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Nitrogen stabilizers: What are they and what can they do for nursery production?

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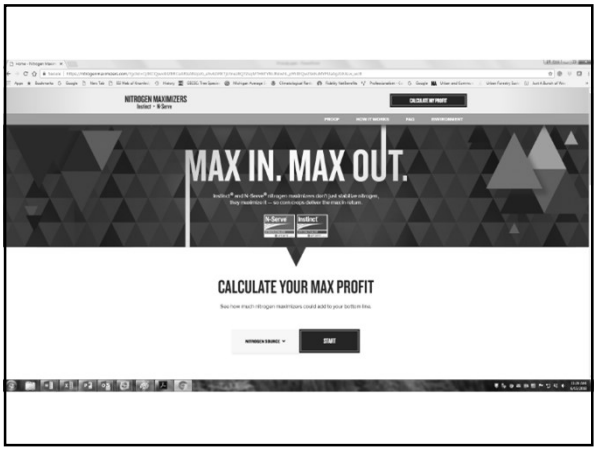
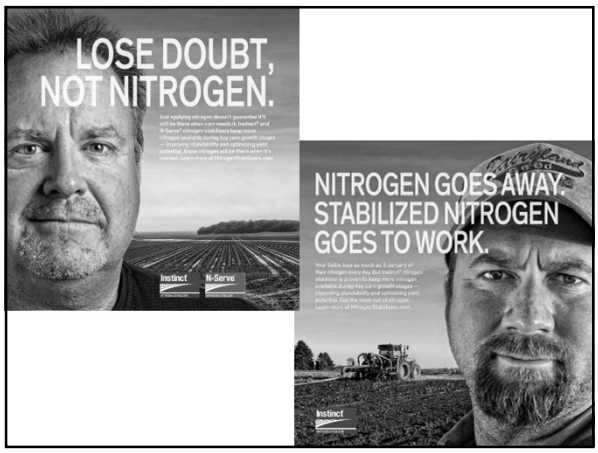
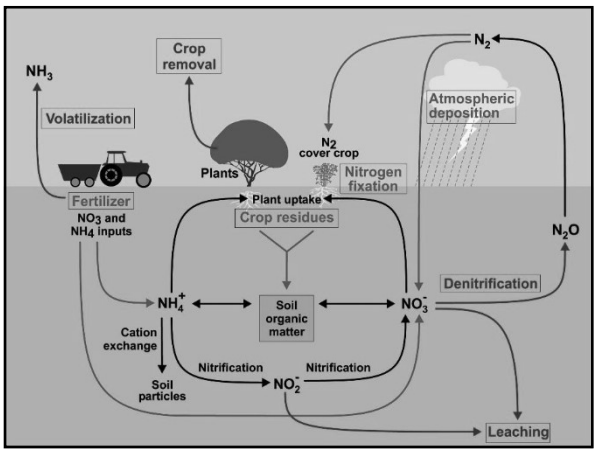
Nitrogen Stabilizers
AKA Efficiency Enhanced Fertilizers







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Two key steps where nitrogen can be lost from plant production systems

- Volatilization
- Nitrification

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Volatilization

- Conversion of urea to NH_3
- Loss of gaseous NH_3 to atmosphere
- In agronomic systems up to 40% of N applied as urea can be lost to volatilization

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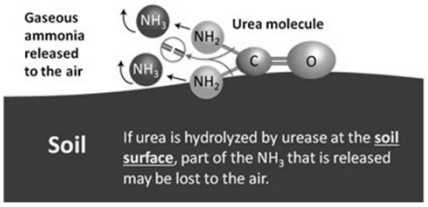
Volatilization



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Nitrification

- Conversion of NH_4^+ to NO_2^- and NO_3^-
- Both are anions and subject to leaching
- NO_3^- can also be lost to denitrification

$$NH_4^+ \xrightarrow{Nitrosomonas} NO_2^-$$

$$NO_2^- \xrightarrow[Nitrosolobus]{Nitrobacter} NO_3^-$$

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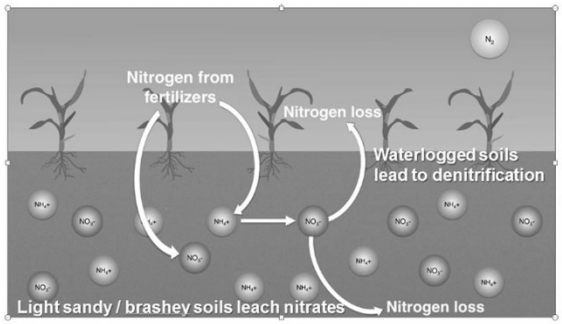
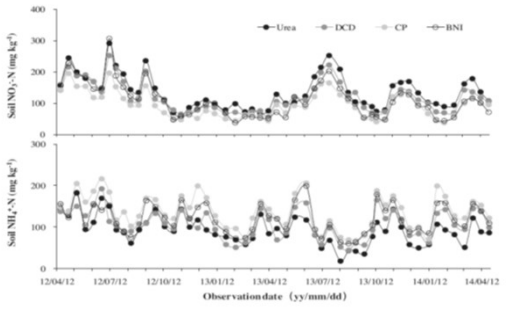
Nitrogen Stabilizers

- Urease inhibitors
- Nitrification inhibitors
- Combination



Nitrification inhibitors maintain N as NH_4 and slow conversion to NO_3



M. Zhang et al. / Agriculture, Ecosystems and Environment 201 (2015) 43–50

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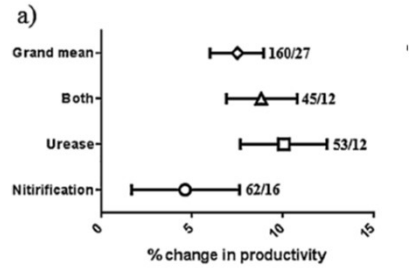
N stabilizers can increase productivity



D. Abalos et al. / Agriculture, Ecosystems and Environment 189 (2014) 136–144

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MSU N stabilizer studies

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

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From Super U label

3. Composition/information on ingredients

Mixtures

Chemical name		CAS number	%
Urea		57-13-6	60 - 100
Non hazardous dye		Proprietary	< 3
Dicyandiamide	Nitrification inhibitor	461-58-5	0.1 - 1
N-(n-butyl)-thiophosphoric triamide	Urease inhibitor	94317-64-3	< 0.1
N-Methyl-2-pyrrolidone		872-50-4	< 0.1
Non hazardous component		Proprietary	< 0.1

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	Spring	Fall
2013		10-17-2013
2014	4-17-2014	10-9 - 2014
2015	4-30-2015	

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	2014	2015
Growth	8-13-2014	7-23-2015

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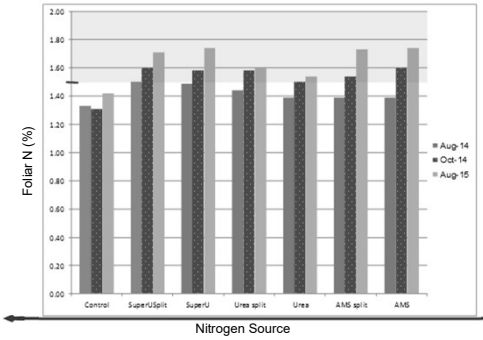
Foliar Nitrogen



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Summary

- 2014:
  - No significant differences
- 2015:
  - Super U spring increased lateral growth relative to control but not other fertilizer treatments

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Summary

- Fertilization increased foliar nitrogen levels compared to unfertilized controls but there was no difference in foliar nitrogen among fertilizer treatments.

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Water crisis grips hundreds of thousands in Toledo area, state of emergency declared

BY TOM HENRY
BLADE STAFF WRITER

Toledo's water crisis was a decade in the making from farms and sewage plants, experts say

Fertilizer pollution fears bubble up in wake of Toledo water crisis

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2016 N stabilizer study

4 locations
7 treatments

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Fertilizer treatments for nitrogen stabilizer trial

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

*1 oz. of N applied per tree

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Lysimeter installation

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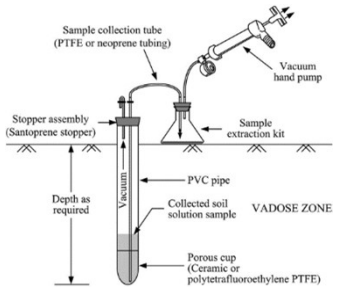
How do suction lysimeters work?



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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

	Farm			
Product	Badger (Fraser fir)	Dutchman (Black hills spruce)	Getty (Fraser fir)	Gwinn (Fraser fir)
Am. sulfate	0.35ab	0.29	0.39	0.37
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
Urea	0.35ab	0.33	0.41	0.44

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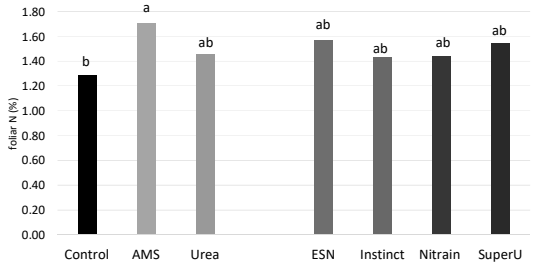
Nitrogen stabilizers did not improve Foliar N



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Leachate sampling:

-Seasonal trend
-Periods with no leaching
-All fertilizer increased NO_3

	Overall NO3 in leachate
AMS	42.57
Control	6.23
ESN	27.36
Instinct	33.05
Nitrain	26.71
Super U	27.33
Urea	29.52

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Summary

Nitrogen stabilizers did not improve growth or needle N concentration compared to standard fertilization

Fertilization increased NO_3 concentration in leachate compared to unfertilized control

For large trees, plant uptake likely limits total amount of water (and NO_3) leached

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Is there a role for nitrogen stabilizers in nursery production?

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Container production

- Primarily use CRF's
- CRF coatings (and incorporation) largely reduce volatilization
- Lots of ways to reduce NO_3 leaching from containers
  - CRF release rate
  - CRF application rate
  - Irrigation

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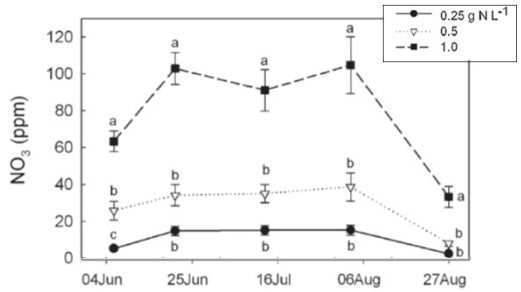
NO3 leaching from conifers in #3 containers



Klooster et al., 2010

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Field production

- More similar to agronomic production systems
  - Use urea
  - Surface broadcast application - potential of volatilization
  - Potential for NO_3 leaching – especially with irrigation or heavy rainfall

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Important differences

- N fertilizer rate and productivity more tightly coupled in agronomic systems
- Fertilizer efficiency can be improved through banding

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Is there a role for NS in nursery production?

- Possibly
- However, many potential benefits of NS could achieved by current irrigation and fertilization BMPs
- If you want to conserve N - there are lots of low hanging fruit

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Are we asking the right question?

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Opinion paper

A re-evaluation of the agronomic effectiveness of the nitrification inhibitors DCD and DMPP and the urease inhibitor NBPT

Terry J. Rose[a,*], Rachel H. Wood[a], Michael T. Rose[b], Lukas Van Zwieten[a,b]

Agriculture, Ecosystems and Environment 252 (2018) 69–73

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- Studies often indicate that nitrogen stabilizers result in modest gains in productivity
- But, maybe we should look at how much N use could be reduced and maintain productivity
- With N stabilizer, N use was reduced by 30% w/o reducing corn yield (Zhang et al., 2010)

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Remaining questions

- Can we reduce N application rates through NS? Enough to make it pay?
- Can NS be incorporated into CRF's? Would there be any benefit?

Thanks for your attention!

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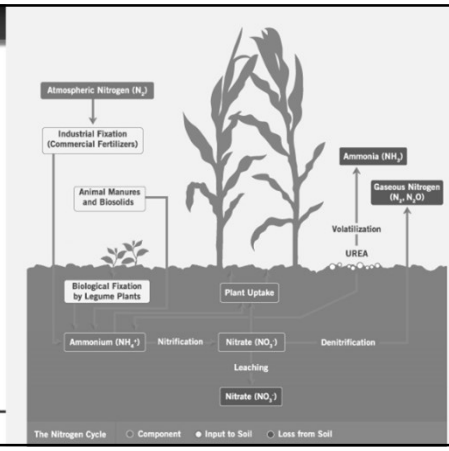

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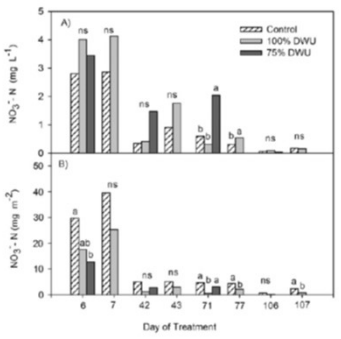
Total nitrate leaching (load) can be reduced by reducing irrigation rate



HortScience 44(6):1573–1580. 2009.

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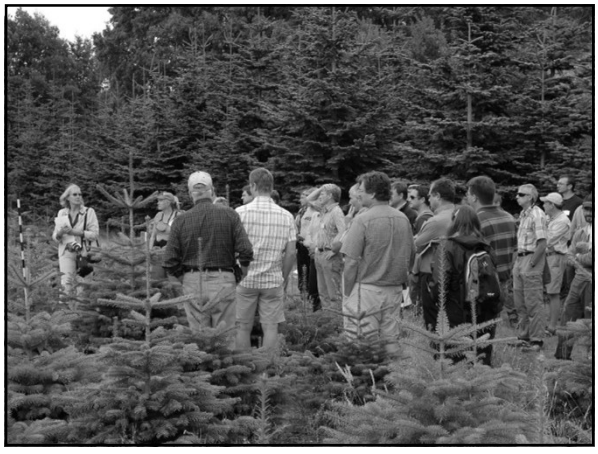
Unique attributes of N

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



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Nutrient budget for a Nordmann fir stand

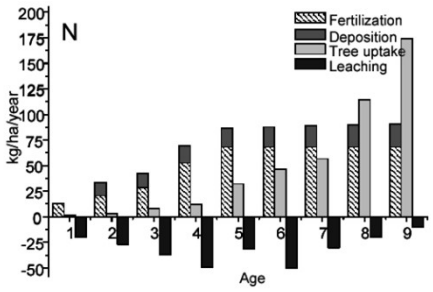

Figure 1 Nitrogen cycling model for a typically Danish Christmas tree stand.

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MSU Nitrogen Source Study

- Objective:
  - Determine the impact of N source (NH_4^+ or NO_3^-) of growth and nutrition of Christmas trees

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Results

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Summary

- N source (ammonium vs. nitrate) had little or no impact on tree growth, foliar nutrition or color
- N fertilizer choice should be made based on:
  - Need for other nutrients
  - Cost
  - Soil reaction
  - Other factors

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More than a loss of $$

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

Photo courtesy NASA

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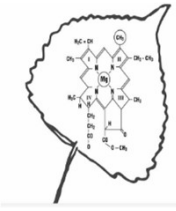
Why is nitrogen so important?

Usually the most limiting element for tree growth and quality

- Component of chlorophyll
- Component of essential amino acids
  - 'Building blocks' of proteins
  - Enzymatic reactions



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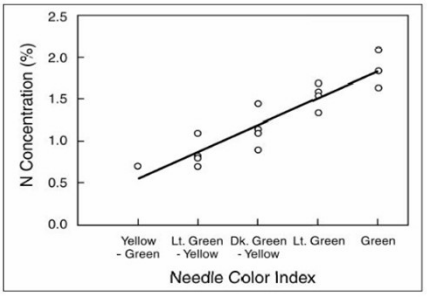

Figure 6. Nitrogen concentration in relation to color of Norway spruce needles (modified from 5).

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Nutrient concentration and soil reaction of common fertilizers

				Acid/Base Equiv.
Fertilizer source	%N	P2O5	K2O	(#CaCO3/ton fert.)
Anhydrous ammonia	82			-2960
Ammonium nitrate	34			-1260
Ammonium sulfate	21			-2240
Urea	46			-1680
Diammonium phosphate	16-21	48-53		-1480
Monoammonium phosphate	11-12	48-61		-1300
Calcium nitrate	15			400
Potassium nitrate	13		46	520

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	2014	2015
Foliar		
Summer	8-13-2014	8-12-2015
Fall	10-9-2014