

Winter Cover Cropping in High Tunnels

Mid West Winter Production Conference
Judson Reid & Caitlin Vore, Cornell Vegetable Program
2/17/2020 Eureka MS

This work is supported by the USDA National Institute of Food and Agriculture, Federal Capacity Funds, [1017082], The Sustainability Foundation at Cornell University, and Specialty Crops Block Grant

Fun Facts: Protected Agriculture Tomato Production

New York State ranks:

#2 in the U.S. for number of farms growing tomatoes under protection with a total of **489 operations**.

#3 in the U.S. for number of square feet under protection at **4,188,563 sq. feet**.

#4 in the U.S. in value of sales at **\$28,590,555**.



Since 2012...

64% increase in # of operations growing tomatoes
47% increase in tomato sales

Not so fun facts:

Intensive multi-farm high tunnel study across NYS found...

- High Tunnel soils often have excessive levels of:
 - Phosphorus – (can inhibit Iron, Zinc)
 - Calcium – (can inhibit uptake of Potassium)
 - Magnesium
- Rising pH above >7 (ideal 5.5-6.5)
- Fertilizers are often over applied OR they contain non-target nutrients
 - Reports of Nitrogen applied 200-600 lbs/Acre!???



GENERAL PURPOSE	
20-10-20	
(For Continuous Liquid Feed Programs)	
Guaranteed Analysis	F1143
Total nitrogen (N)	20%
7.77% ammoniacal nitrogen	
12.23 % nitrate nitrogen	
Available phosphate (P ₂ O ₅)	10%
Soluble potash (K ₂ O)	20%
Magnesium (Mg) (Total)	0.05%
0.05% Water Soluble Magnesium (Mg)	
Boron (B)	0.0068%
Copper (Cu)	0.0036%
0.0036% Chelated Copper (Cu)	
Iron (Fe)	0.05%
0.05% Chelated Iron (Fe)	
Manganese (Mn)	0.025%
0.025% Chelated Manganese (Mn)	
Molybdenum (Mo)	0.0009%
Zinc (Zn)	0.0025%
0.0025% Chelated Zinc (Zn)	
Derived from: ammonium nitrate, potassium phosphate, potassium nitrate, magnesium sulfate, boric acid, copper EDTA, manganese EDTA, iron EDTA, zinc EDTA, sodium molybdate. Potential acidity: 487 lbs. calcium carbonate equivalent per ton.	

How can we :

- **increase** soil Nitrogen in a sustainable way?
- **reduce** the nutrient demand of a tomato crop?
- **reduce** the cost of fertilizing?

...all while maintaining or improving tomato yields and quality?



WINTER COVER CROPPING

Exploring...

1. Species selection

- Winter Grain – nitrogen *scavenging*
- Legume – nitrogen *fixation*

2. Timing of planting

- Two planting dates, couple weeks apart
- Early vs. Late
 - 2018 Dates: 10/4, 10/23

3. Row Cover

- Improve winter survival
- Increase biomass → lbs. Nitrogen
- Improve stand



Treatments:

- 1) Triticale with ROW COVER
- 2) Triticale, no cover
- 3) Triticale & Austrian Field Peas with ROW COVER
- 4) Triticale & Austrian Field Peas

*Compared
against bare
ground,
uncovered
control*



Plot 1	Triticale w/ cover	Triticale no cover
Plot 2	Triticale + Field Peas w/cover	Triticale + Field Peas no cover
Plot 3	Bare Ground	

Fall/Winter

Agribon AG-19 Row Cover



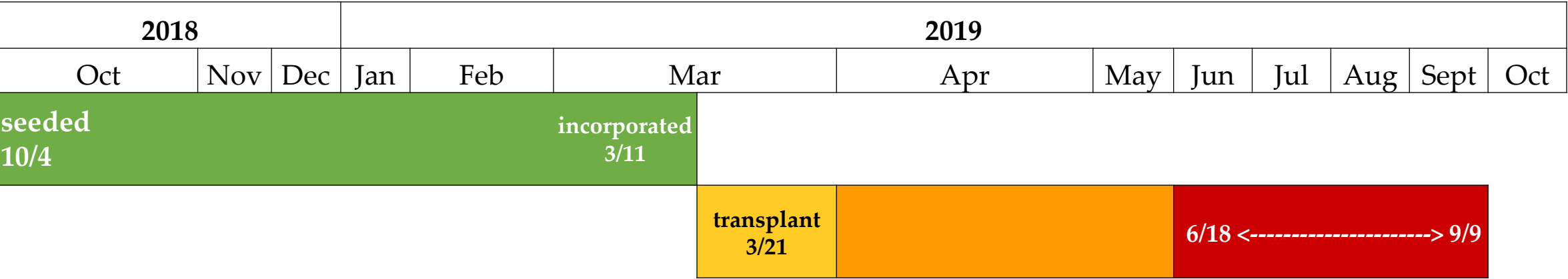
Spring/Summer

Red Deuce

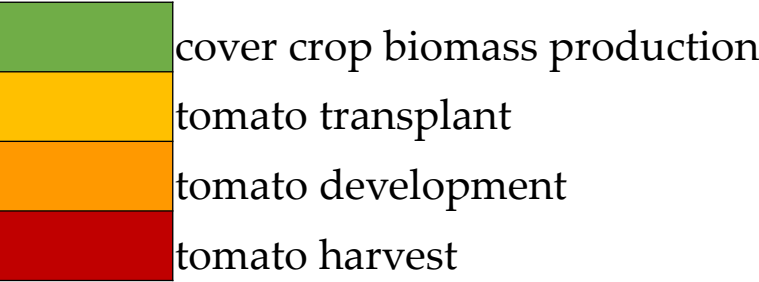
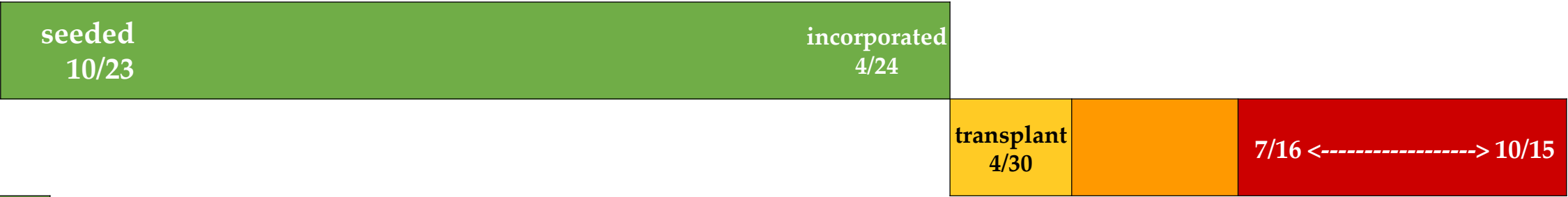


2018 – 2019 timeline

Tunnel 1



Tunnel 3



<i>Treatment</i>	Yield/Plant (lbs.)		Yield/Plot (lbs.)	
	Tunnel 1	Tunnel 3	Tunnel 1	Tunnel 3
Bare Ground	19.11	16.52	344	305
Triticale, w/ cover	15.45	21.09	278	392
Triticale, no cover	17.22	20.53	310	376
Triticale + Peas w/ cover	18.91	18.61	340	370
Triticale + Peas , no cover	17.32	17.19	312	340

Nitrogen Fertility

Cost-Savings

Tunnel 1	lbs. N /Acre from cover crop
Triticale, w/ cover	73
Triticale, no cover	72
Triticale + Peas, w/ cover	40
Triticale + Peas, no cover	61

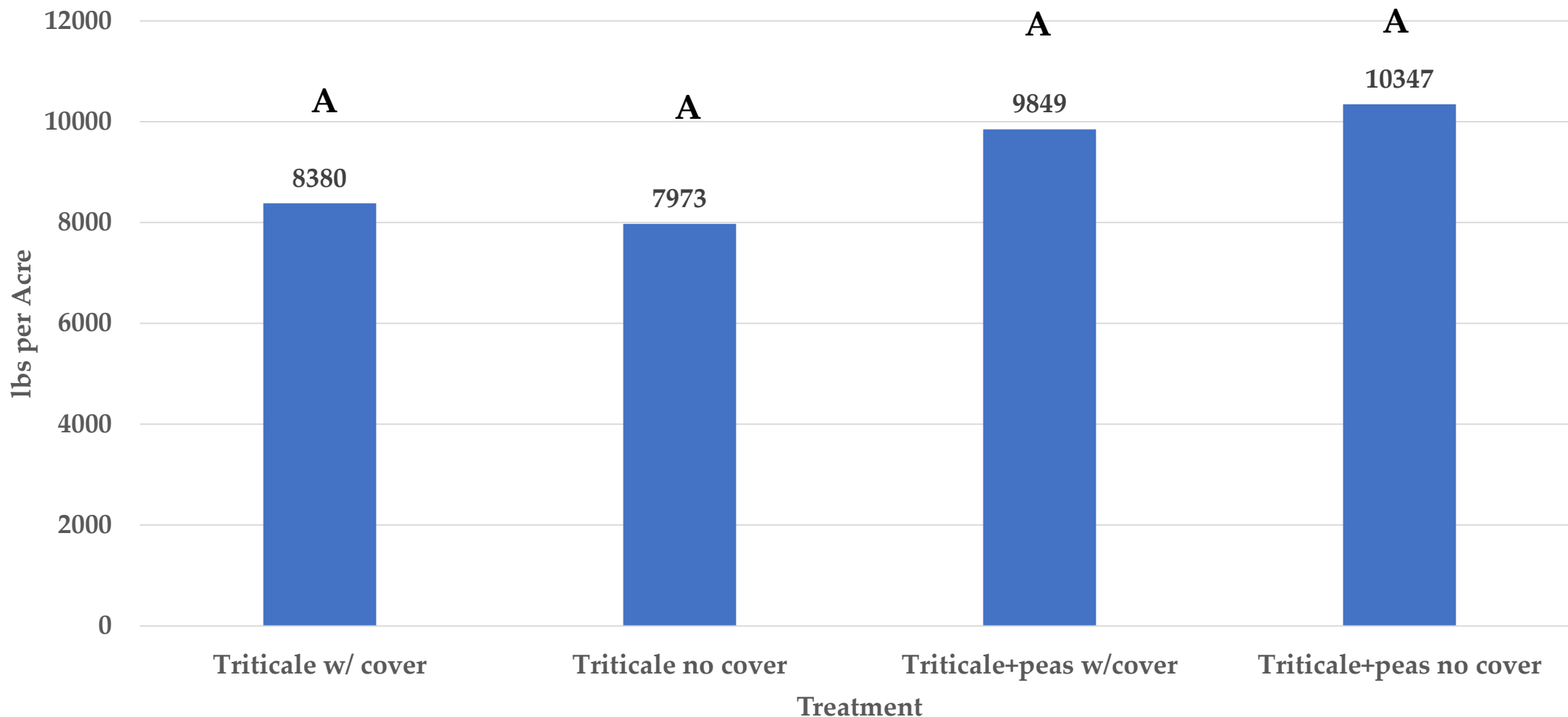
Tunnel 3	
Triticale, w/ cover	24
Triticale, no cover	19
Triticale + Peas, w/ cover	25
Triticale + Peas, no cover	27

<i>Organic N</i>			<i>Conventional N</i>		
Pro-Booster 10-0-0 \$6.40/lb	Feather Meal 13-0-0 \$8.00/lb	Soybean Meal 7-1-2 \$13.00/lb	Urea 46-0-0 \$0.43/lb		Miller's 20-20-20 \$2.14/lb
\$467	\$584	\$949	\$31		\$156
\$461	\$576	\$936	\$31		\$154
\$256	\$320	\$520	\$17		\$86
\$390	\$488	\$793	\$26		\$131

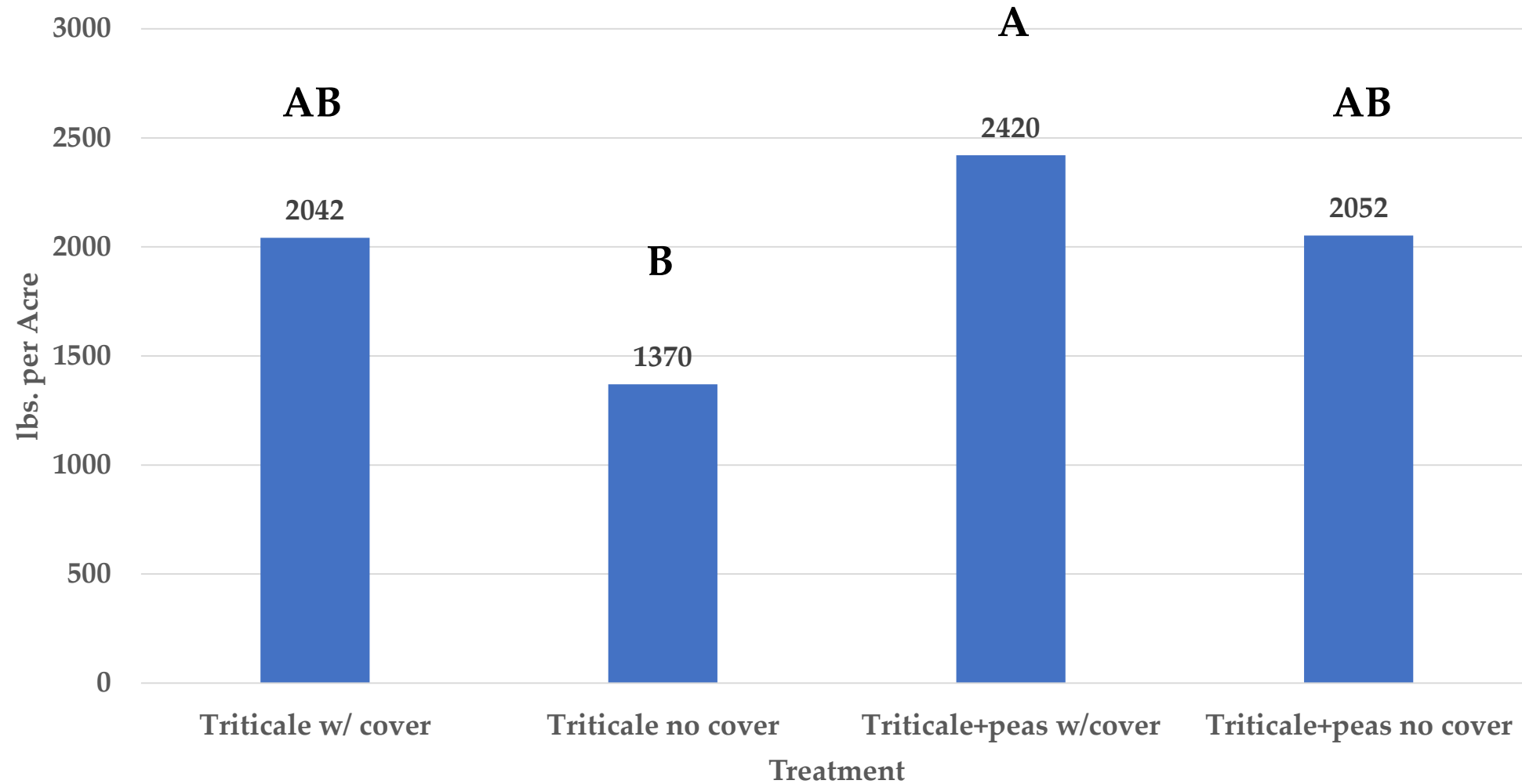
\$152	\$190	\$309	\$10		\$51
\$122	\$153	\$248	\$8		\$41
\$158	\$197	\$320	\$11		\$53
\$171	\$214	\$347	\$11		\$57

Year 1: Cover Crop Data

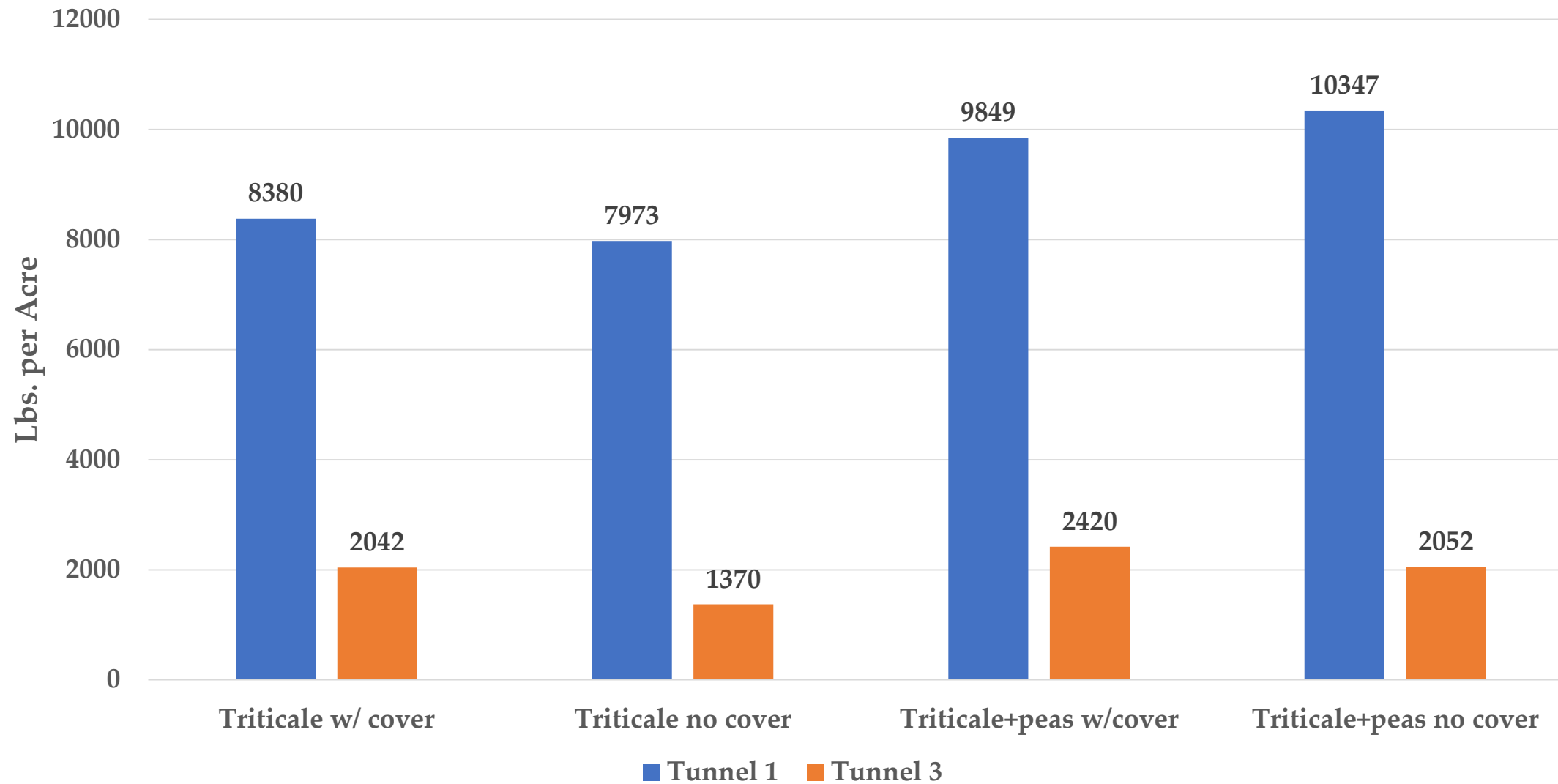
*end of season biomass, (10/4/2018 , early planting)
– biomass collected March 6th 2019*



end of season biomass, (10/23/2018, *late planting*)
-biomass collected March 6th, 2019



end of season biomass



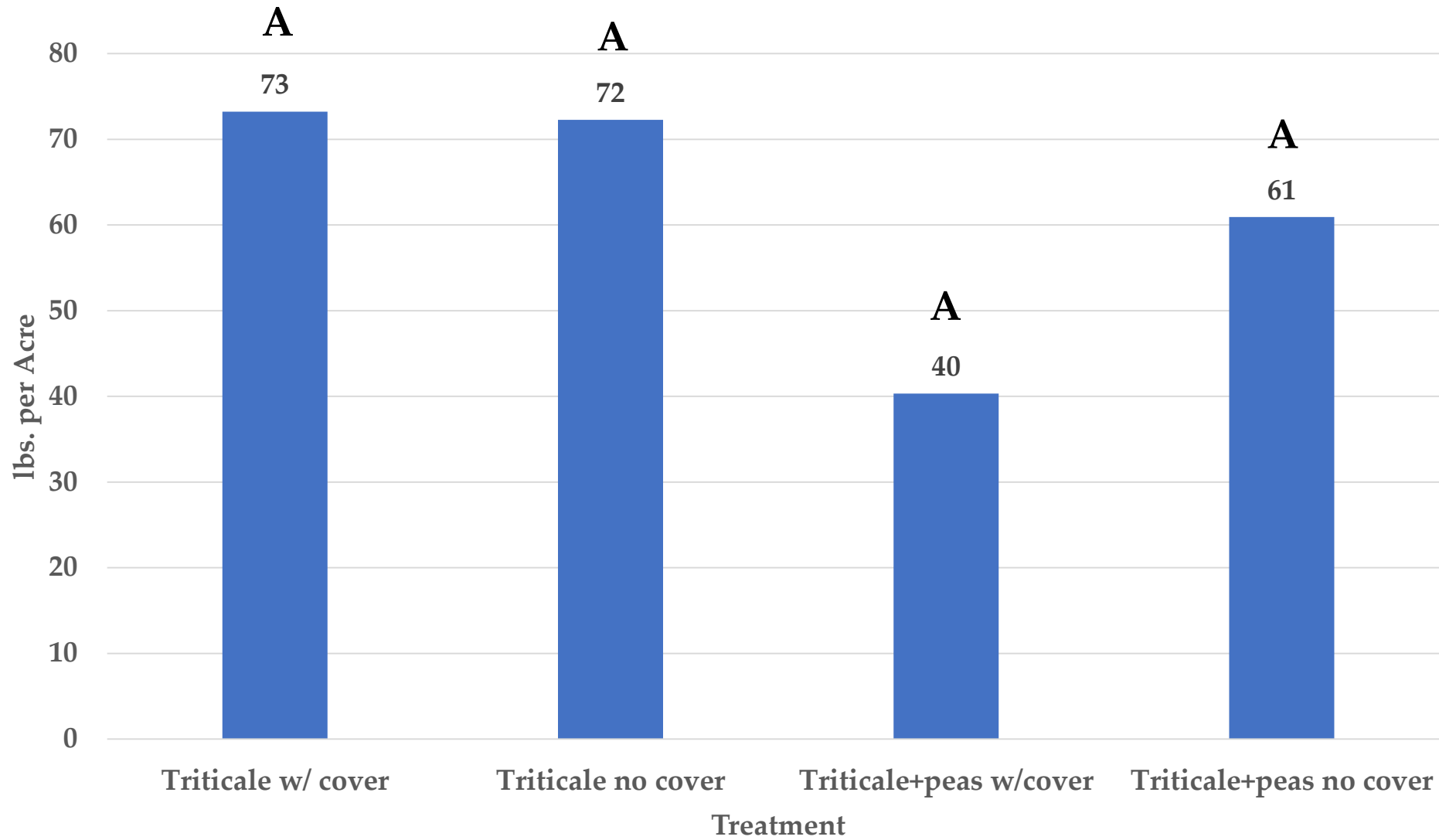


Tunnel 3,
3/21/2019

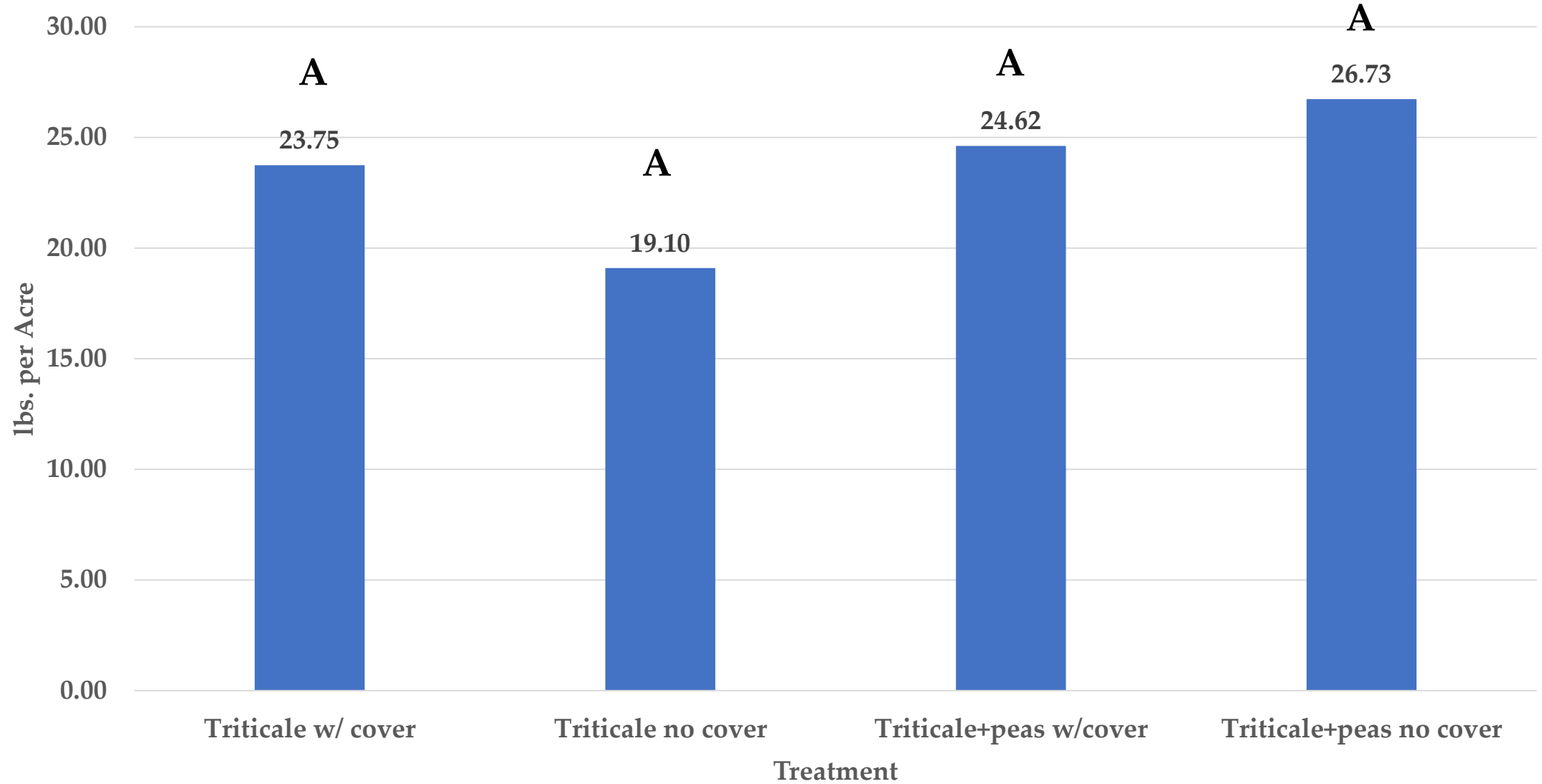
row cover

no row cover

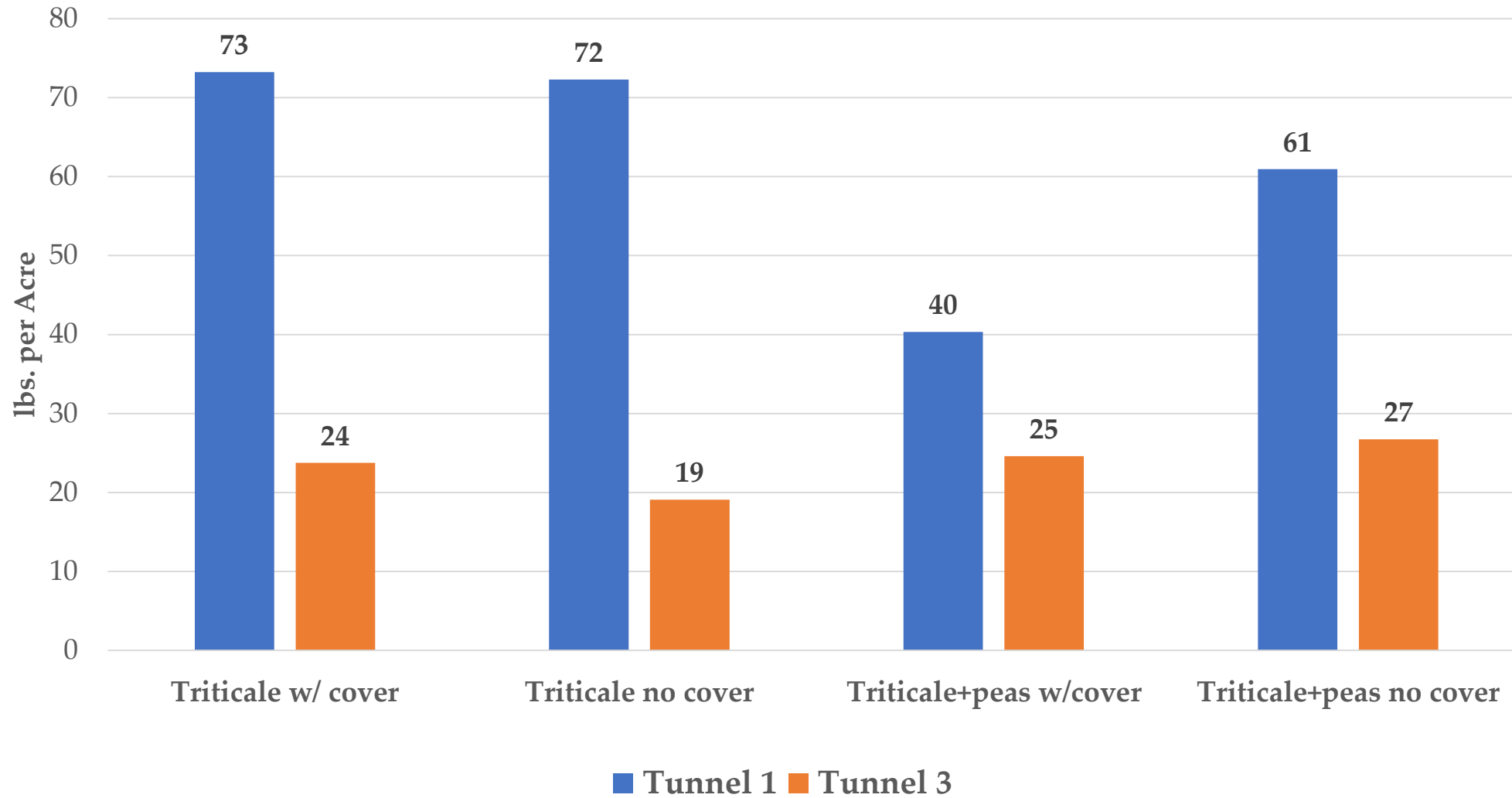
lbs. Nitrogen contributed/Acre (10/4/2018, *early planting*)



lbs. Nitrogen contributed/Acre (10/23/2018, *late planting*)



lbs. Nitrogen contributed/Acre



Recommendation:

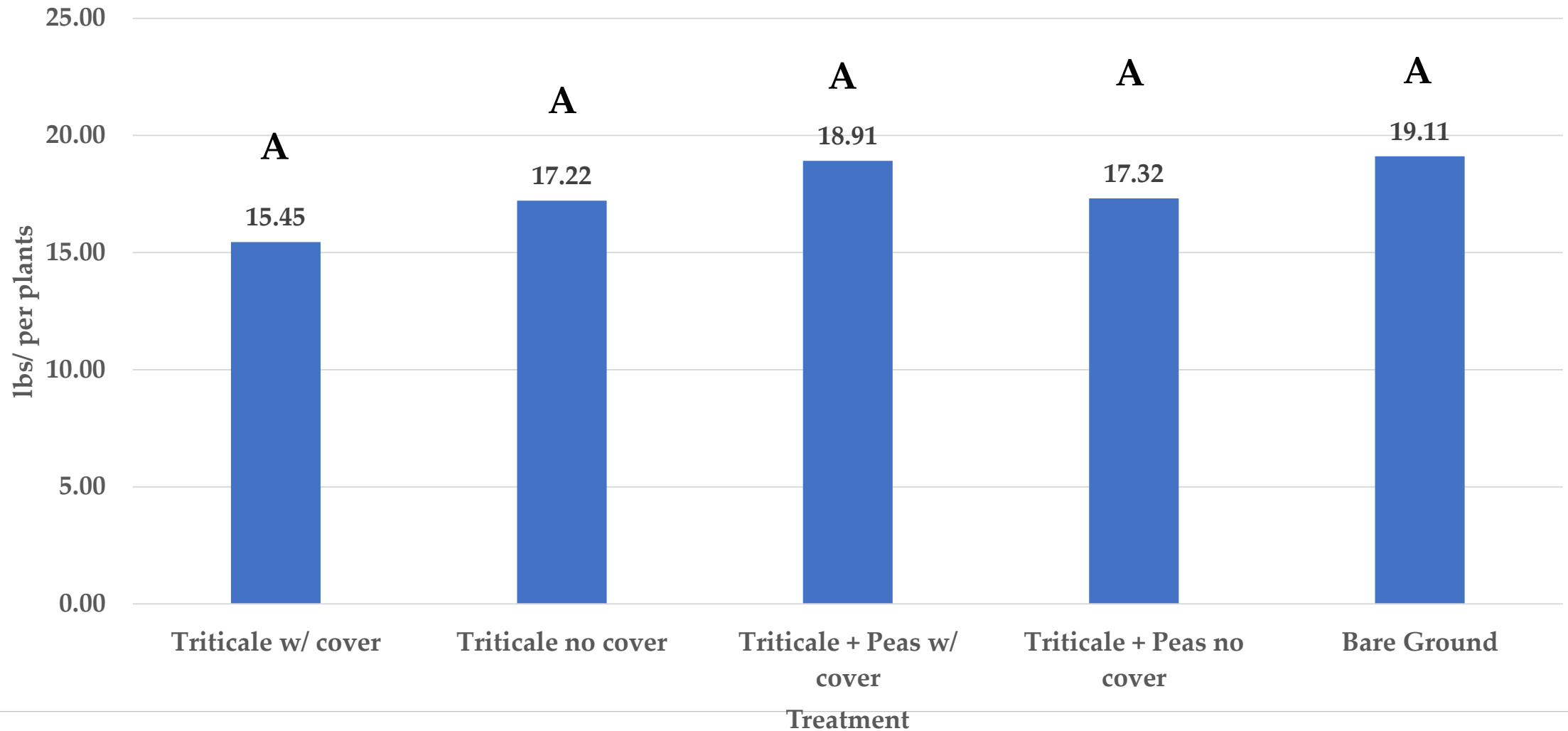
- 125-150 pounds of nitrogen/Acre

OR

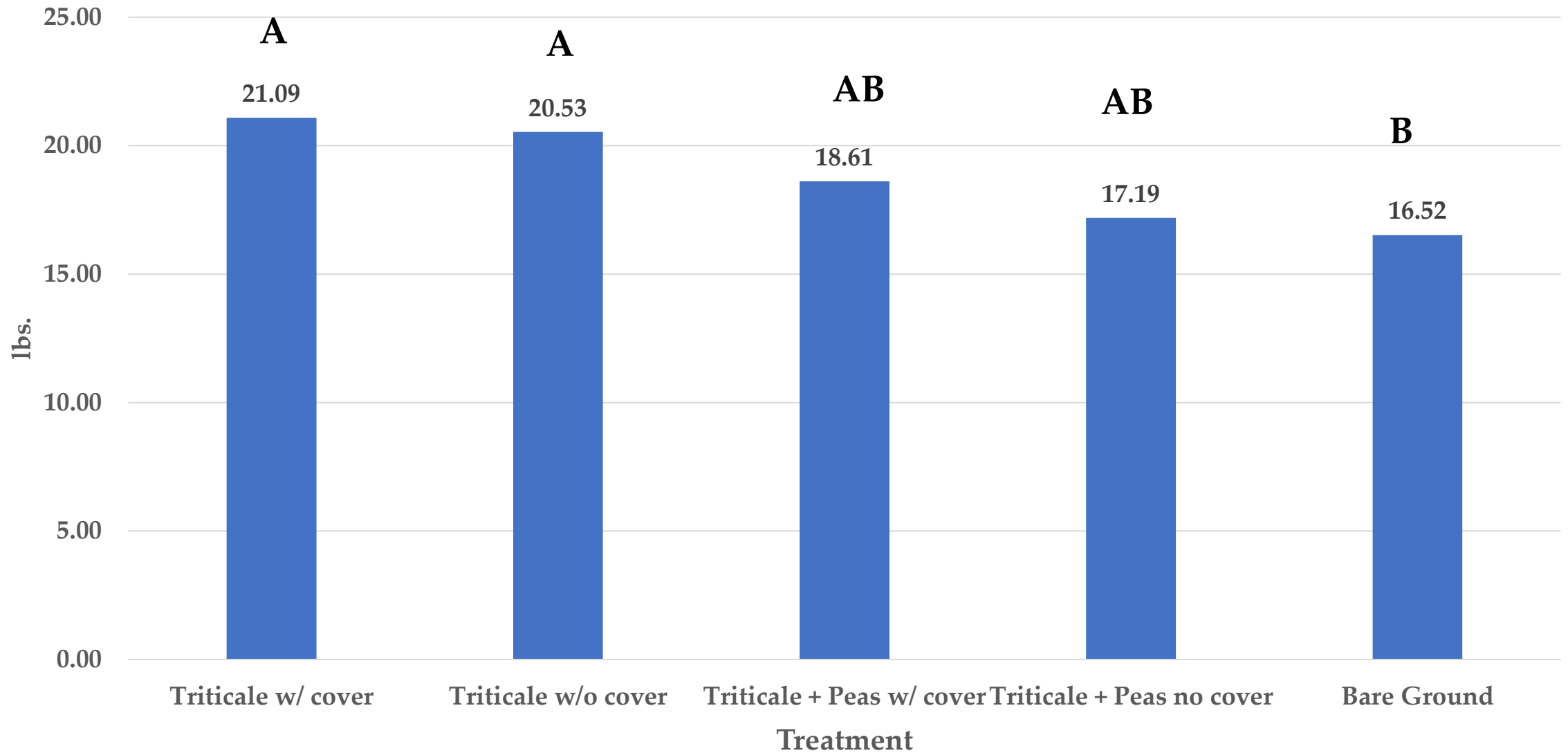
- 9-11 lbs. total nitrogen per 3,000 sq. ft. (0.07 acre)

Year 1: Tomato Data

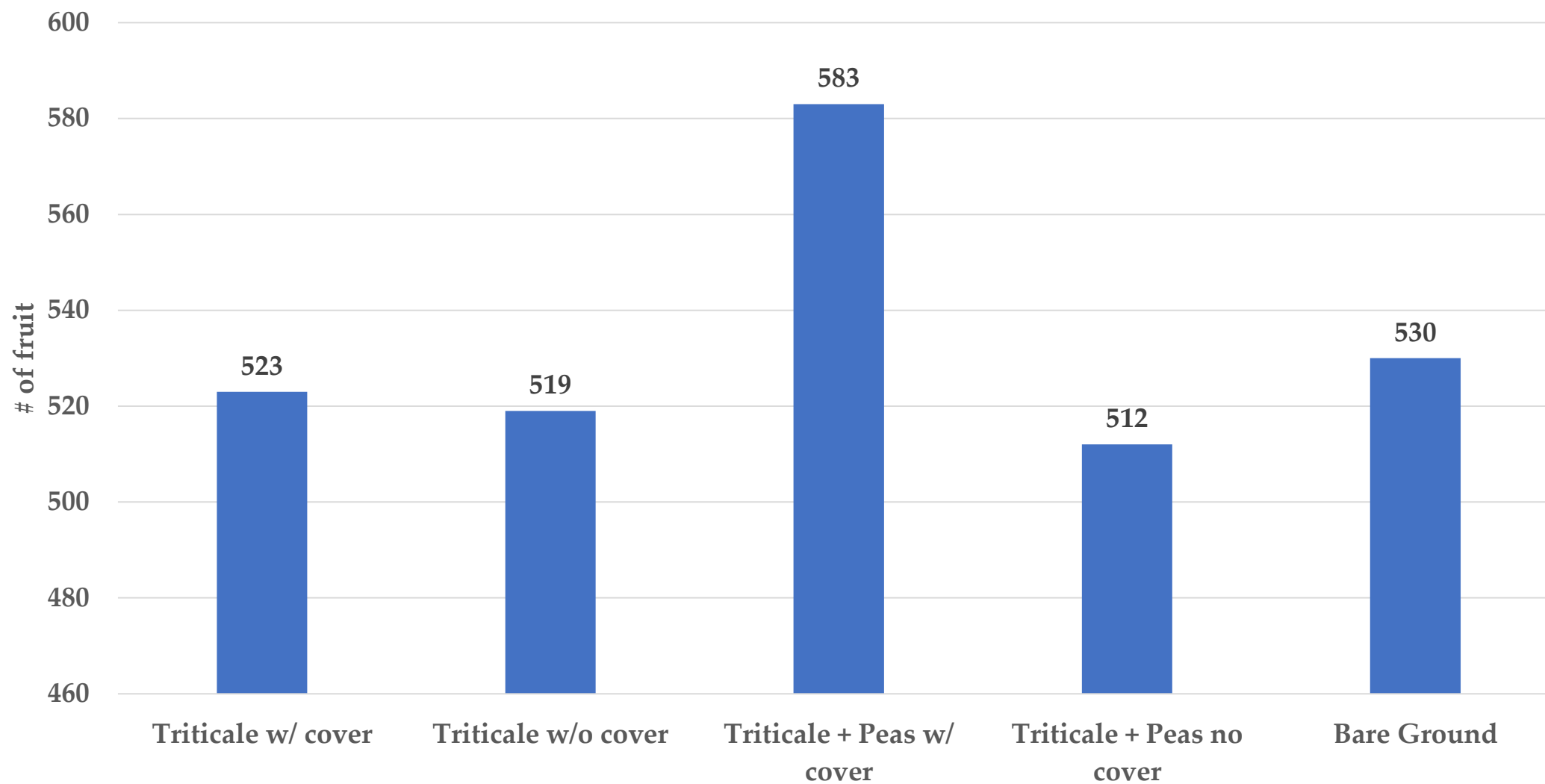
Yield/Plant, (10/4/2018, *early planting*)

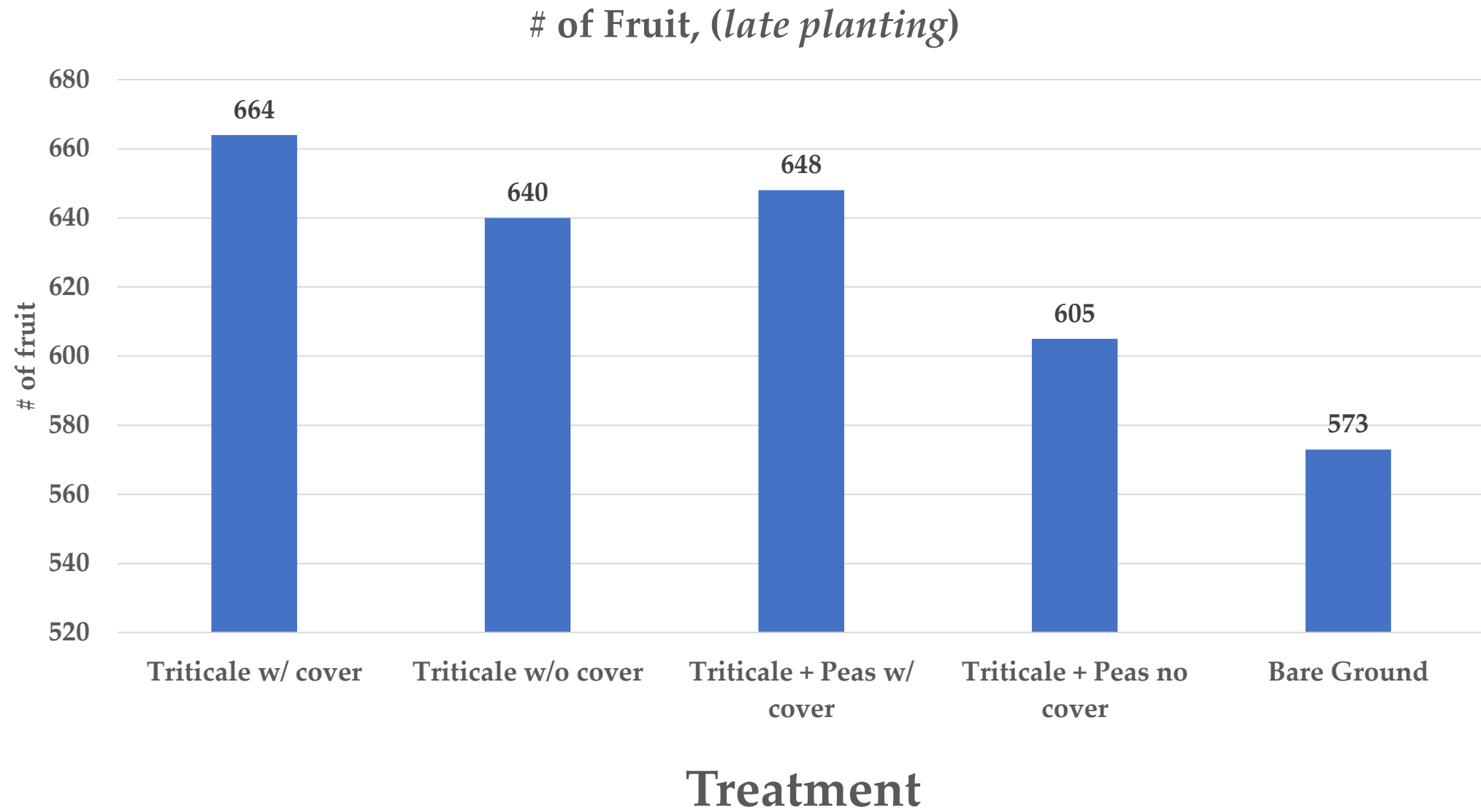


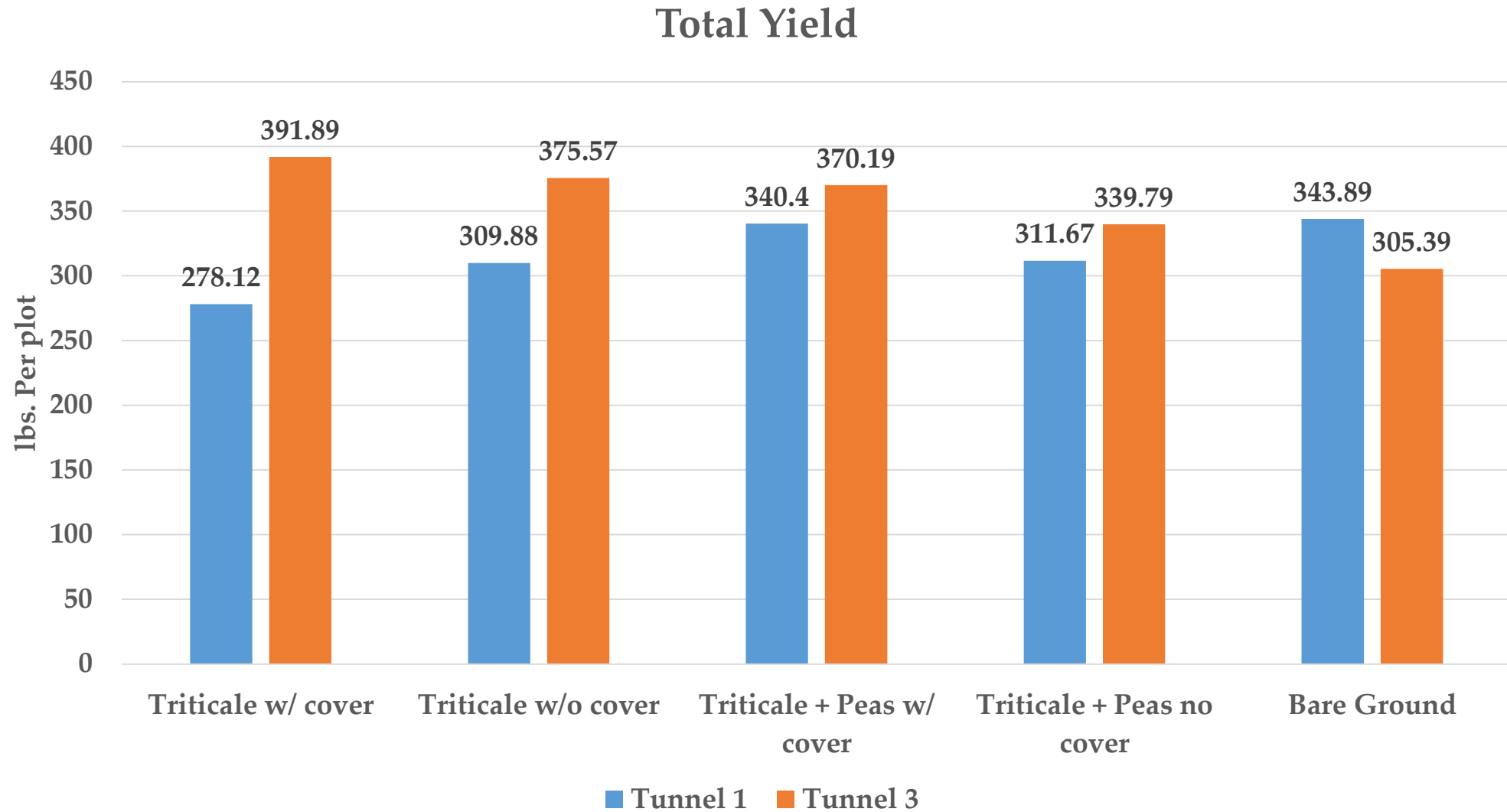
Yield/Plant, (10/23/2018, *late planting*)



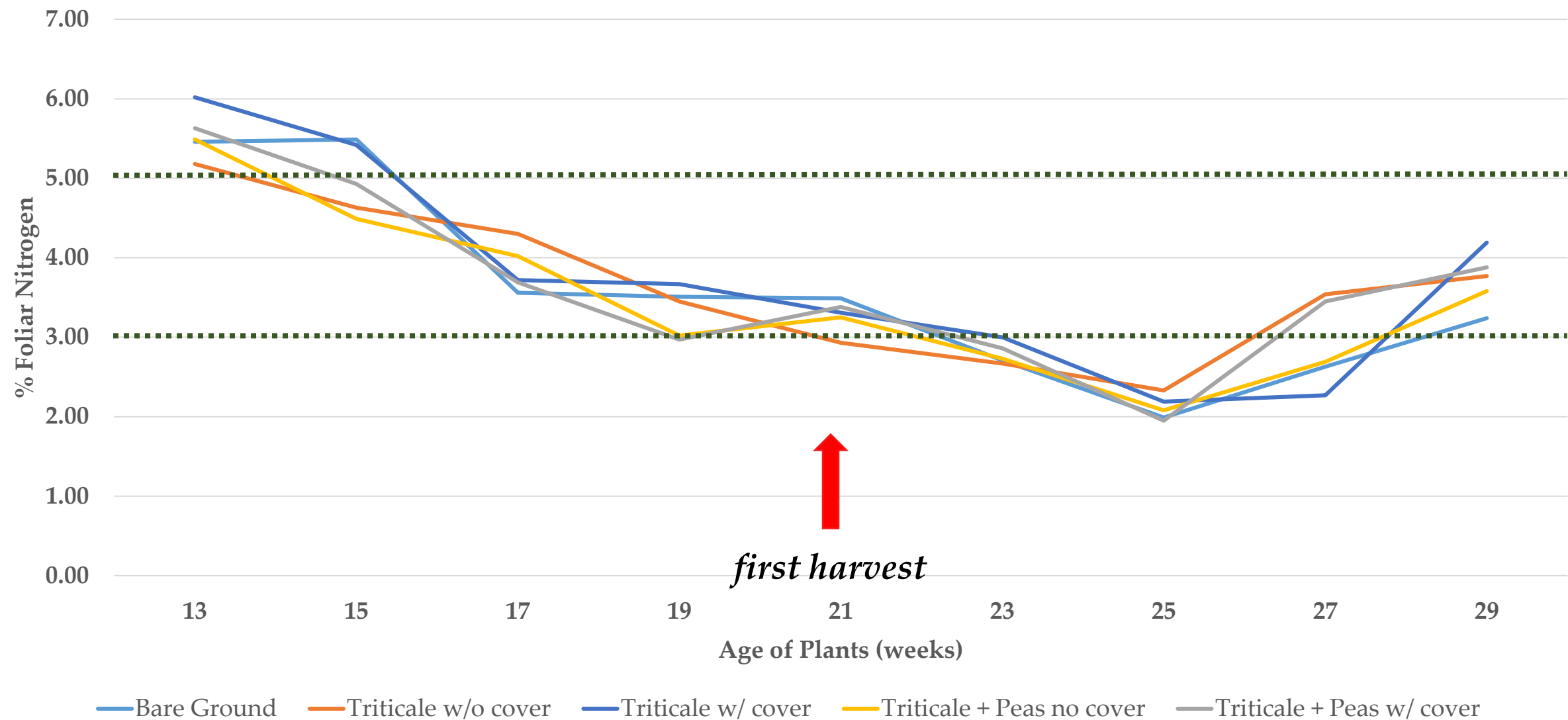
of Fruit, (*early planting*)



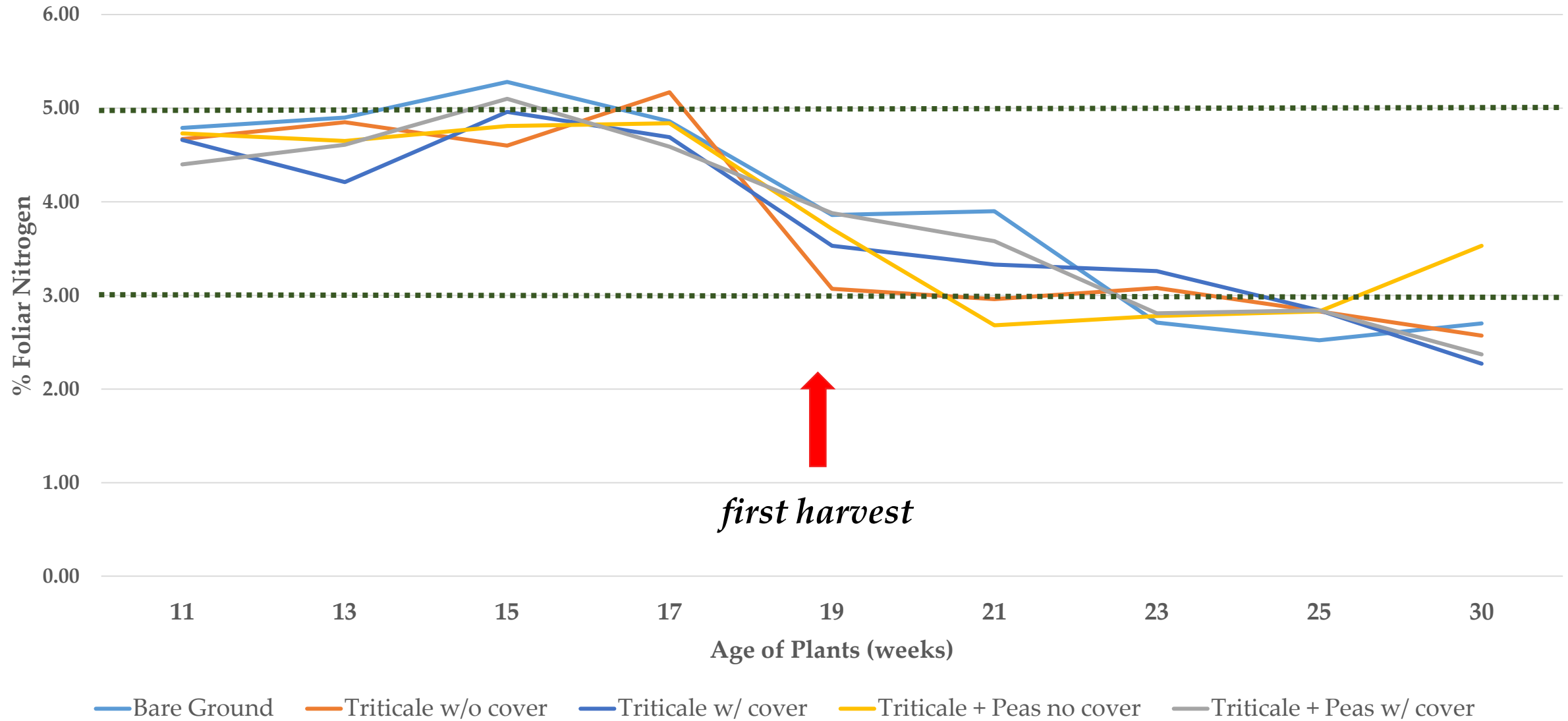




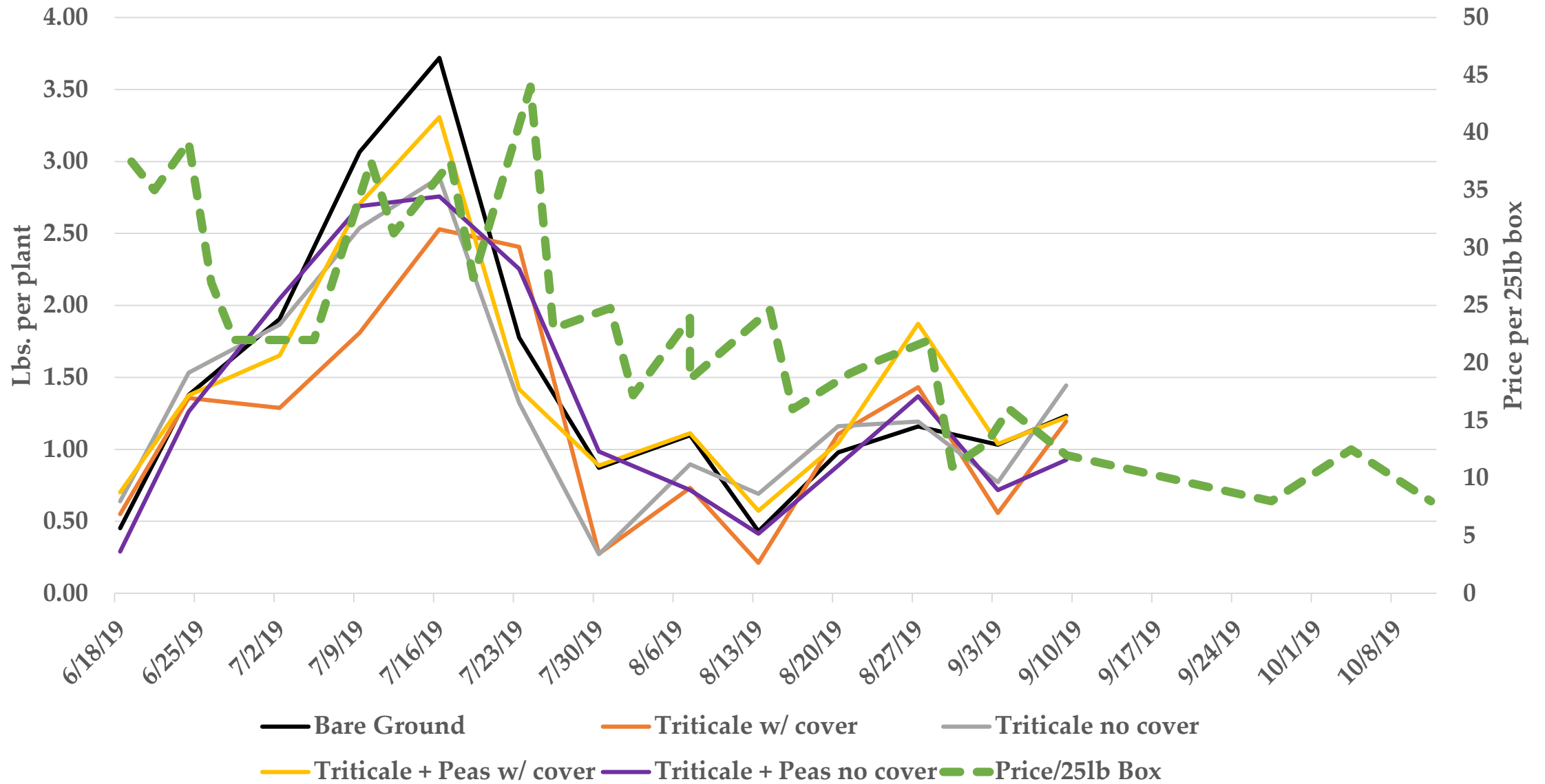
% Foliar Nitrogen Tomatoes, 10/4/2018, Early Planting



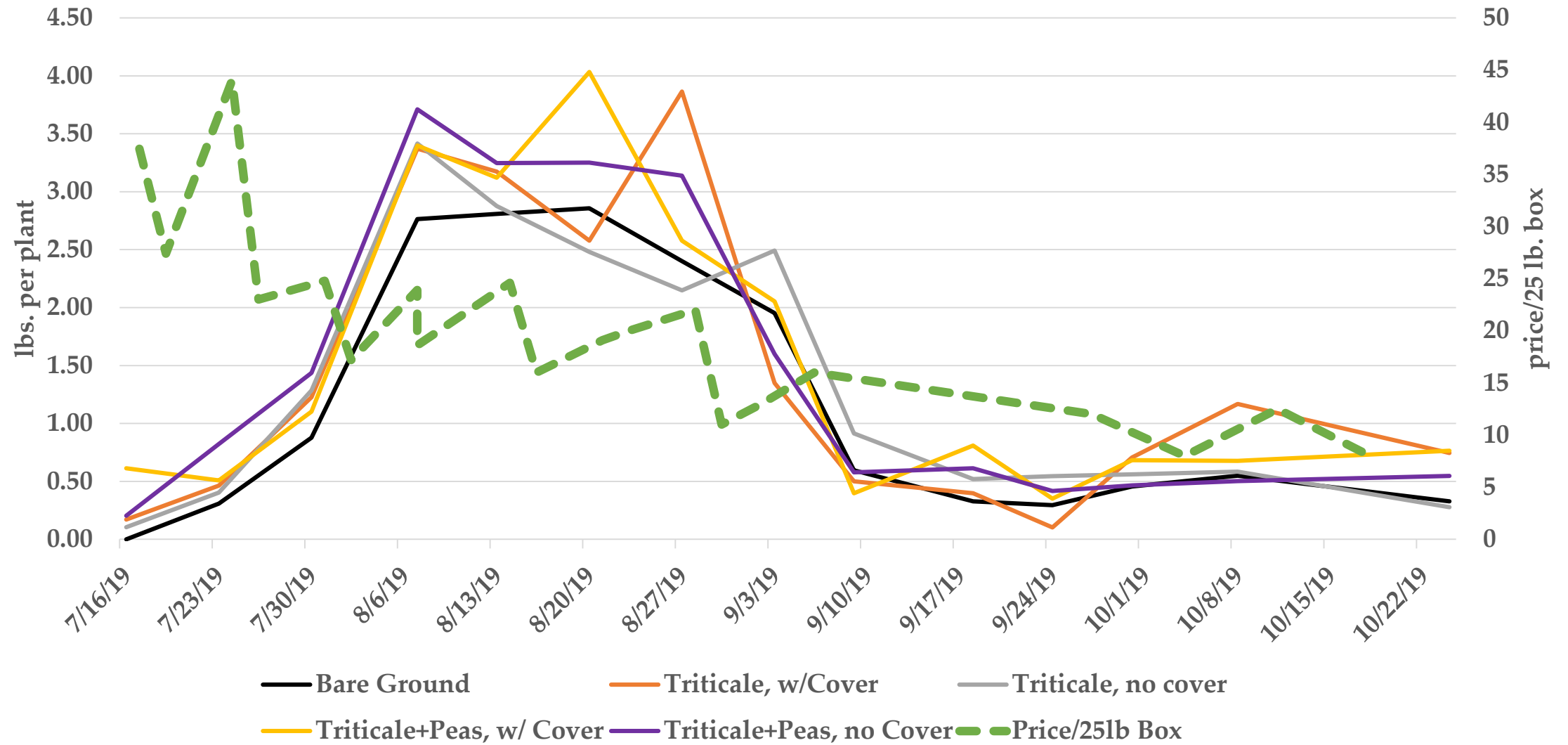
% Foliar Nitrogen Tomatoes, 10/23/2018, Late Planting



Seasonal Prices & Tomato Yields, (10/4/2018, *early planting*)



Seasonal Prices & Tomato Yields, (10/23/2018, *late planting*)





1/10/2020, 11 weeks old



1/10/2020, 11 weeks old

Legumes & N₂ Fixation

- Symbiotic relationship between plants and Rhizobia bacteria
- Plant provides shelter, food $\leftrightarrow$ bacteria fix atmospheric N₂ gas into NH₃
- Naturally occur in soil
- Species-specific!
- Bacteria invade the roots and produce small nodules
- Pink hue inside nodules = leghemoglobin (carries oxygen to the bacteria)
 - Is a sign that nitrogen fixation is occurring!



1/10/2020, 11 week old plant

Nitrogen Fixation Problems

- Temperature, moisture, and nutrition will impact fixation
- If legumes haven't been grown in your field , you may have a very low population of bacteria
 - Nodules should be pink inside. Old, dead nodules will be white/gray/green
- Inoculants are cheap, readily available!
 - Less than \$10 to treat 100 lbs. of seed
 - Seed contact is necessary
 - They're living organisms → they have an expiration date
 - Store properly
- Excess Nitrogen?!
 - Rhizobia get lazy – nitrogen fixation isn't necessary.
 - Much easier for plant to take up N from soil than *trade* for fixed N



Questions?

	Cover Crop Seeding	Incorporation	Tomato Transplant	First Harvest	Last Harvest
Tunnel 1	10/4/2018	3/11/2019	3/21/2019	6/18/2019	9/9/2019
Tunnel 3	10/23/2018	4/24/2019	4/30/2019	7/16/2019	10/15/2019

Biomass Sampled:
Tunnel 1: 11/1/2018, 1/9/2019, 2/7/2019, 3/6/2019
Tunnel 3: 11/30/2018, 1/9/2019, 2/7/2019, 3/6/2019, 3/26/2019