

Evaluating nitrogen sources and using drones in Christmas tree production

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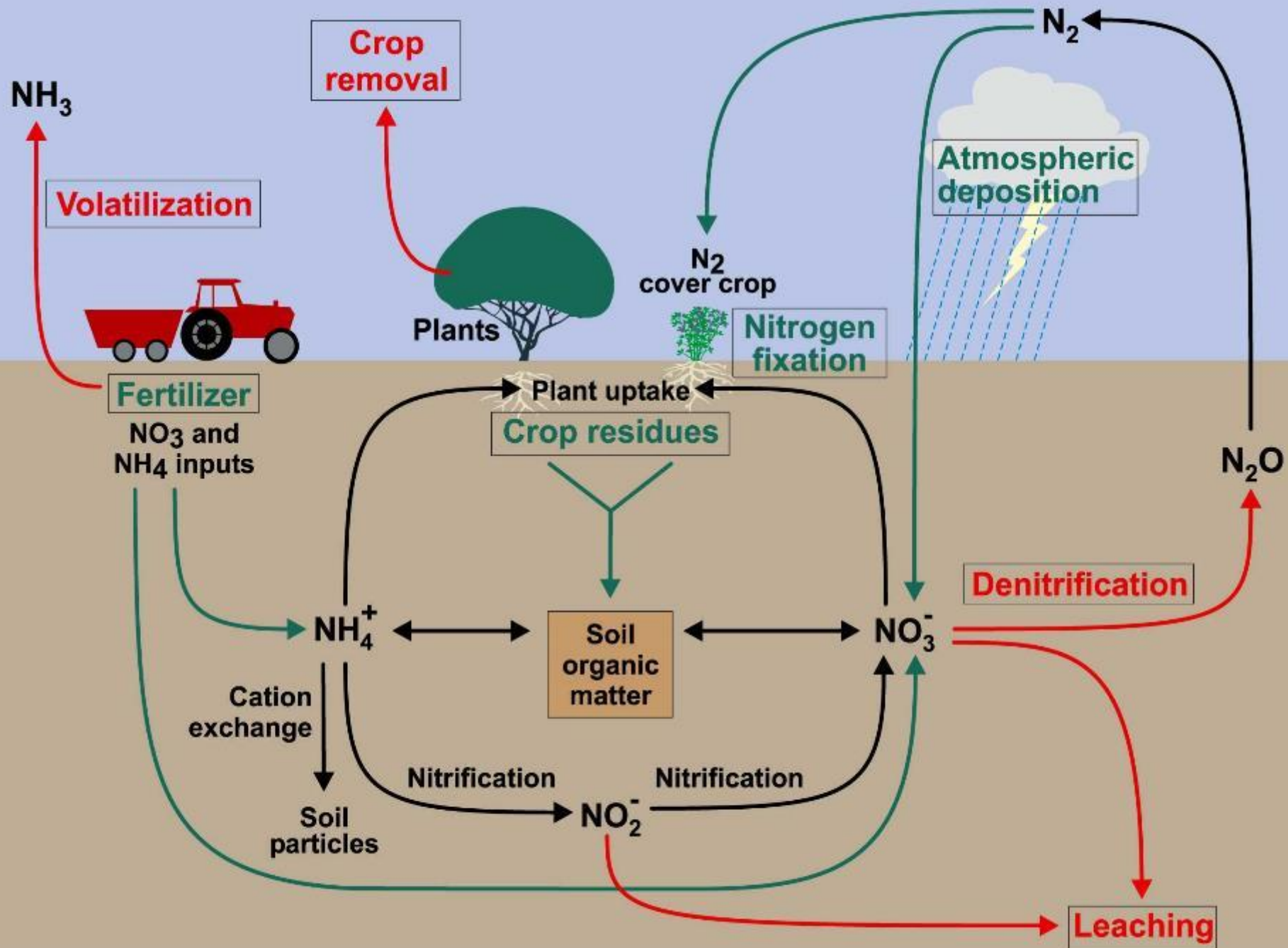
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Unique attributes of N

- Extremely dynamic in soils
 - Many forms are subject to loss







Nutrient budget for a Nordmann fir crop

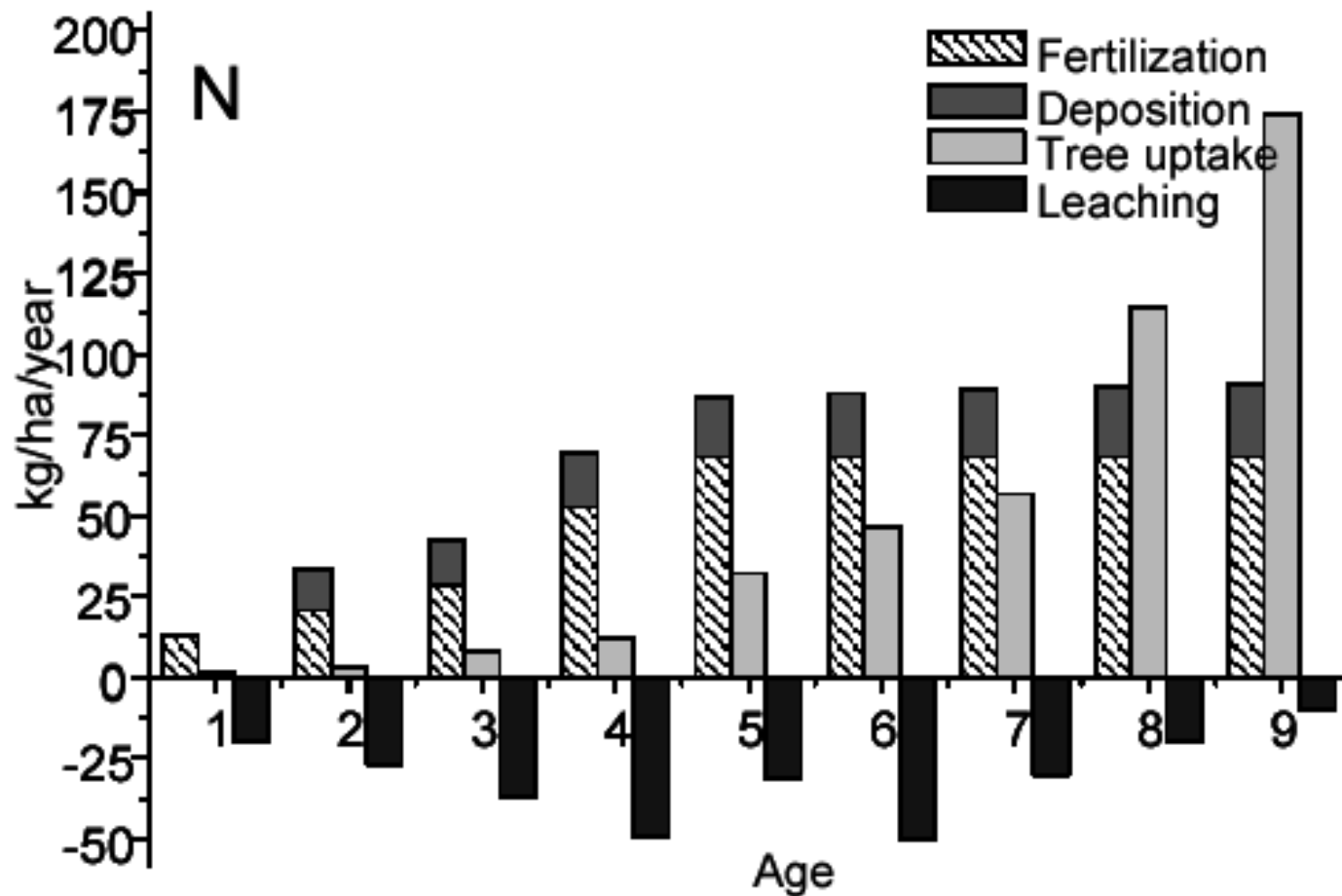


Figure 1 Nitrogen cycling model for a typically Danish Christmas tree stand.

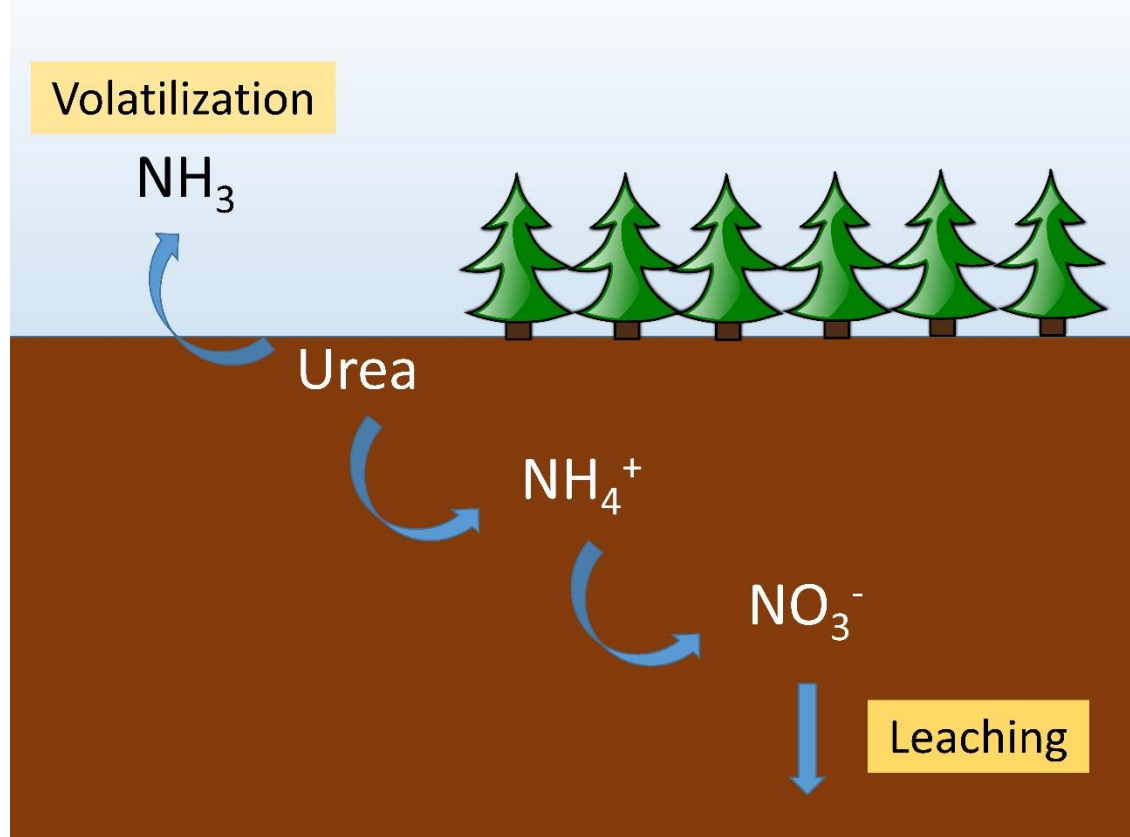
Program outline

- Potential benefits of nitrogen stabilizers
- 2014 Trial
 - Growth and foliar N response
- 2016 Trials
 - Growth and foliar N response
 - Lysimeter sampling
- Assessing tree N status with spectral imagery



Don't Lose it...use it!

Keeping nitrogen in the root zone



More than a loss of \$\$

- Nitrate in surface water contributes to harmful algal blooms and oxygen depletion



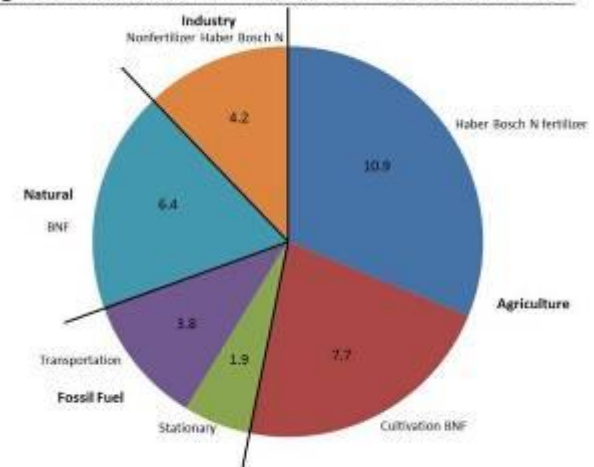
Photo courtesy NASA



Nr is receiving regulatory attention

- EPA Science Advisory Board report attributes over 50% of the Nr released annually in the U.S. to agriculture
- Currently the report recommends:
 - Monitoring
 - Efficient utilization

Figure 1: Sources of Nr introduced into the US in 2002

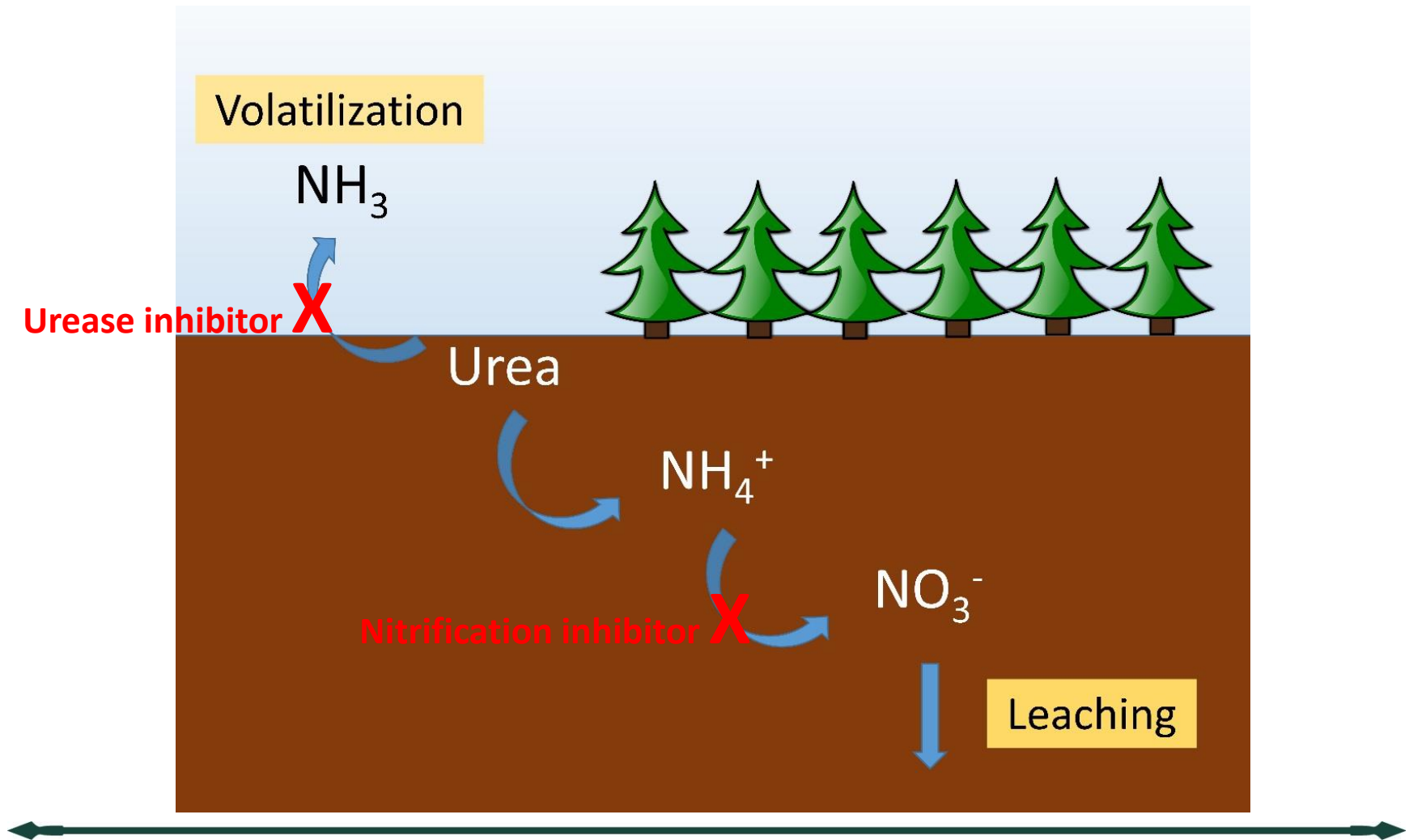


Adopted from EPA-SAB report: *Reactive Nitrogen in the Environment*

- **Goal** – optimize plant uptake and reduce nitrogen loss
- **Objective** - to determine if timing of nitrogen application or the choice of nitrogen fertilizer products influenced growth or foliar nitrogen values.



What are Nitrogen Stabilizers?



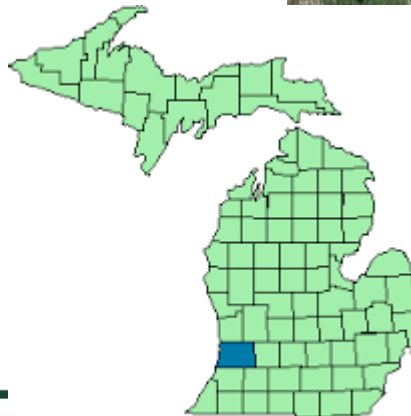
Badger Evergreen – Allegan Co. MI

- Tekenink loamy fine sand

Typical profile

Ap - 0 to 10 inches: loamy fine sand
B/E - 10 to 15 inches: sandy loam
Bt - 15 to 24 inches: sandy loam
Bt - 24 to 50 inches: sandy loam
BC - 50 to 60 inches: sandy loam

- pH – 5.5
- CEC 9.5



Plot layout (Badger 2014)

Sup-Split	AS-Spr	AS-Split	AS-Split	U-Split
Sup-Spr	CON	U-Spr	AS-Spr	AS-Spr
AS-Spr	Sup-Split	U-Split	Sup-Spr	AS-Split
U-Spr	AS-Split	Sup-Spr	Sup-Split	U-Spr
AS-Split	U-Split	Sup-Split	U-Split	CON
CON	Sup-Spr	CON	U-Spr	Sup-Spr
U-Split	U-Spr	AS-Spr	CON	Sup-Split

- Urea
- SuperU® -stabilized nitrogen
- Ammonium sulfate
- 1 oz. of actual N (28 grams)
- Split – ½ oz. (14 grams) spring and ½ oz. (14 grams) fall



	Spring	Fall
2013		10-17-2013
2014	4-17-2014	10-9 - 2014
2015	4-30-2015	10-30-2015
2016	5-6-2016	



Soil pH

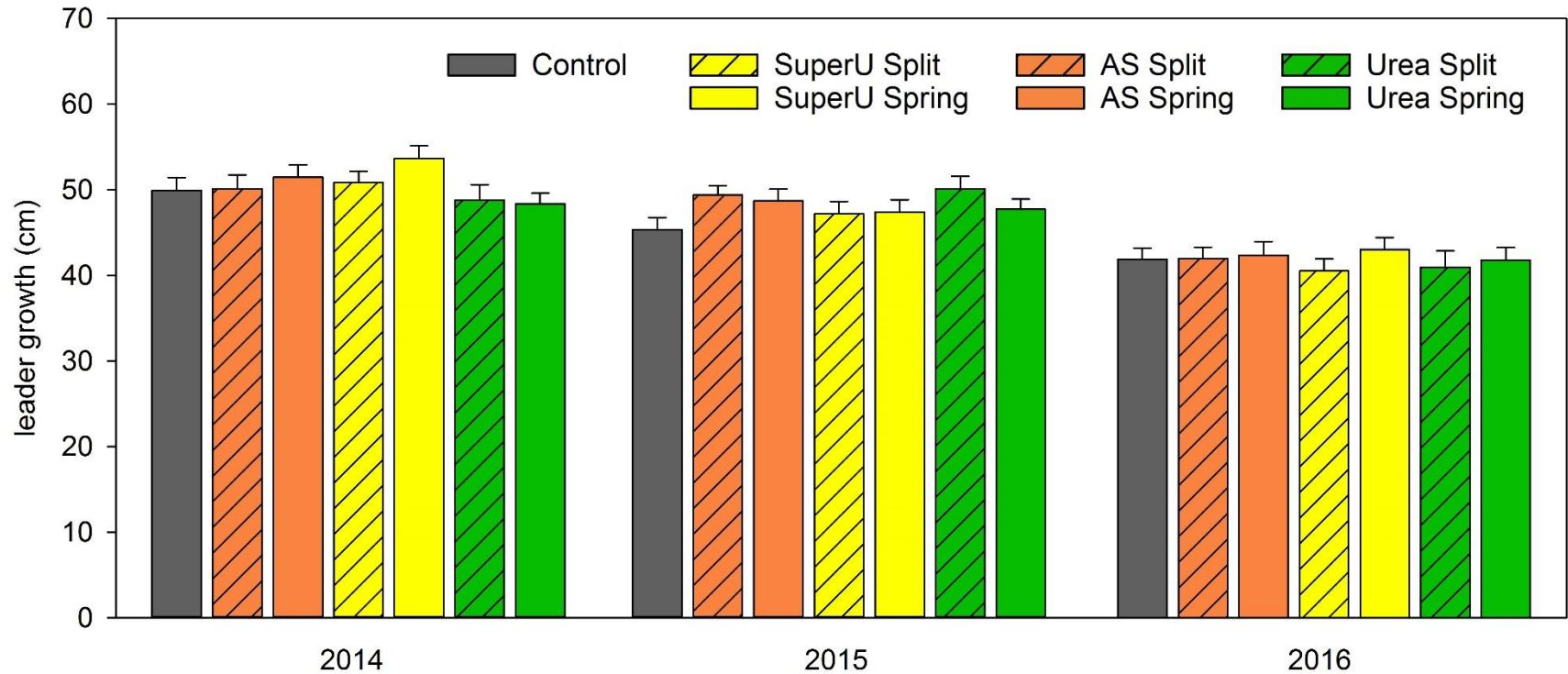
- After 3 years:
 - Urea and Super U reduced soil pH by 0.5
 - AMS reduced soil pH by 1.0



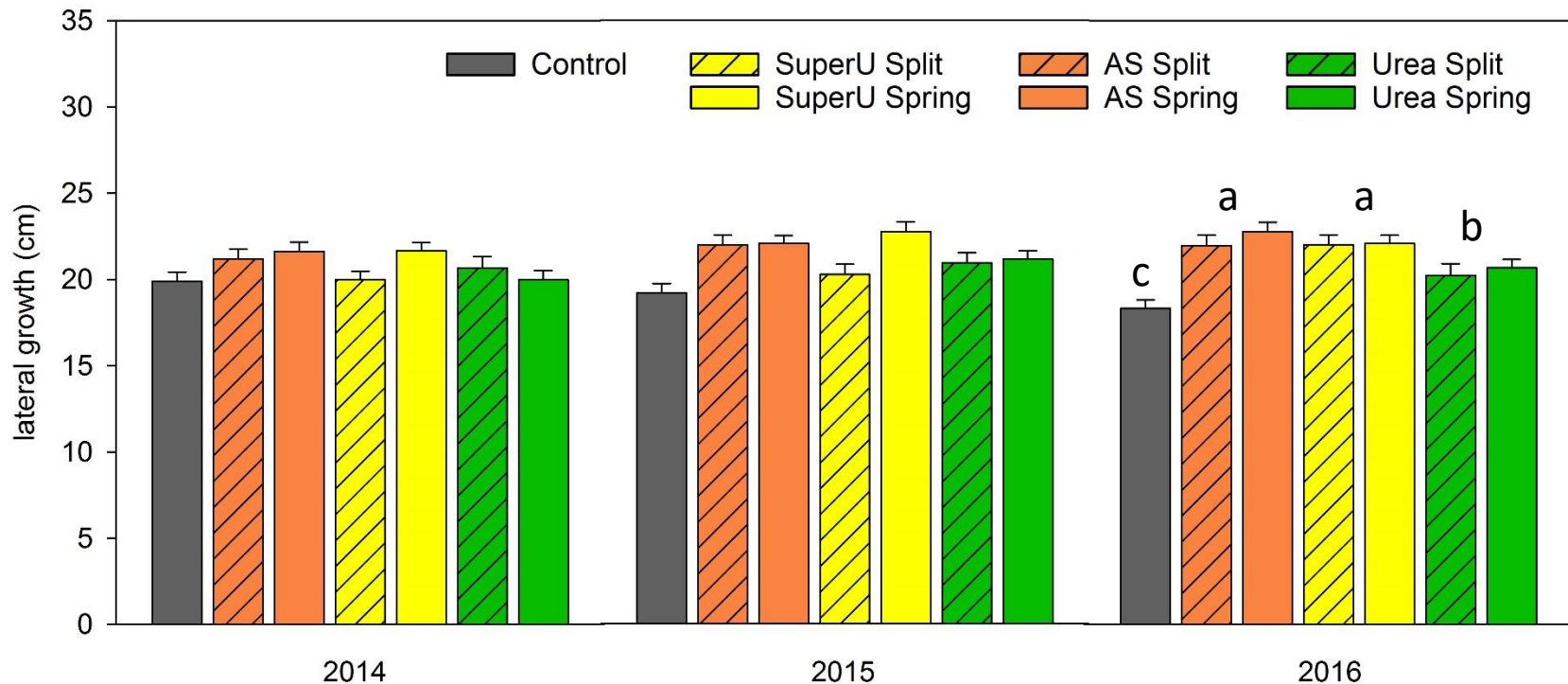
	2014	2015	2016
<u>Growth</u>	8-13-2014	7-23 -2015	7-29-2016



Leader growth: Little effect of fertilization on growth



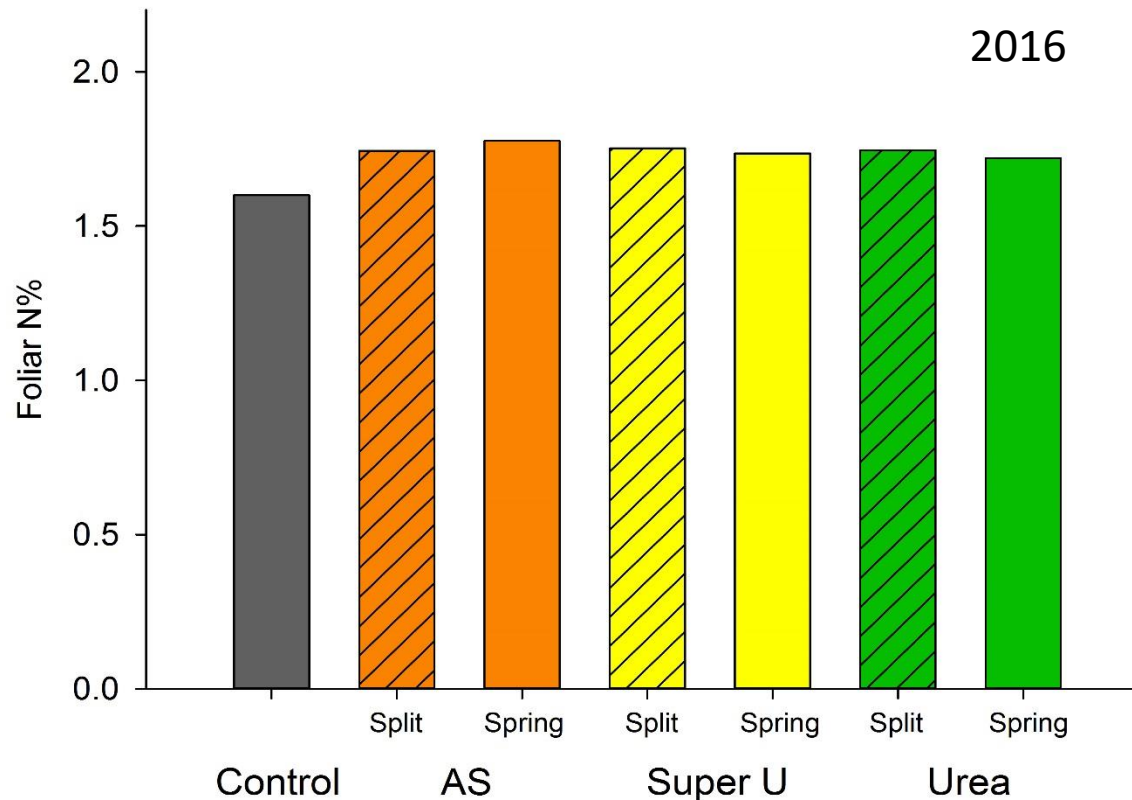
Lateral growth: Slight improvement with AMS and SuperU



	2014	2015	2016
<u>Foliar</u>			
Fall	10-9-2014	10-30-2015	9-19-2016



2014 Trial: Fertilization increased foliar N No benefit from split application



Summary 2014 – 2016

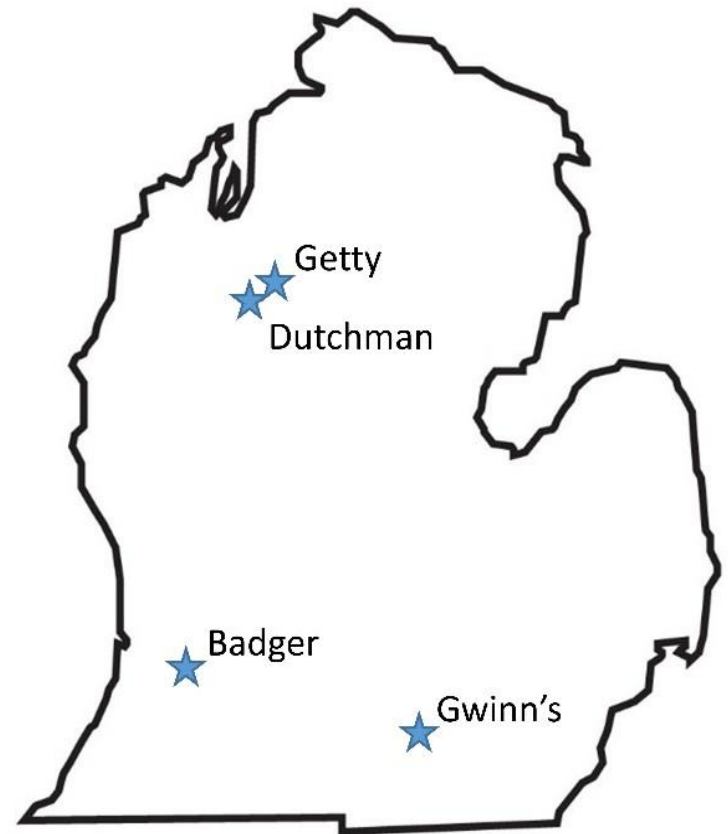


- Fertilization increased foliar nitrogen levels compared to unfertilized controls but there were no differences in foliar nitrogen among fertilizer treatments.
- No benefit to split application



Methods 2016 trial

- 4 locations
- 6 treatments plus untreated control
- Measured:
 - Growth
 - Foliar N
 - Nitrate leaching



Methods 2016 Trials

Treatment	Fertilizer
Control	None
Ammonium sulfate	Ammonium sulfate
Urea	Urea only
Instinct [®]	Urea + nitrification inhibitor
Nitrain [™] Express	Urea + urease inhibitor
SuperU [®]	Urea + urease and nitrification inhibitor
ESN [®]	Polymer coated urea



Cost comparison of N stabilizer products

Nitrogen source		Cost per ton	Cost per lb. of N
UREA	(46-0-0)	\$343 - \$390	\$0.37 – \$0.43
AMS	(21-0-0)	\$300 - \$345	\$0.72 - \$0.82
Instinct	(46-0-0)	\$375 - \$422	\$0.41 - \$0.46
Nitrain Express	(46-0-0)	\$425 - \$473	\$0.46 - \$0.51
Super U	(46-0-0)	\$480	\$0.52
ESN	(44-0-0)	\$675	\$0.77



2016 N Stabilizer Trials: Growth Results

- Evaluated 2 of 4 farms
- Getty: No treatment effect
- Badger: Control trees had longer leaders than trees with Instinct or Nitrain plots
 - Probably an artifact of treatment randomization
 - Control plots grouped downslope



Growth response: No products provided better response than standard fertilization

Mean shoot growth (m) of Fraser fir and Black hills spruce trees in response to nitrogen fertilizer products at four farms in Michigan

Product	Farm			
	Badger (Fraser fir)	Dutchman (Black hills spruce)	Getty (Fraser fir)	Gwinn (Fraser fir)
AMS	0.35ab	0.29	0.39	0.37
Urea	0.35ab	0.33	0.41	0.44
Control	0.33bc	0.33	0.40	0.45
ESN	0.36ab	0.31	0.41	0.45
Instinct	0.33bc	0.31	0.40	0.44
Nitrain	0.29c	0.34	0.41	0.44
SuperU	0.39a	0.35	0.39	0.38



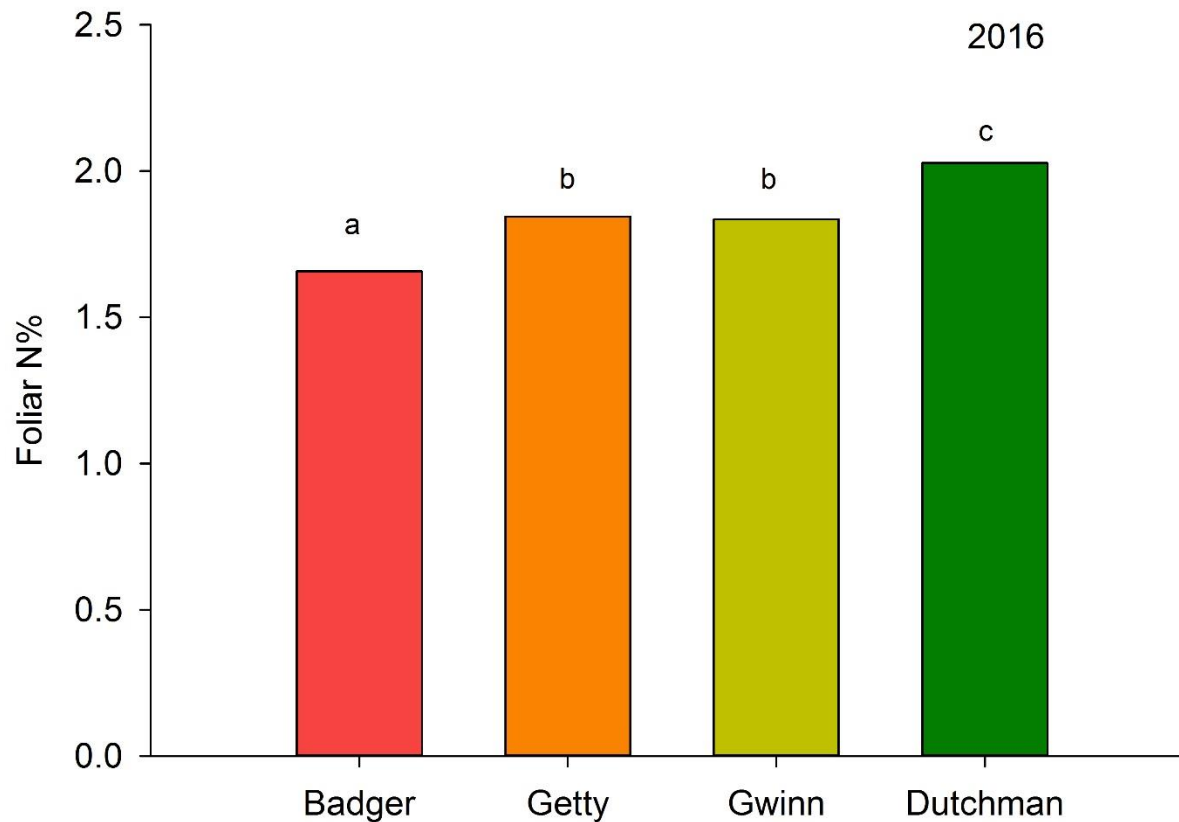
Growth response: No products provided better response than standard fertilization

Mean shoot growth (m) of Fraser fir and Black hills spruce trees in response to nitrogen fertilizer products at four farms in Michigan

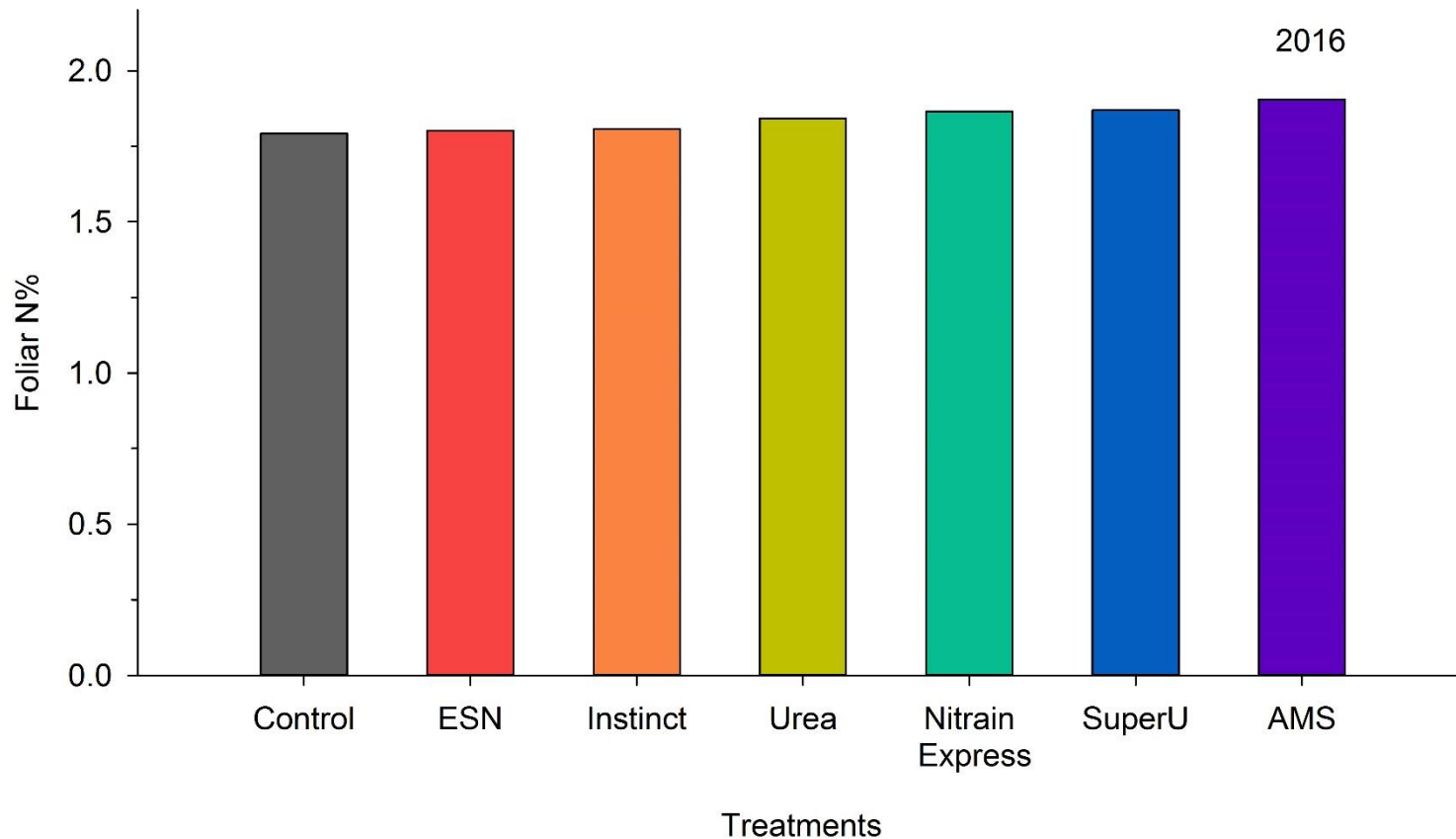
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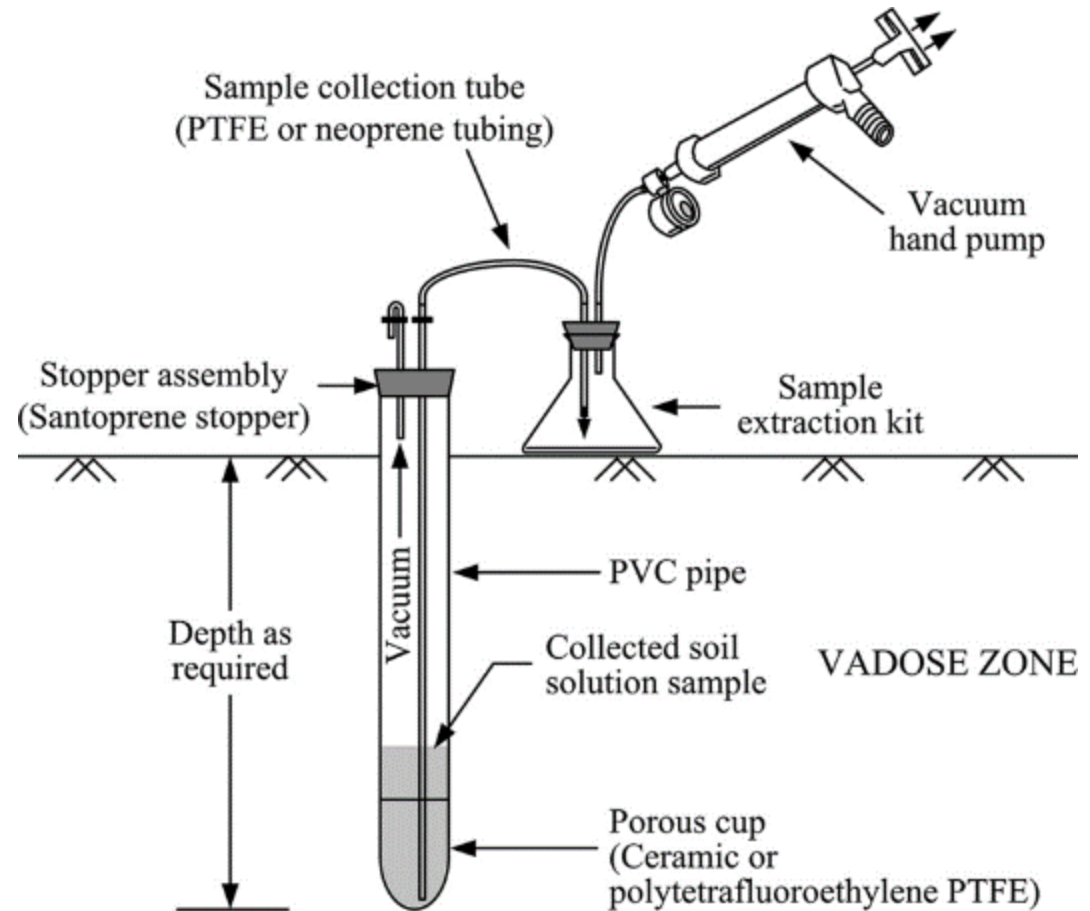
2016 Trials: Foliar N varied among farms



2016 Trials: N stabilizer products did not affect foliar N



- Suction lysimeters



Lysimeter installation



Farm	Species	Fertilizer treatments applied	Lysimeters installed	Lysimeter sample dates	
Dutchman	Black Hills spruce	May 2016 May 2017	July 7, 2016	July 17, 2016 August 2, 2016* August 12, 2016 August 24, 2016 September 2, 2016 September 8, 2016 September 23, 2016	April 18, 2017* April 28, 2017 May 10, 2017 May 19, 2017* May 26, 2017 June 1, 2017* June 7, 2017* June 14, 2017* June 29, 2017* July 7, 2017 July 14, 2017 July 20, 2017 August 9, 2017*
Gwinn	Fraser fir	May 2016 May 2017	July 12, 2016	July 19, 2016 July 27, 2016 August 15, 2016 August 17, 2016* August 30, 2016* September 13, 2016* September 28, 2016* October 13, 2016*	May 1, 2017* May 3, 2017* May 10, 2017* May 22, 2017* June 6, 2017 June 28, 2017 June 12, 2017 August 1, 2017

42 lysimeters in each trial



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Gwinn	Fraser fir	May 2016 May 2017	July 12, 2016	July 19, 2016 July 27, 2016 August 15, 2016 August 17, 2016* August 30, 2016* September 13, 2016* September 28, 2016* October 13, 2016*	May 1, 2017* May 3, 2017* May 10, 2017* May 22, 2017* June 6, 2017 June 28, 2017 June 12, 2017 August 1, 2017

Not every treatment plot had a sample every time.



Leachate sampling:

- Seasonal trend
- Periods with no leaching
- All fertilizer increased NO₃

Mean Nitrate concentration (ppm) of water samples collected from suction lysimeters at Dutchman Tree Farms, Manton, MI. 2016-2017

	8/2/2016	4/18/2017	5/19/2017	6/1/2017	6/7/2017	6/14/2017	6/27/2017	8/9/2017	Overall
AMS	65.10					0.93	27.97	76.28	42.57
Urea	69.90			0.04	0.23	15.19	62.24		29.52
Control	28.50		0.29	2.76	0.04	0.52	1.33	10.17	6.23
ESN	44.10			3.03	6.87	16.44	66.38		27.36
Instinct	88.00	0.64			0.20	25.73	50.70		33.05
Nitrain	72.60		7.56		1.25	4.28	61.01	13.59	26.71
Super U	57.70		0.66		0.22	5.54	72.55		27.33

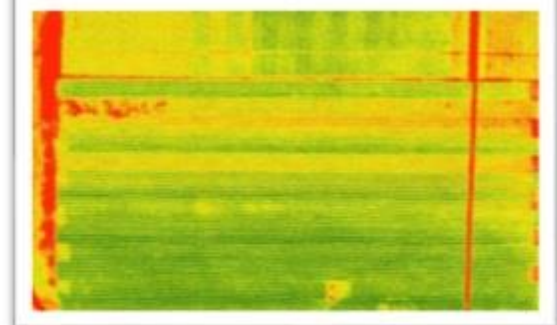
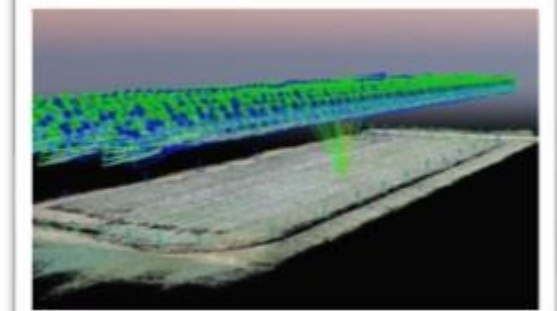


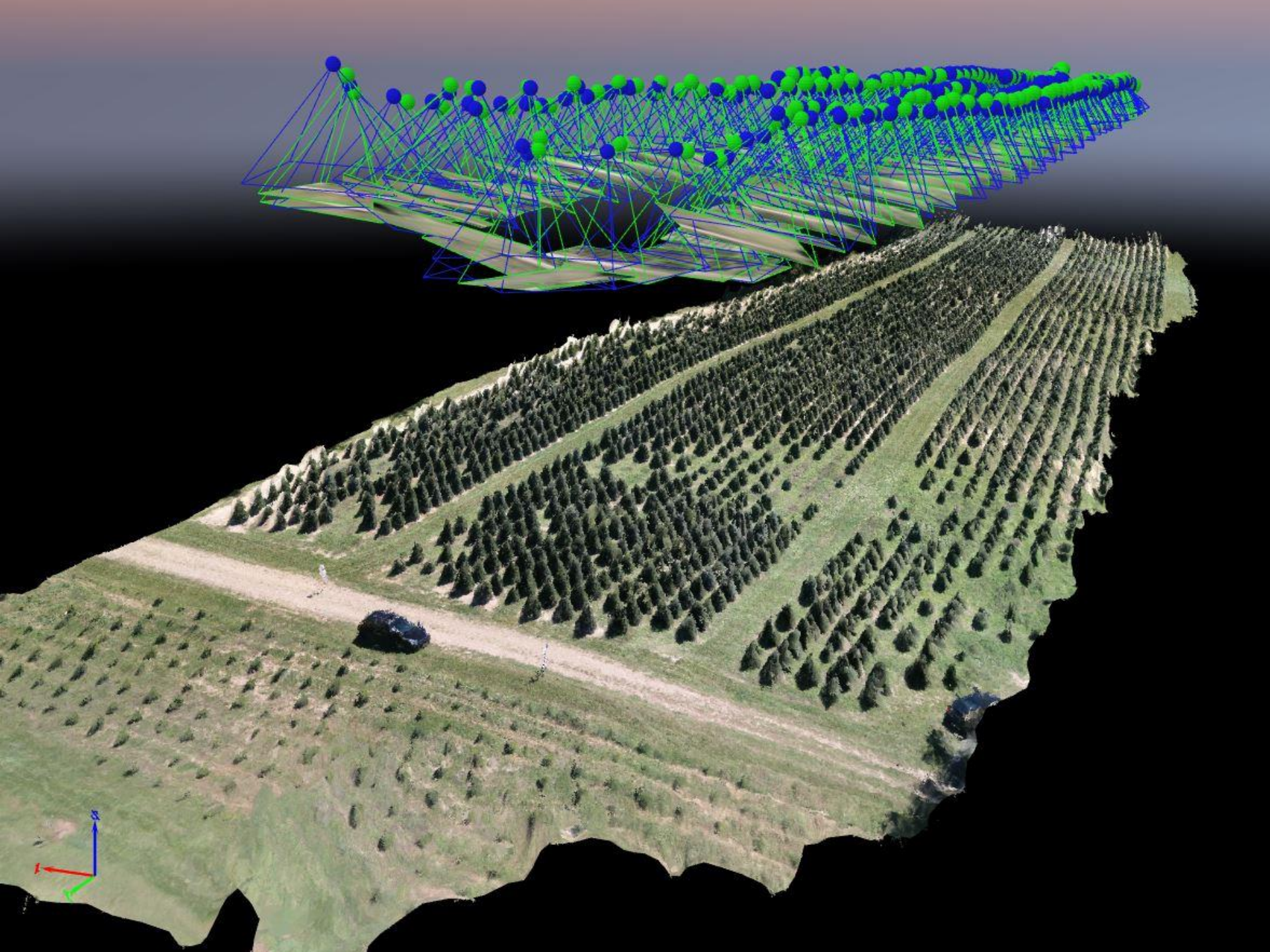
Summary

- Nitrogen stabilizers did not improve growth or needle N concentration compared to standard fertilization or control
- Fertilization increased NO_3 concentration in leachate
- Weedy fields and large trees - plant uptake likely limits total amount of water (and NO_3) leached



Assessing N status with spectral imaging









Row: 5
Treatment: Sup-Spr

Row: 4
Treatment: U-Spr

Row: 2
Treatment: Sup-Spr

Row: 5
Treatment: CON

Row: 4
Treatment: U-Split

Row: 2
Treatment: U-Split

Row: 1
Treatment: AS-Split

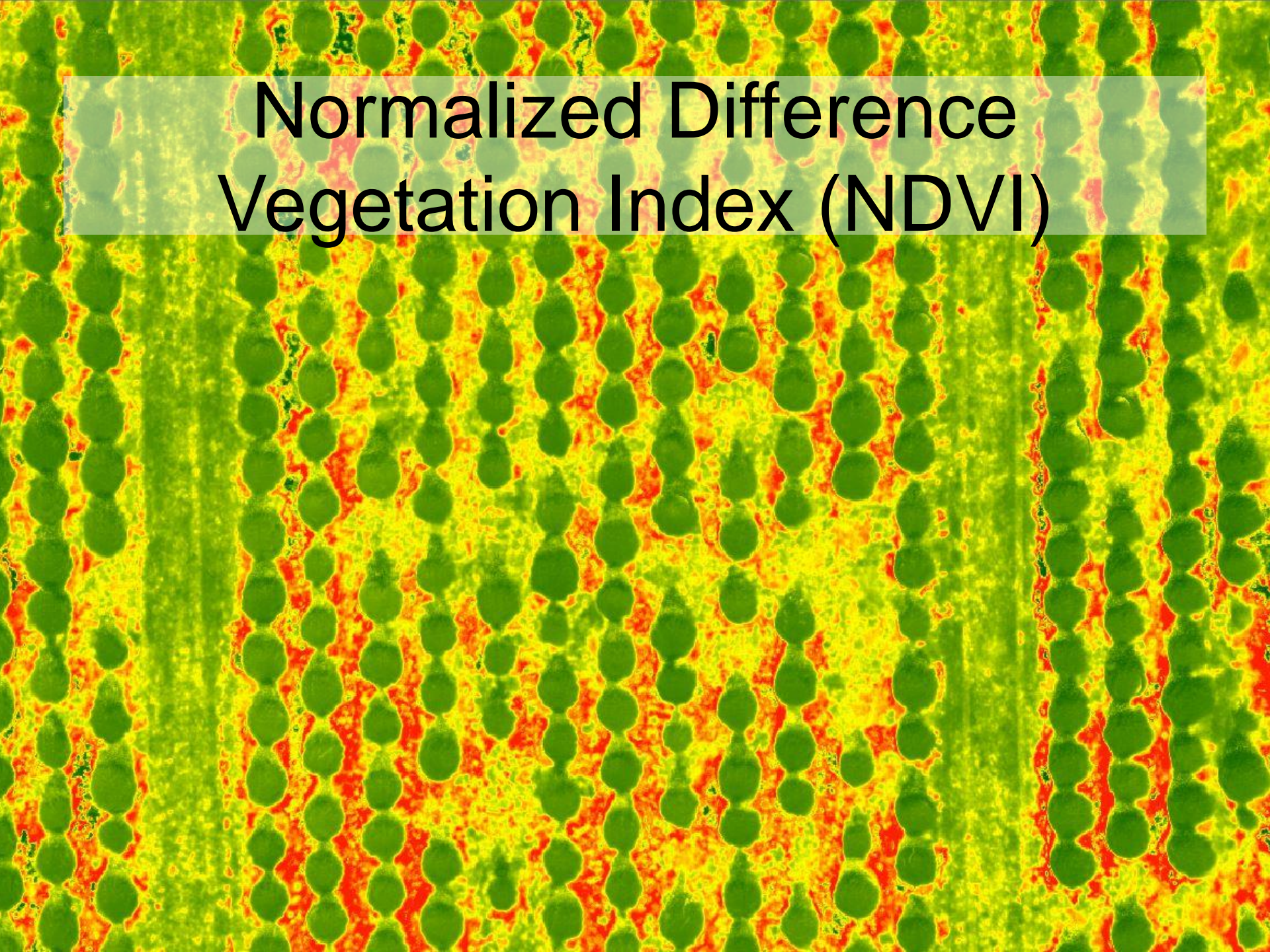
Row: 5
Treatment: U-Spr

Row: 4
Treatment: Sup-Split

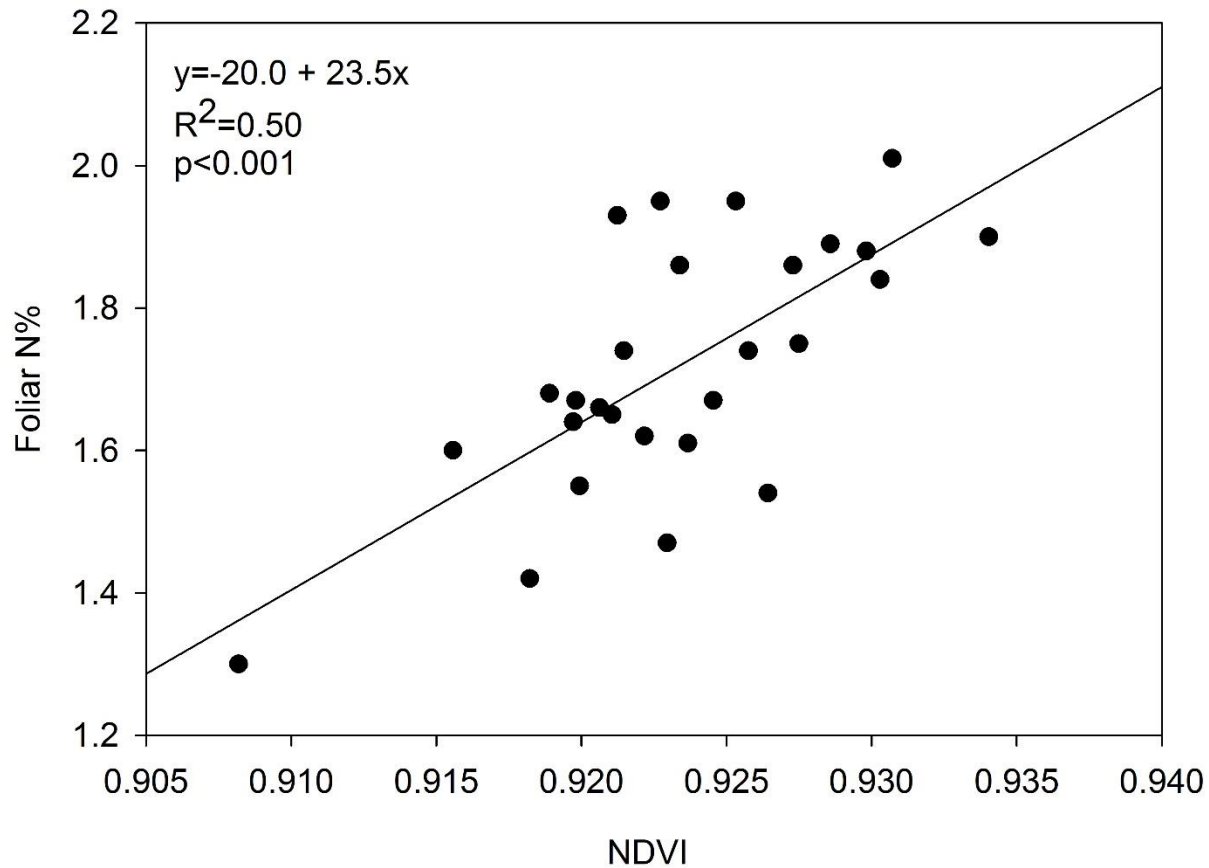
Row: 2
Treatment: AS-Split

Row: 1
Treatment: U-Spr

Normalized Difference Vegetation Index (NDVI)

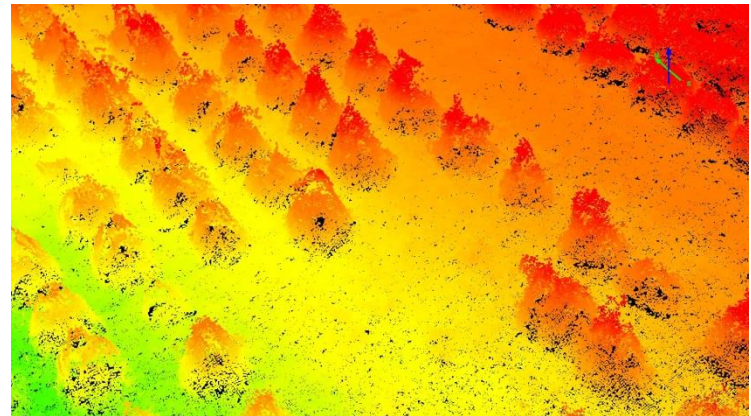


Correlation between foliar N and NDVI



Summary

- Spectral imaging shows potential for assessing tree nutrient status
- Future research effort will be to investigate other UAS applications for Christmas trees
 - Inventory
 - Scouting



Thanks to...

Badger Evergreen

Dutchman Tree Farms

Getty Tree Farm

Gwinn Tree Farm

MCTA

MDARD Hort Fund

Project 
GREEN

