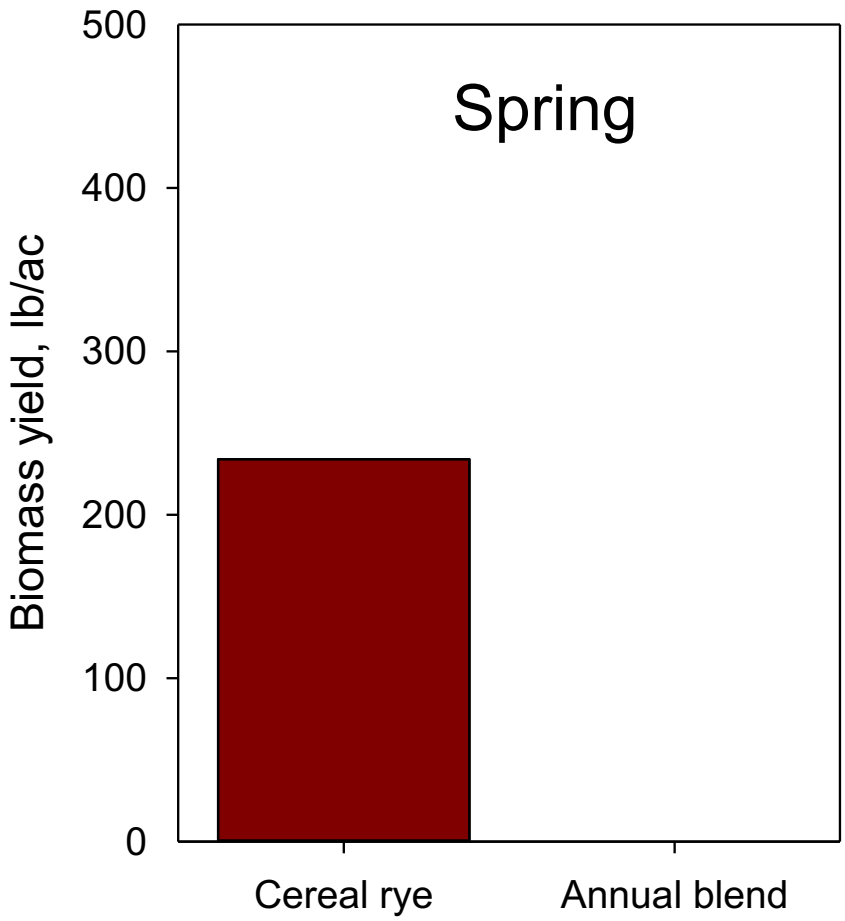
Cover crop biomass yield on 21 October 2016 and 17 April 2017.





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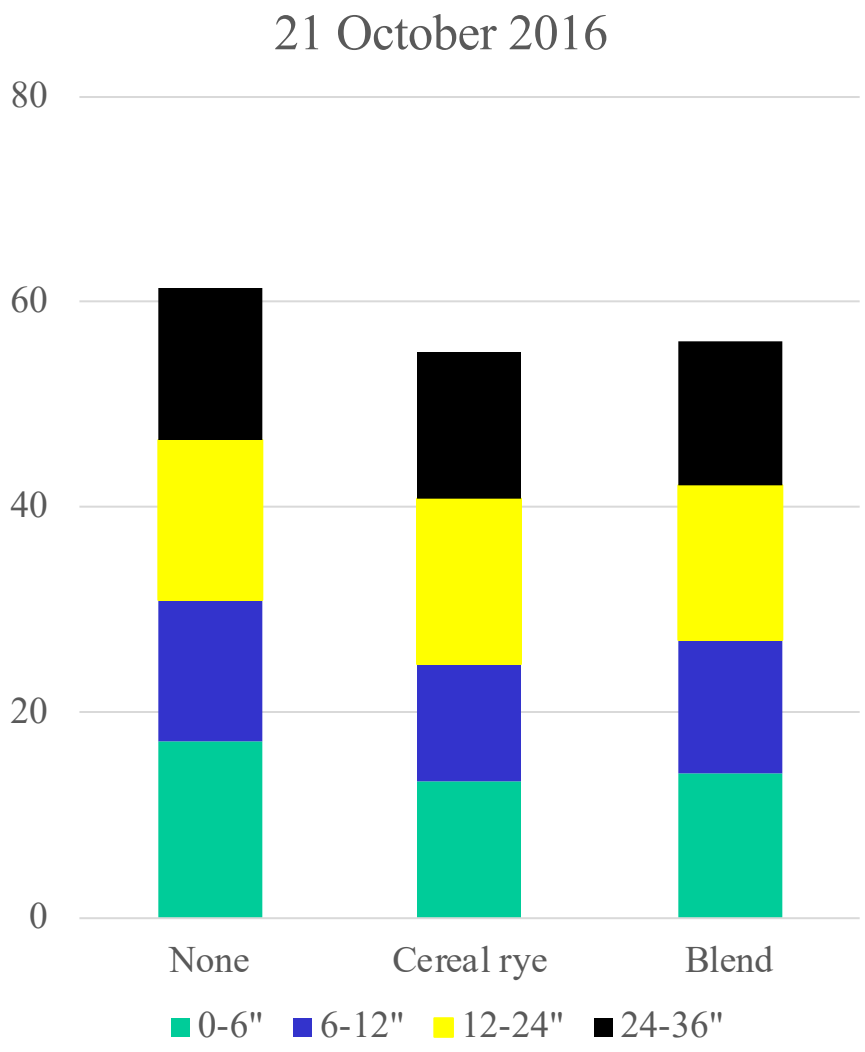
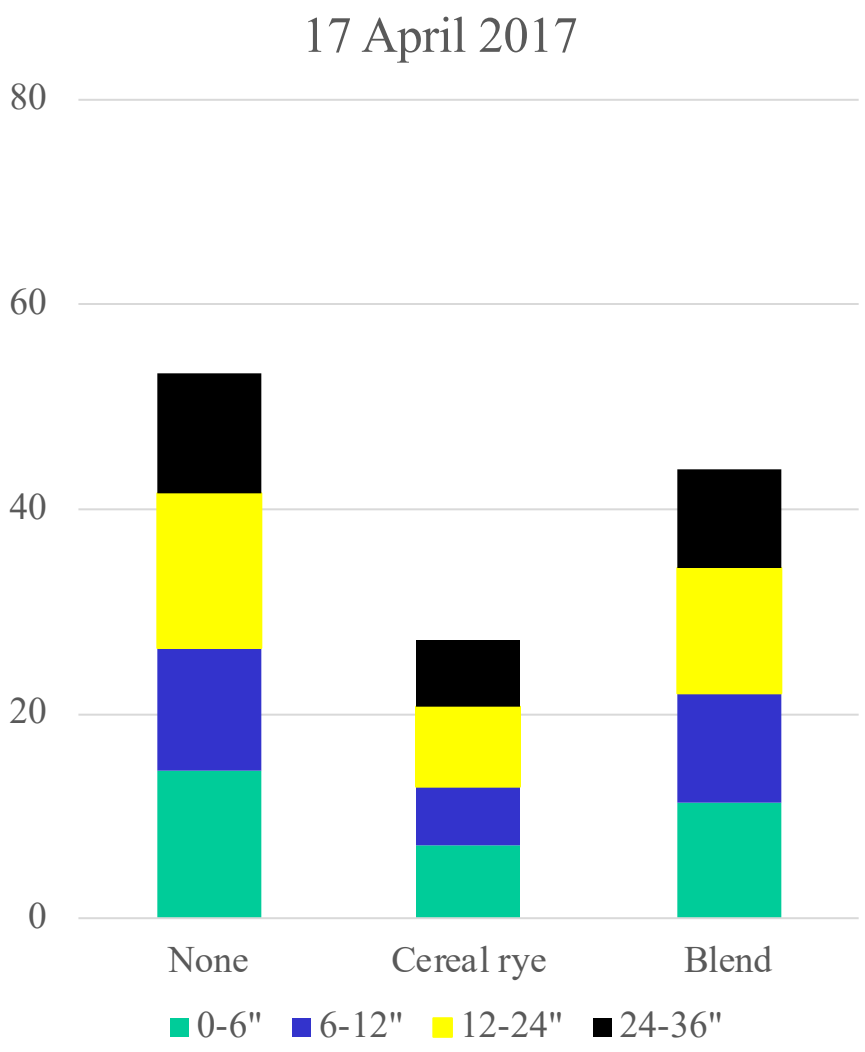
Soil nitrate-N as affected by cover crops.





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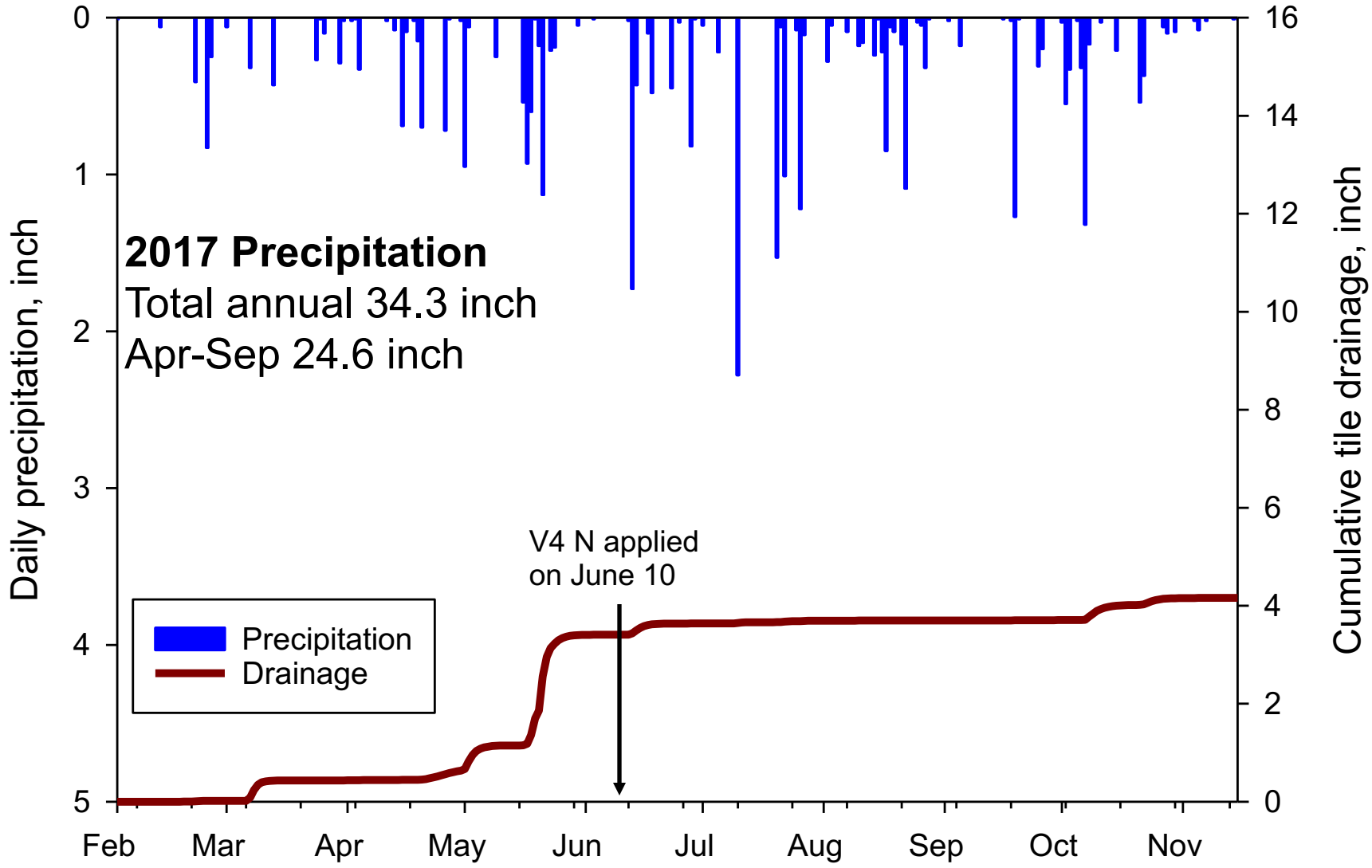
Tile drainage and daily precipitation in 2017.

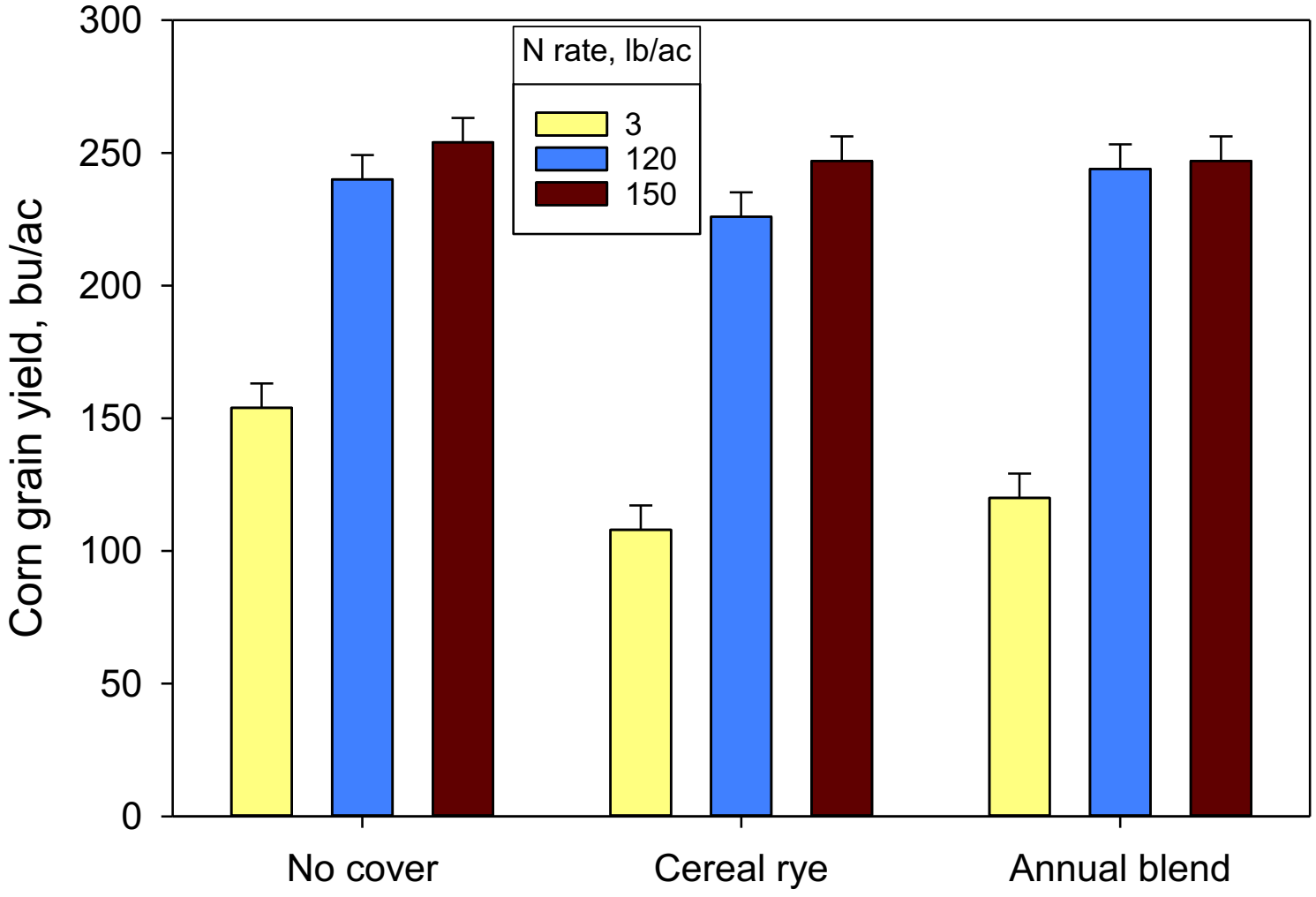


Flow-wieghted NO_3-N concentration, NO_3-N loss, and flow-adjusted loss in 2017.

	Cover	N application		NO_3-N conc.	NO_3-N loss	Flow adj.
Trt	Crop	Planting	V4	Annual Avg.	Annual total	NO_3 loss
#		---- lb/ac	----	mg/L	lb/ac	lb/inch
1	None	3	0	8.4	6.9	1.8
2	None	30	90	9.3	9.5	2.0
3	None	30	120	8.8	4.4	1.9
4	Rye	3	0	2.8	3.7	0.7
5	Rye	30	90	2.5	2.2	0.5
6	Rye	30	120	2.4	2.6	0.5
7	Blend	3	0	5.8	4.8	1.2
8	Blend	30	90	7.8	7.9	1.7
9	Blend	30	120	6.9	4.9	1.5
Stats for RCB Design with a two-factor factorial arrangement						
Cover crop						
No cover				8.8 A	6.9	1.9 A
Cereal rye				2.6 C	2.8	0.6 C
Annual blend				6.8 B	5.9	1.5 B
N rate for corn						
3				5.7	5.1	1.2
120				6.5	6.6	1.4
150				6.0	4.0	1.3


120 lb N/ac w/cereal rye
150 lb w/cereal rye, Sept. 6

Corn grain yield as affected by cover crop species and nitrogen rate in 2017.



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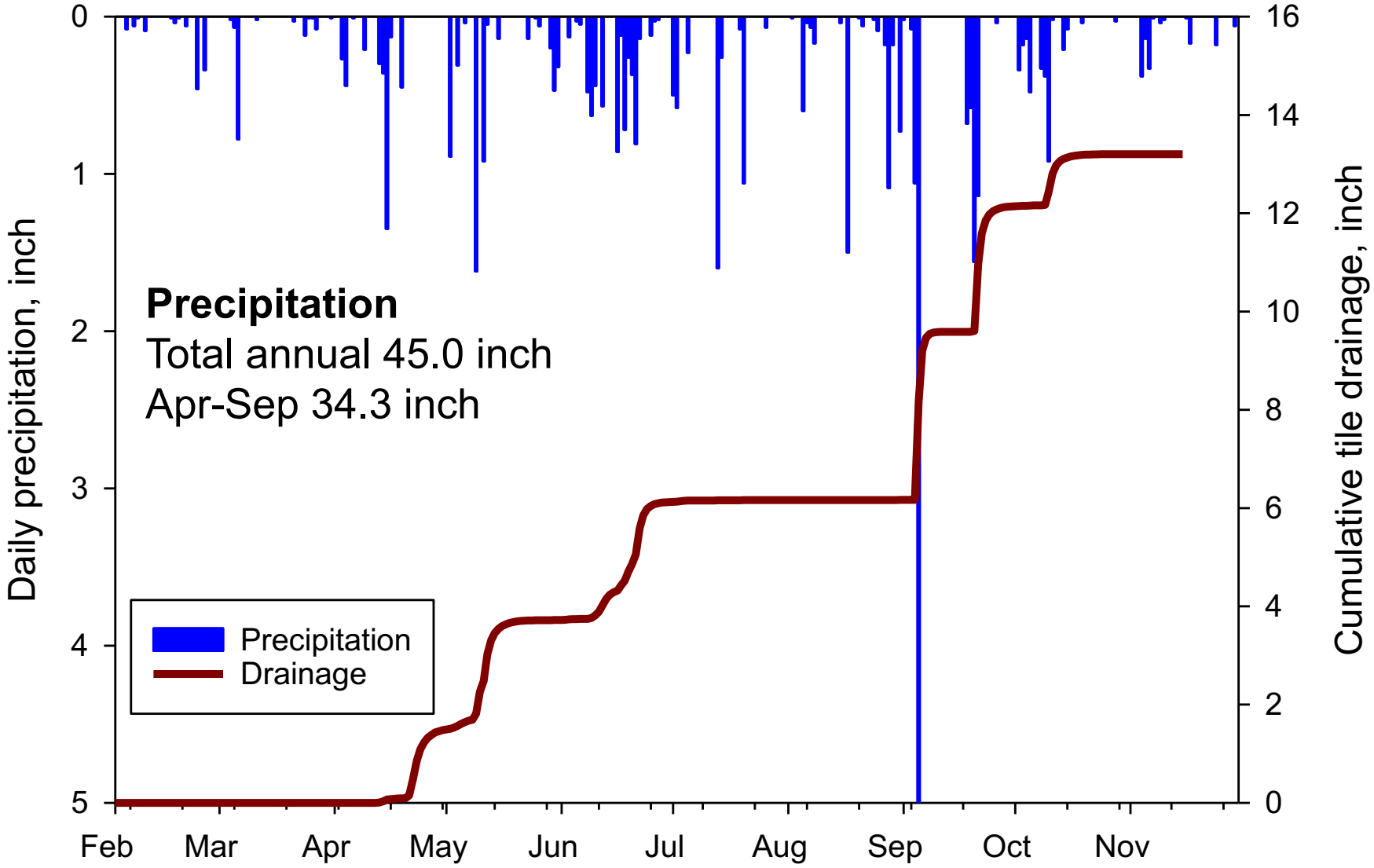
Tile drainage and daily precipitation in 2018.



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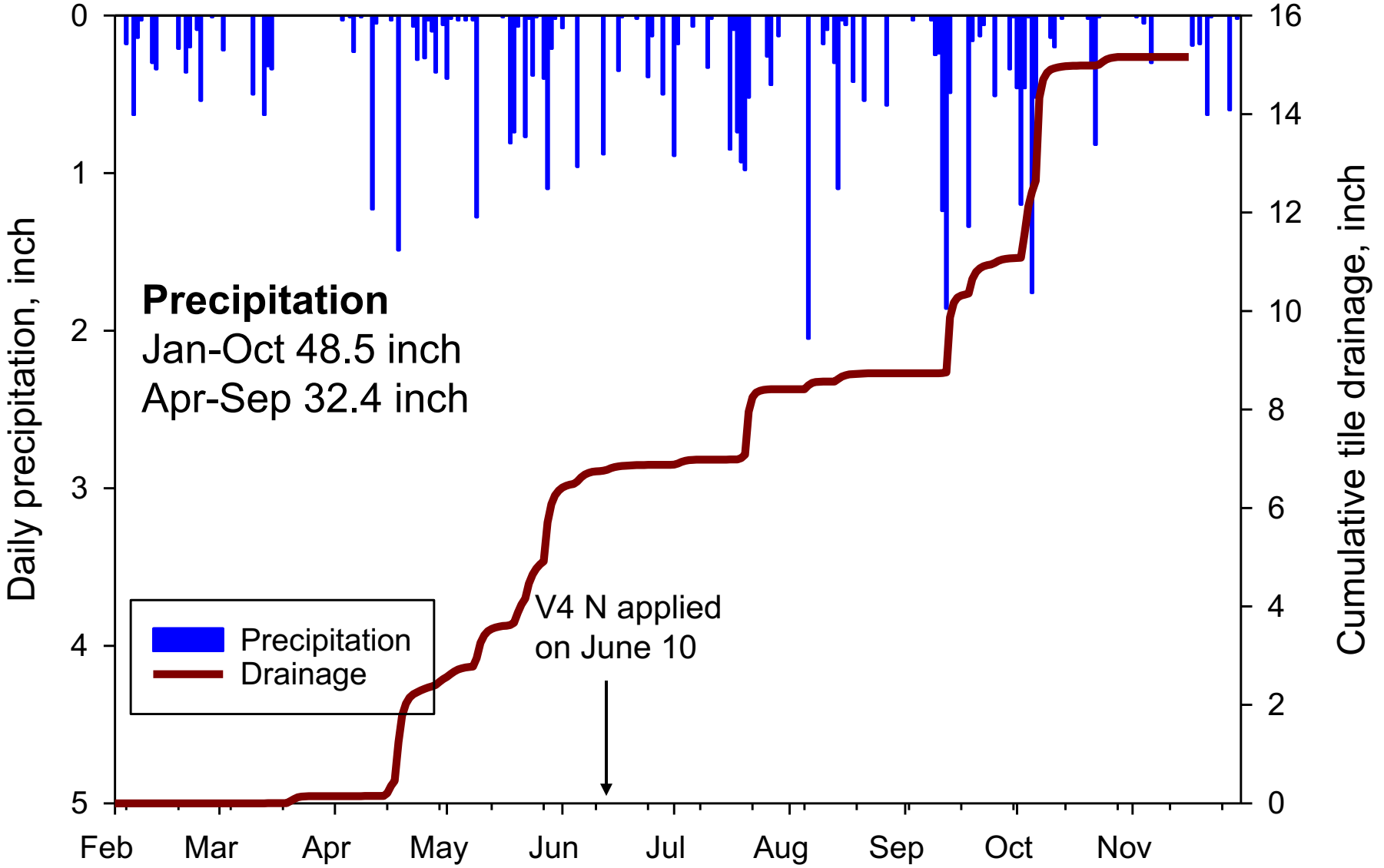
	Cover	N application		NO_3-N conc.	NO_3-N loss	Flow adj.
Trt	Crop	Planting	V4	Annual Avg.	Annual total	NO_3 loss
#		---- lb/ac	----	mg/L	lb/ac	lb/inch
1	None	3	0	1.6 d	3.1 d	0.35 d
2	None	30	90	3.9 ab	11.1 a	0.88 ab
3	None	30	120	4.4 a	11.1 a	1.00 a
4	Rye	3	0	1.9 cd	6.5 bc	0.43 cd
5	Rye	30	90	2.1 c	6.8 bc	0.48 c
6	Rye	30	120	3.4 b	11.4 a	0.78 b
7	Blend	3	0	2.1 c	5.2 c	0.48 c
8	Blend	30	90	3.6 ab	9.7 ab	0.81 ab
9	Blend	30	120	3.4 b	8.5 ab	0.77 b
Stats for RCB Design with a two-factor factorial arrangement						
Cover crop						
No cover				3.0 A	7.3	0.68 A
Cereal rye				2.4 B	8.0	0.55 B
Annual blend				3.0 A	7.5	0.67 A
Total N rate for corn in 2017						
3				1.9 C	4.7 B	0.42 C
120				3.1 B	9.0 A	0.70 B
150				3.7 A	10.3 A	0.84 A


May 4, 2019
112

Tile drainage and daily precipitation in 2019.



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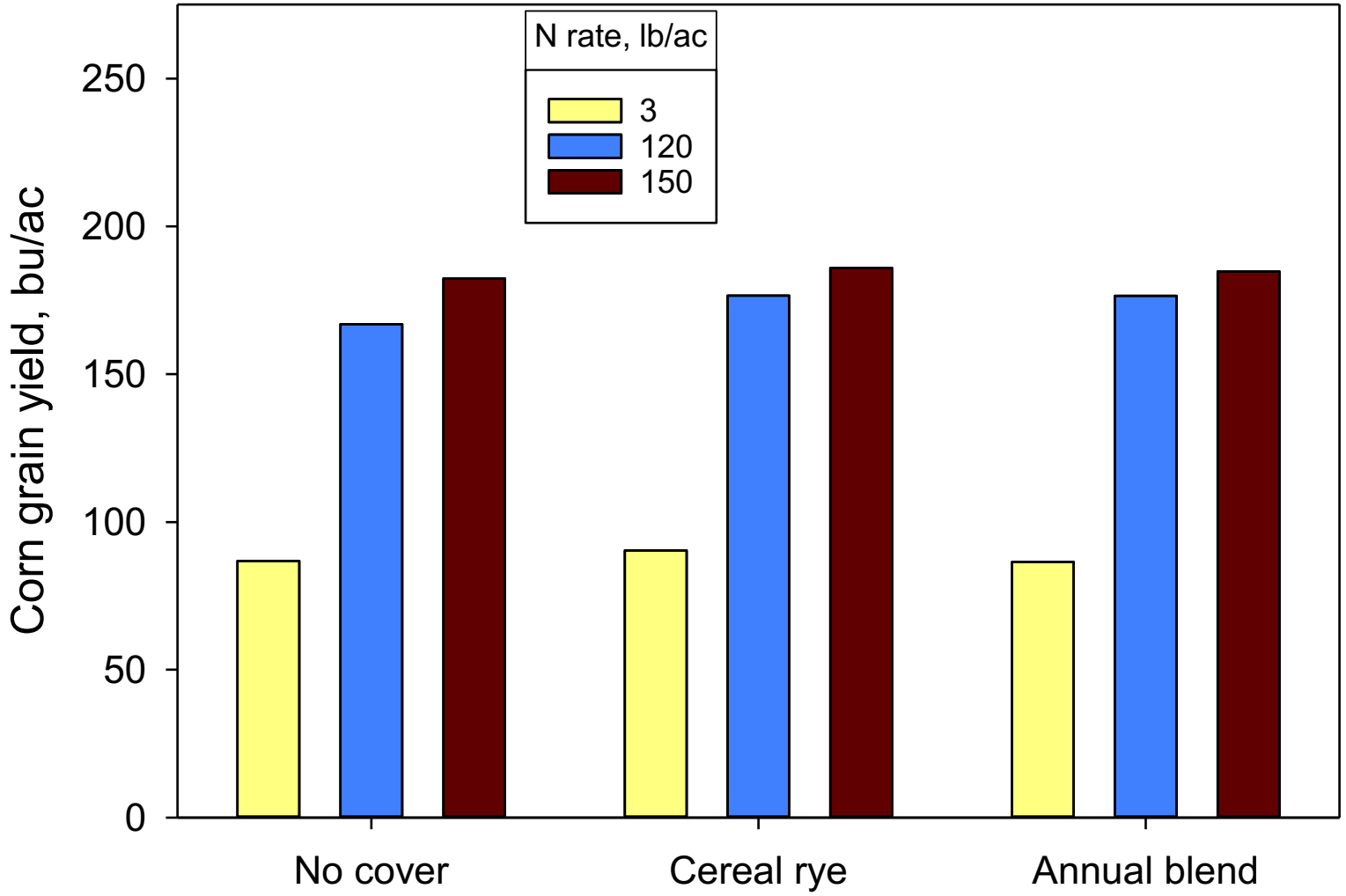

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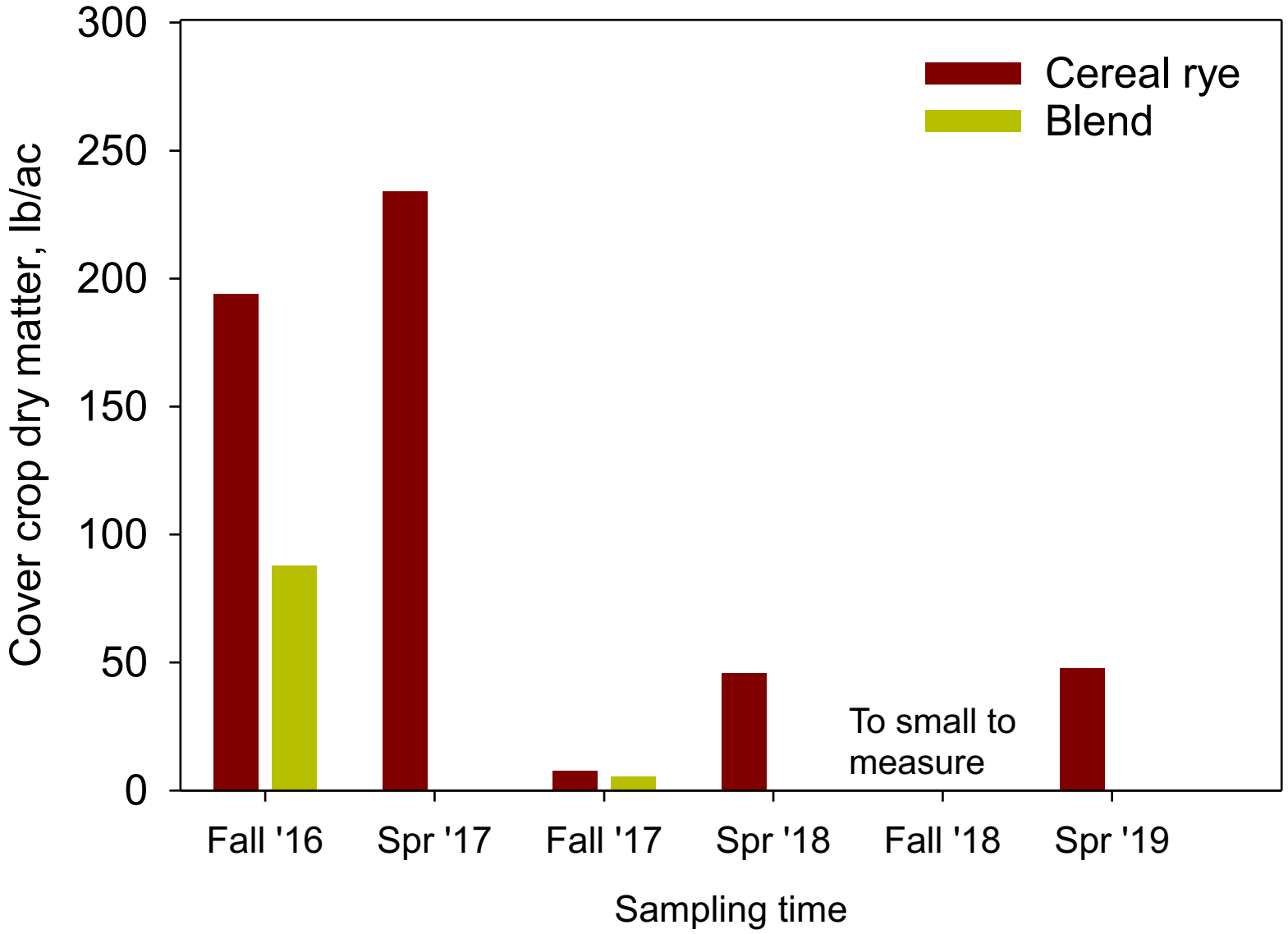
Treatment effects on nitrate-N in tile drainage from 1997–2019

Cover crop biomass yields across years



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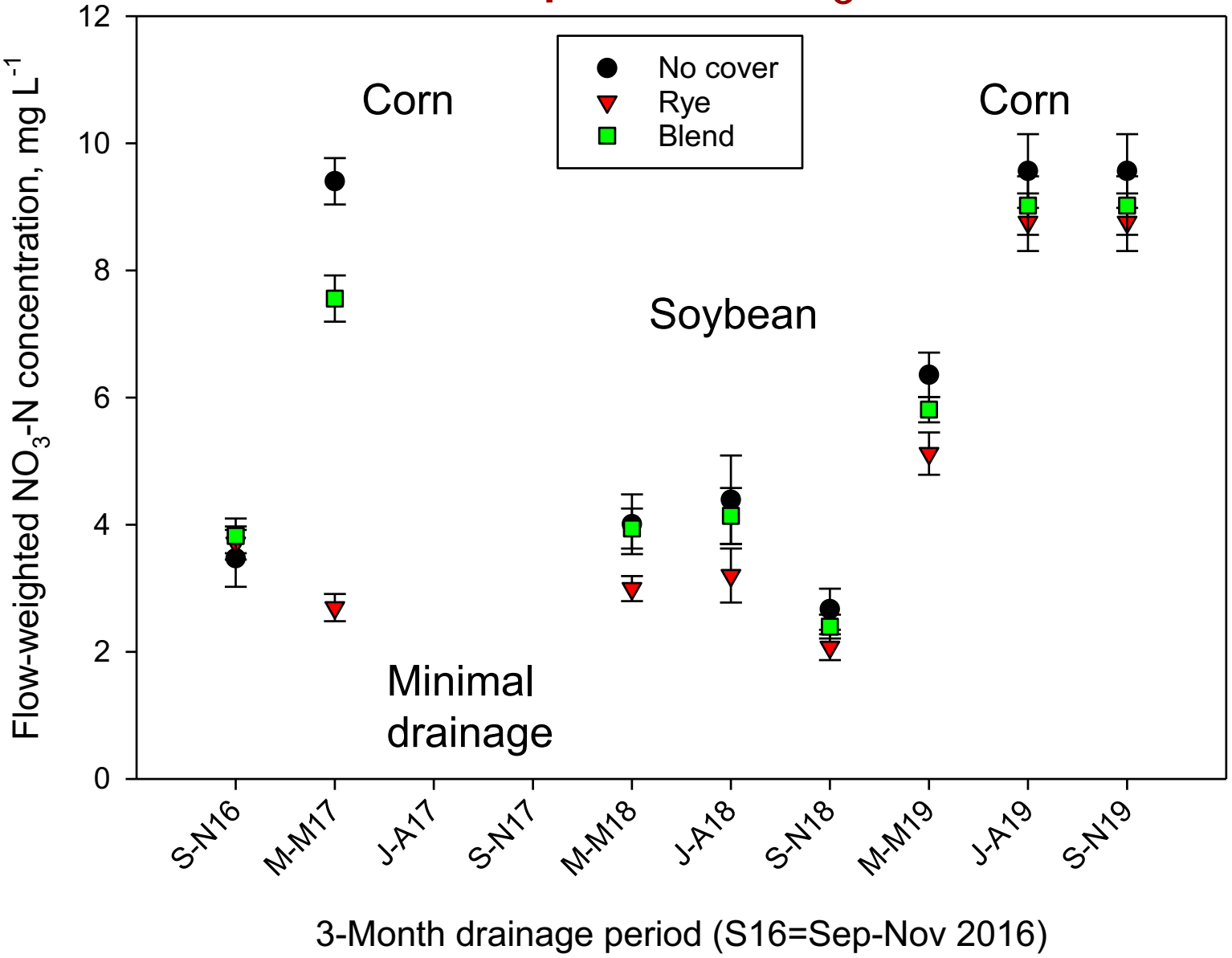
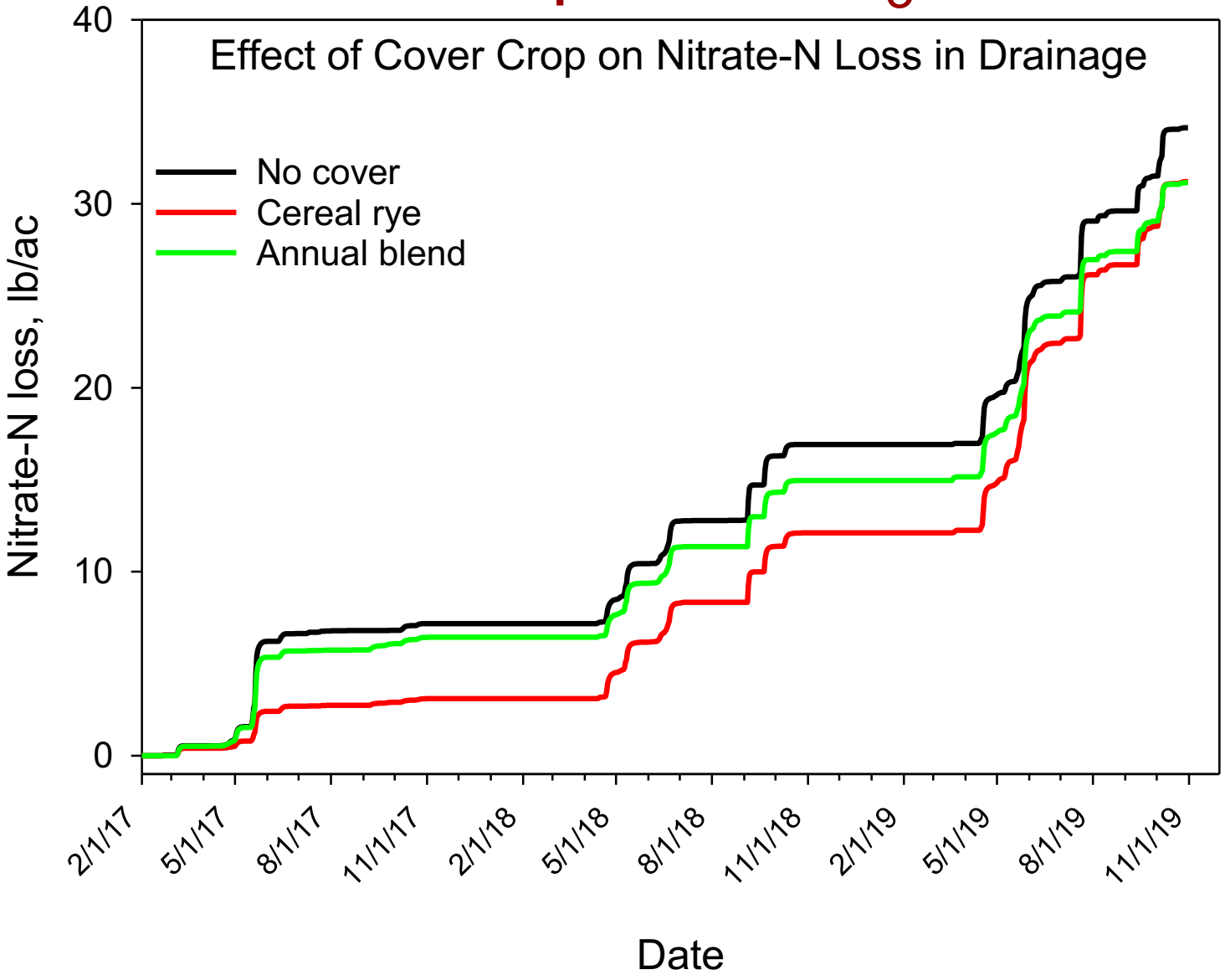
Effects of cover crops on NO_3-N concentration.



Effects of cover crops on NO_3-N loss or load



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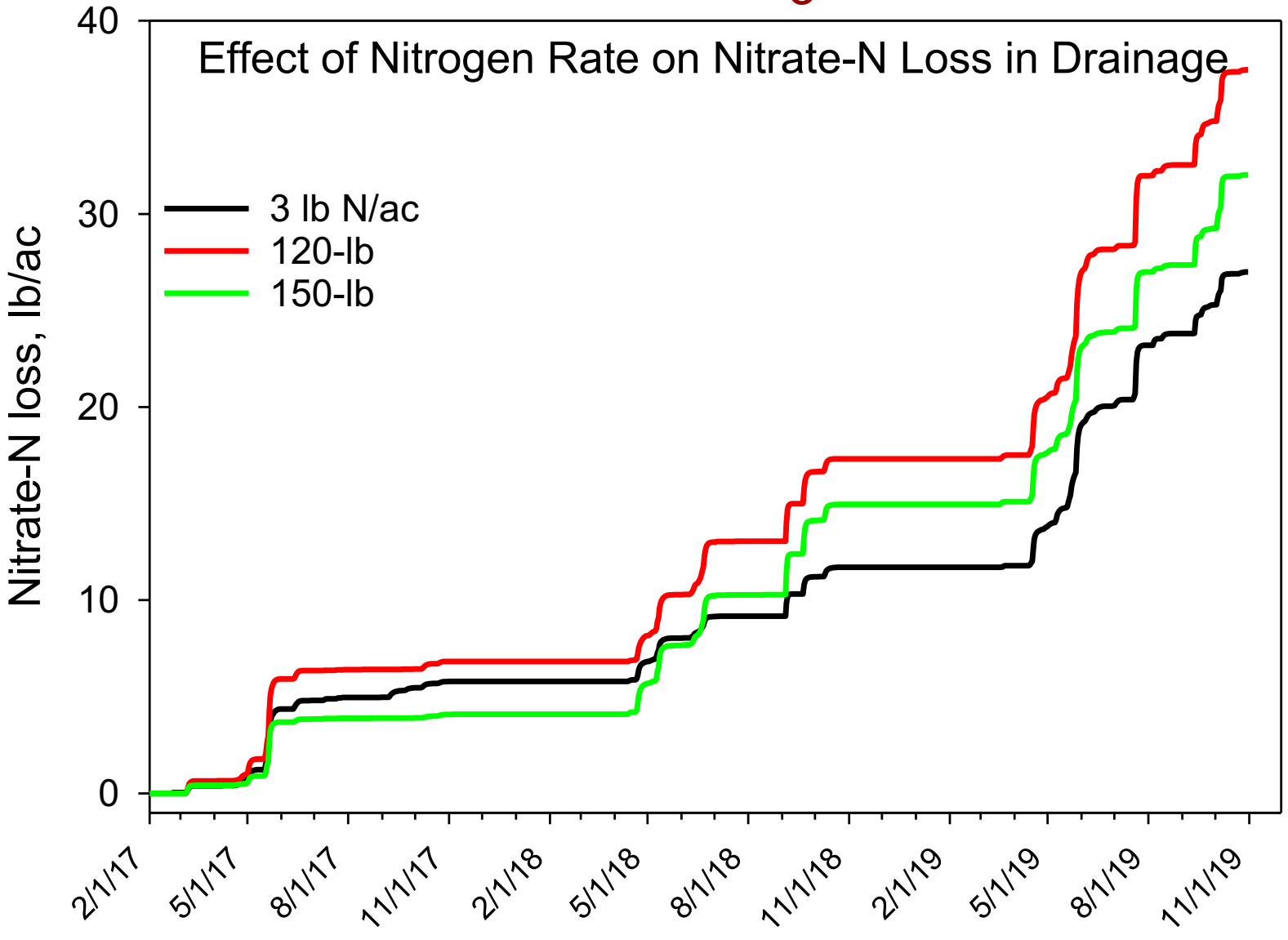
Effects of N rate on NO_3-N loss or load



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Summary

- A cereal rye cover, that was terminated in spring prior to planting, reduced nitrate-N concentration and flow-adjusted loss in tile drainage by 70% in 2017 corn and by 20% in 2018 soybean.
- A greater N rate was needed to optimize corn yield with cereal rye in 2017, but not in 2019.
- Minimal water quality benefit from annual blend.
- No treatment effects on soybean yields.
- Challenges:
  - Cover crop establishment in 2018 and 2019.
  - Economics when overseeding cover crops

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Questions

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