

Why can't I apply nitrogen in September?

The Nitrogen Story

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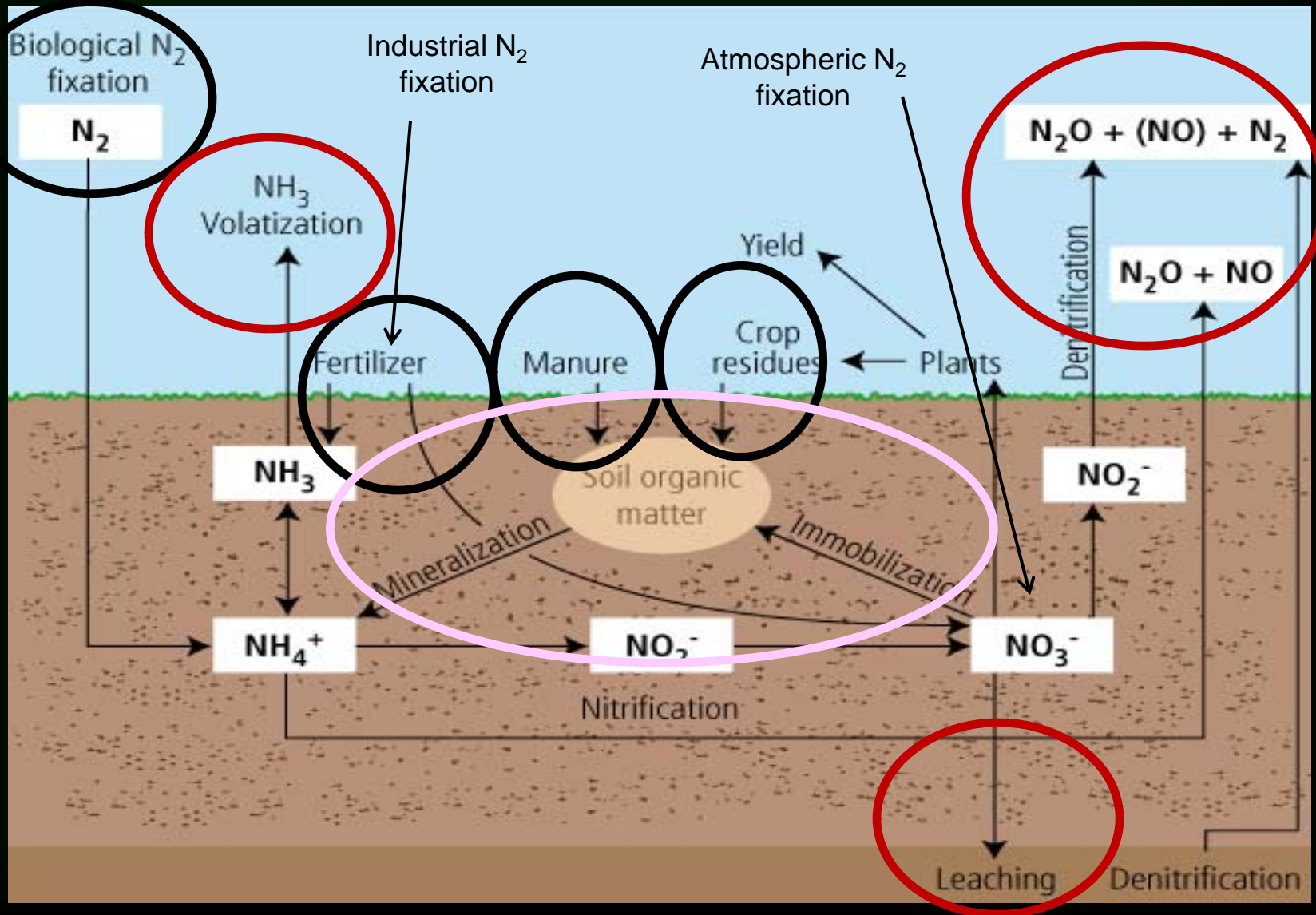
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Basic Education about Nitrogen (N)

- Significant amount of N was applied in September
 - Weather was good (86° and dry)
 - Field work was caught up
 - What are the potential consequences?
- Will cover some basic information about nitrogen.
- Will focus on soil N.
 - Transformations
 - Loss from the crop zone

The N cycle

<http://www.fertilizer.org/ifa/Homepage/Sustainability/Climate-change/Nitrogen-cycle.html>



Soil Nitrogen Pools

- Pool Concept:
 - Conceptual compartmentalization of soil N.
- 2 Basic Soil N Pools
 - Organic N
 - N bound to carbon
 - Protein, enzymes, amino sugars
 - Inorganic N
 - Mineral N not bound to carbon
 - Gas: NH_3 , N_2 , N_2O
 - Gasses expand to fill void and rise
 - Non-Gas: NH_4^+ , NO_2^- , NO_3^-

Organic N

- > 95% of all soil N
 - Approx. 1000 lbs. N per 1% O.M.
- Organic N is not available for a crop
 - Must be converted to inorganic N (mineralized).
- Immobilization: conversion of inorganic N to organic N
 - Occurs during plant uptake and utilization
 - Occurs when residue/organic matter does not contain sufficient N for decomposition.
 - **Microbes absorb soil inorganic N**

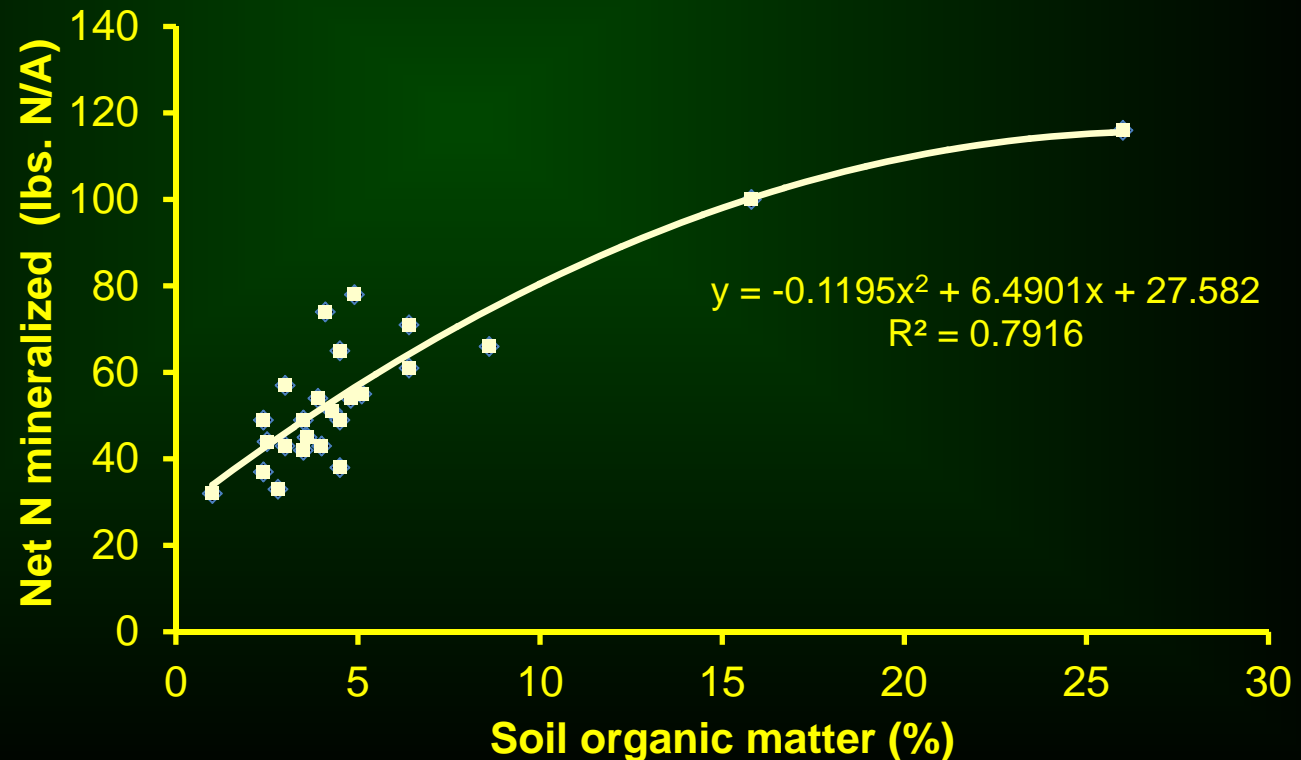
Organic N

- Mineralization
 - Conversion of organic N to inorganic N
 - residue/organic matter contains more N than needed
 - Usually first N product is NH_3 or NH_4^+ .
- Immobilization and Mineralization occur simultaneously
 - We measure/see the net effect of dominate process
 - Which is dominate process depends on:
 - Organic matter type and amount
 - Fresh vs old
 - Resistance to decomposition
 - Temperature, moisture, aeration

N mineralized during the growing season

- Southern Minnesota Beet Sugar Coop grower area.
 - Various sites across the landscape in 2 to 4 fields in each of 3 years.
 - 2 to 5 positions across the landscape within a field
 - Positions based on variation in soil O.M.

Sims, Lamb, Bredehoeft
(unpublished data)



Inorganic N

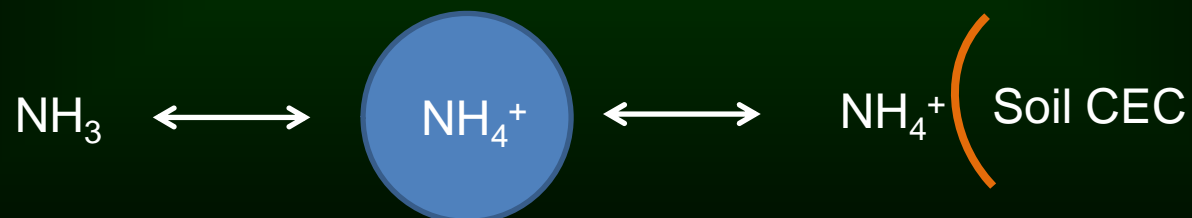
- Where plants get their N
- Gaseous N:
 - NH_3 , N_2 , N_2O
 - Gasses expand to fill voids in the soil
 - Gasses rise to the soil surface
 - Will diffuse into the atmosphere
 - Lost from the crop root system
- Non-gaseous N:
 - NH_4^+ and NO_3^-
 - Primary forms taken up by plants
 - Both have their risks and advantages

Inorganic N

- NH_3 and NH_4^+



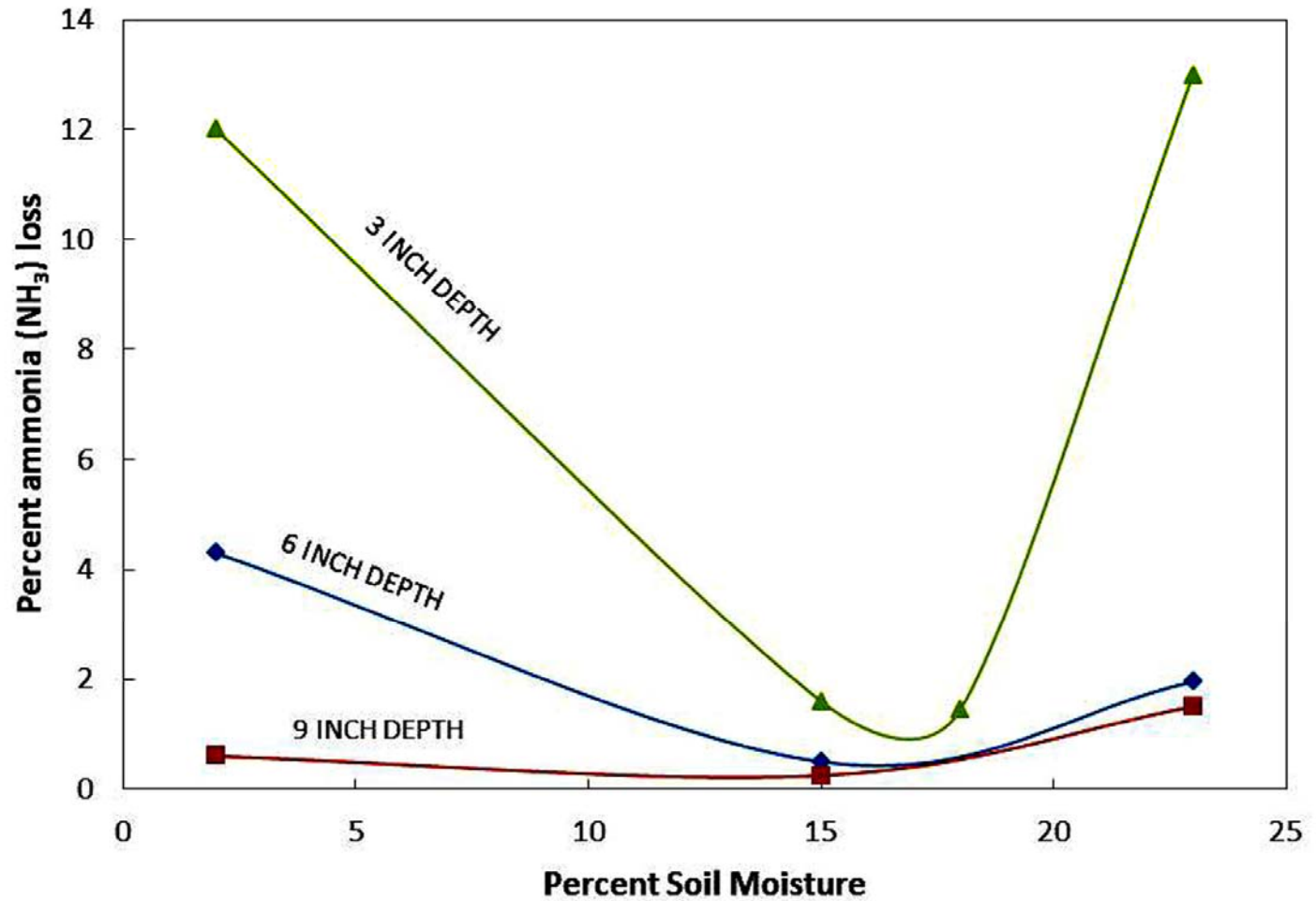
- NH_4^+ : cation attaches to soil CEC (exchangeable)
 - Solution and exchangeable NH_4^+ in equilibrium
- High pH drives solution NH_4^+ reaction left to NH_3
- Prevent NH_3 loss by soil incorporation



NH₃ Volatilization: depth of application and soil moisture

Stanley and
Smith, 1956
SSSAJ
20:557

Retrieved
from
Ledbetter,
2011,
agrilife.org
Texas A&M

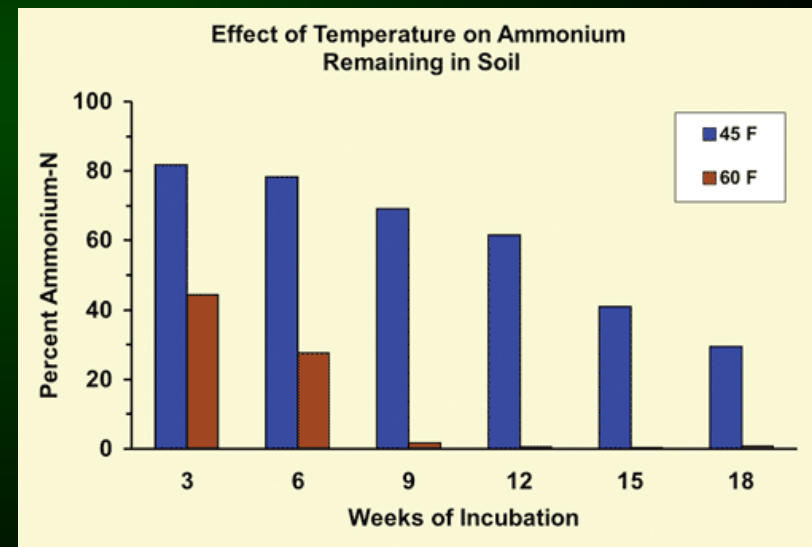
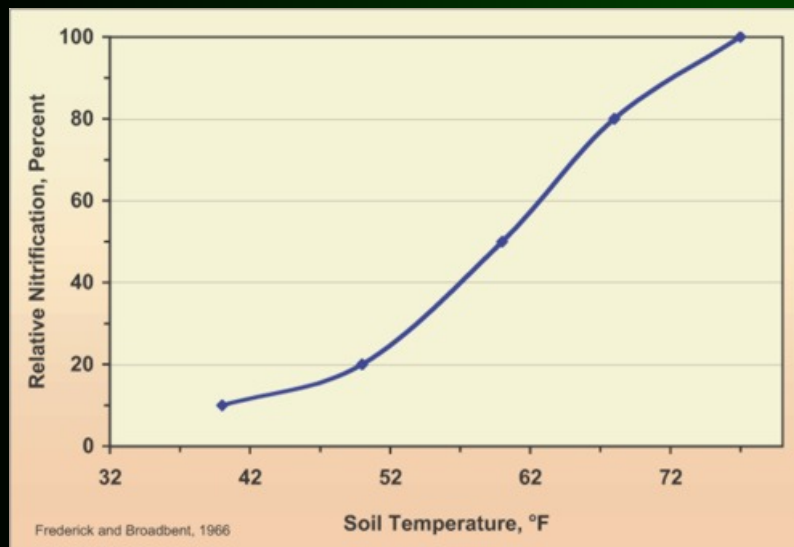


Inorganic N

- Nitrification: conversion of NH_4^+ to NO_2^- and NO_3^-
 - $2\text{NH}_4^+ + 3\text{O}_2 \longrightarrow 2\text{NO}_2^- + 4\text{H}^+$
 - $2\text{NO}_2^- + \text{O}_2 \longrightarrow 2\text{NO}_3^-$
 - Effected by:
 - Supply of NH_4^+ , aeration, moisture, temperature

Temperature Effects on Nitrification

- Nitrification slows as temperatures decline.

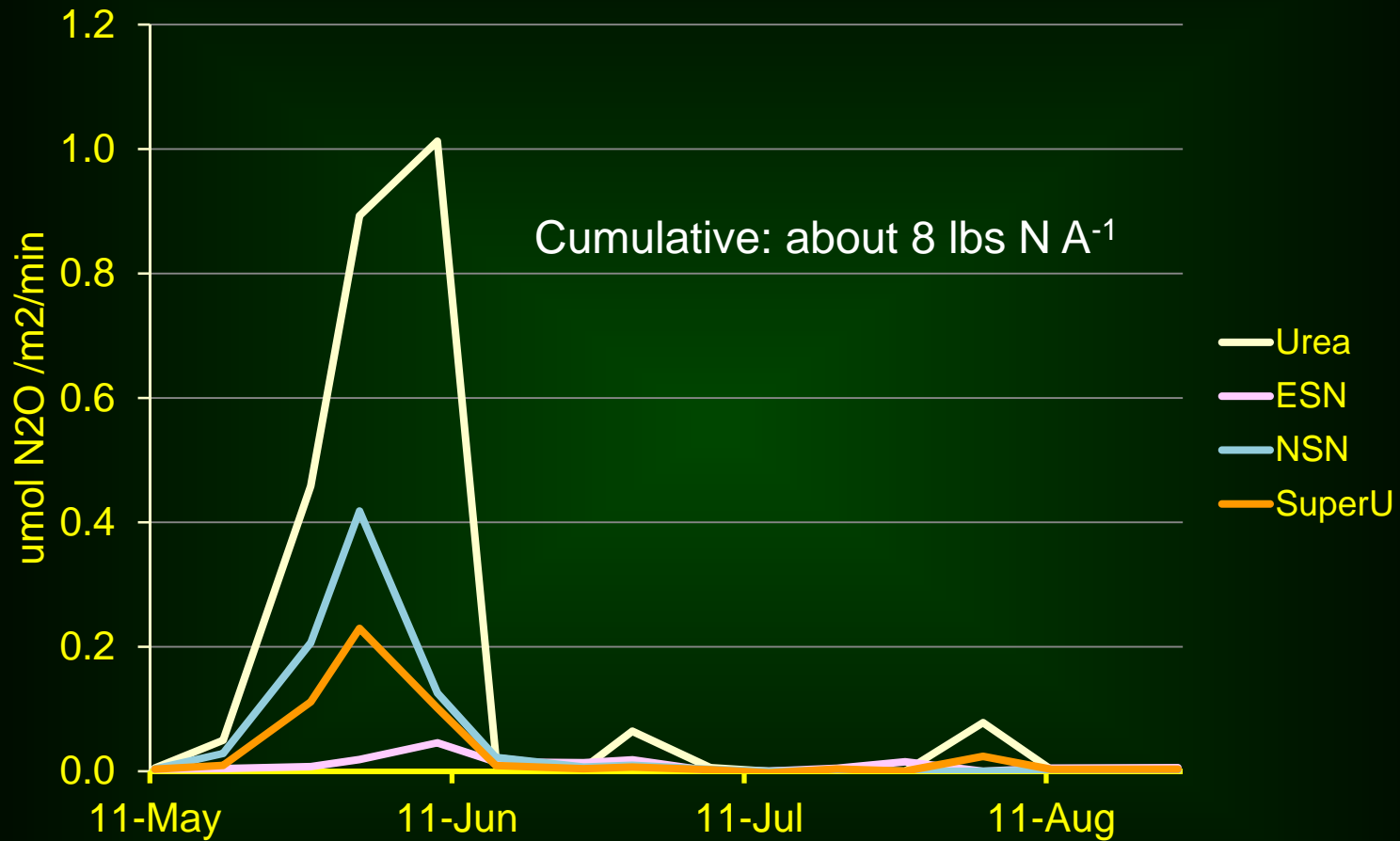


Obtained from Sawyer and Taylor. Integrated Crop Management
ICM > 2005 > IC-494(23) Sept 19, 2005

Inorganic N

- NO_3^-
 - Form most absorbed up by many crops
 - Formation in Soil inhibited by:
 - Anaerobic conditions
 - NH_4^+ forms of fertilizers
 - Applied at Cold temperatures
 - Nitrification inhibitors
 - Is highly water soluble
 - Moves with the soil water
 - Denitrification
 - Saturated conditions.....no O_2
 - Microbes use O_2 from NO_3^-

Nitrogen Denitrification

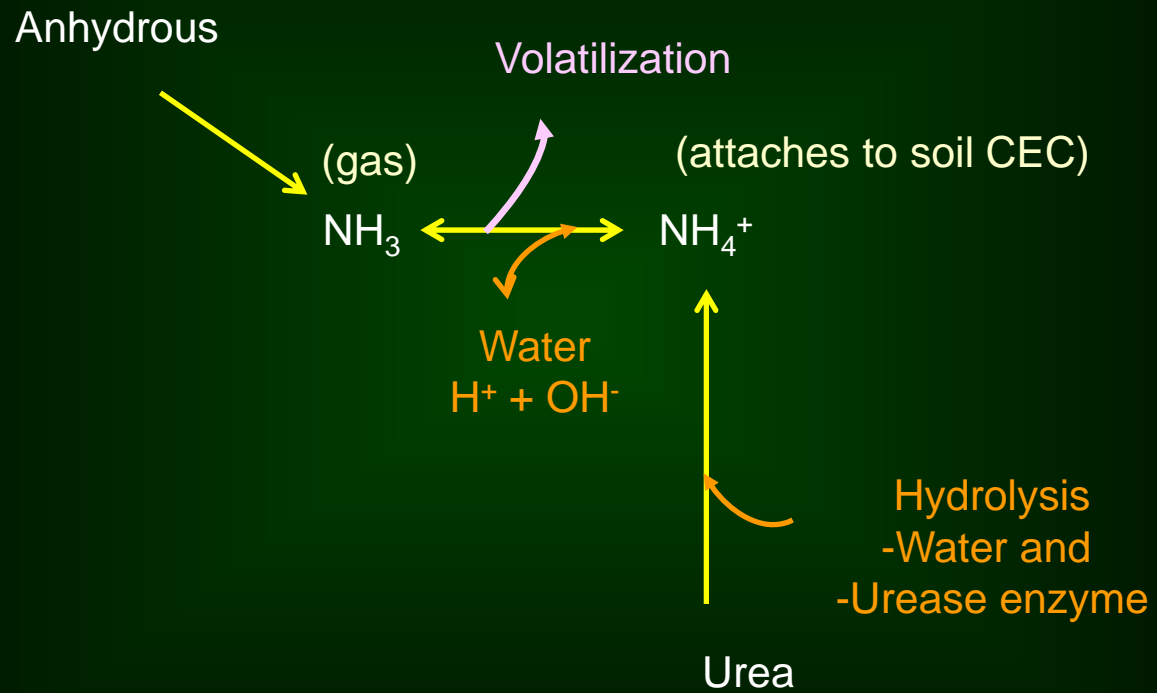


120 lbs N A⁻¹ broadcast applied in Spring (May 11)

Where does the crop get its N?

- 3 main sources:
 - Residual soil N—left over N and naturally deposited N
 - Estimated with soil test for nitrate-N (NO_3^- -
 - Mineralized N
 - Fertilizer— Industrial fixation of atmospheric N_2 :
 - NH_3 , NH_4^+ , NO_3^- or a combination.
 - Urea is first converted to NH_4^+

Fertilizer in the Soil

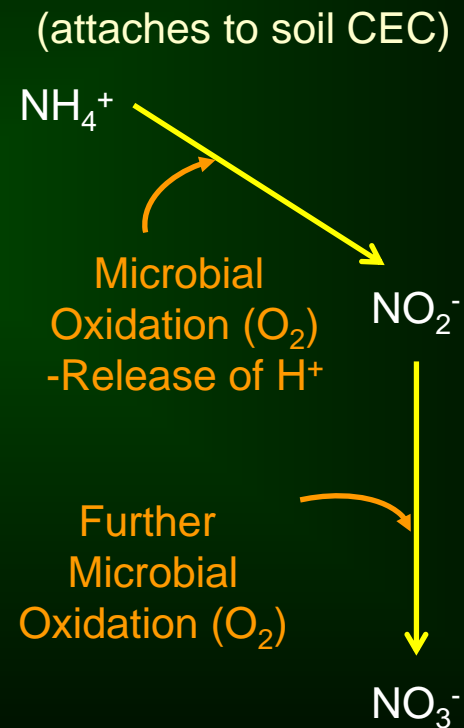


Inhibit NH_3 Volatilization

- Incorporation
 - Inhibit gas diffusion to the soil surface
 - exposes NH_3 to soil water
 - Converts to NH_4^+
- With dry conditions this last fall:
 - Potential for insufficient soil water?
 - Potential for unsealed shank cuts?
- Urease Inhibitors
 - Agrotain: inhibits conversion of urea to NH_4^+

Fertilizer **Nitrification** In the Soil

- Warm temperatures
- Moisture
- Aeration



Nitrate-N Loss

- Nitrate susceptible to Loss
 - Leaching?
 - Denitrification?
- Fall applied Nearly spring applied N
 - Want to inhibit NO_3^- formation
 - Wait for cold soils
 - Nitrification inhibitors
- September applications of Anhydrous Ammonia?
 - Might get away with it this year
 - Dry soil conditions in the fall
 - Drier soil conditions this spring?
- Limit Risk Exposure.
- Spring apply N?