# Soil Nitrogen

**<u>Ammonium</u>** ($NH_4^+$), **N<u>itrite</u>** ($NO_2^-$), **N<u>itrate</u>** ($NO_3^-$), **and Nitrogen gas** ($N_2$)

## Where and How

Ammonification/Mineralization, Nitrification, Denitrification, Volatilization, Immobilization

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We must first understand the where and how of nitrogen,

Before we talk about nitrogen recommendations.

# Primary Source of Nitrates

- Addition of fertilizers contain nitrate, ammonia and ammonium.


- Microbial conversion of ammonium fertilizers and organic matter to Nitrate –N,

- Microbial conversion of Organic Nitrogen (i.e., soil organic matter, manures, and compost) to ammonium and then nitrate-N.

# Primary ***fates*** of Nitrates

- Utilization by microorganisms or plant roots (immobilization),


- Leached below the root zone,
- Moved off-site in surface runoff and sediment,
- Microbial conversion of nitrate-N to nitrogen gas.

# Ammonification or Mineralization

Nitrogen is initially in an organic form (protein). This nitrogen will eventually be mineralized and made available to the plant and soil biota.

**Mineralization -** the release of organically bound nutrients in an inorganic form usable to organisms and/or plants

Nitrification is the oxidation of ammonium by bacteria to nitrite and then to nitrate in an aerobic environment.

Ammonia/Ammonium

$NH_3 \rightleftarrows NH_4^+$

pH


Nitrosomonas

Nitrite

$NO_2^-$ plus acid

Nitrate

$NO_3^-$

Nitrobacter

# Denitrification

Denitrification process is basically outlined below, with the nitrate being converted back by reduction to gaseous nitrogen in anaerobic conditions (e.g., water-logged / compacted soils).

Nitrate's

$NO_3$

Anaerobic Bacteria

Anaerobic

Gas

Nitrogen Oxides

$N_2$ NO $N_2O$

# Biologically Fixed Nitrogen

***Photo Top Right: Frankia*** on roots of an Alder (*Ceanothus*)

$N_2$

Atmospheric / Gaseous Nitrogen

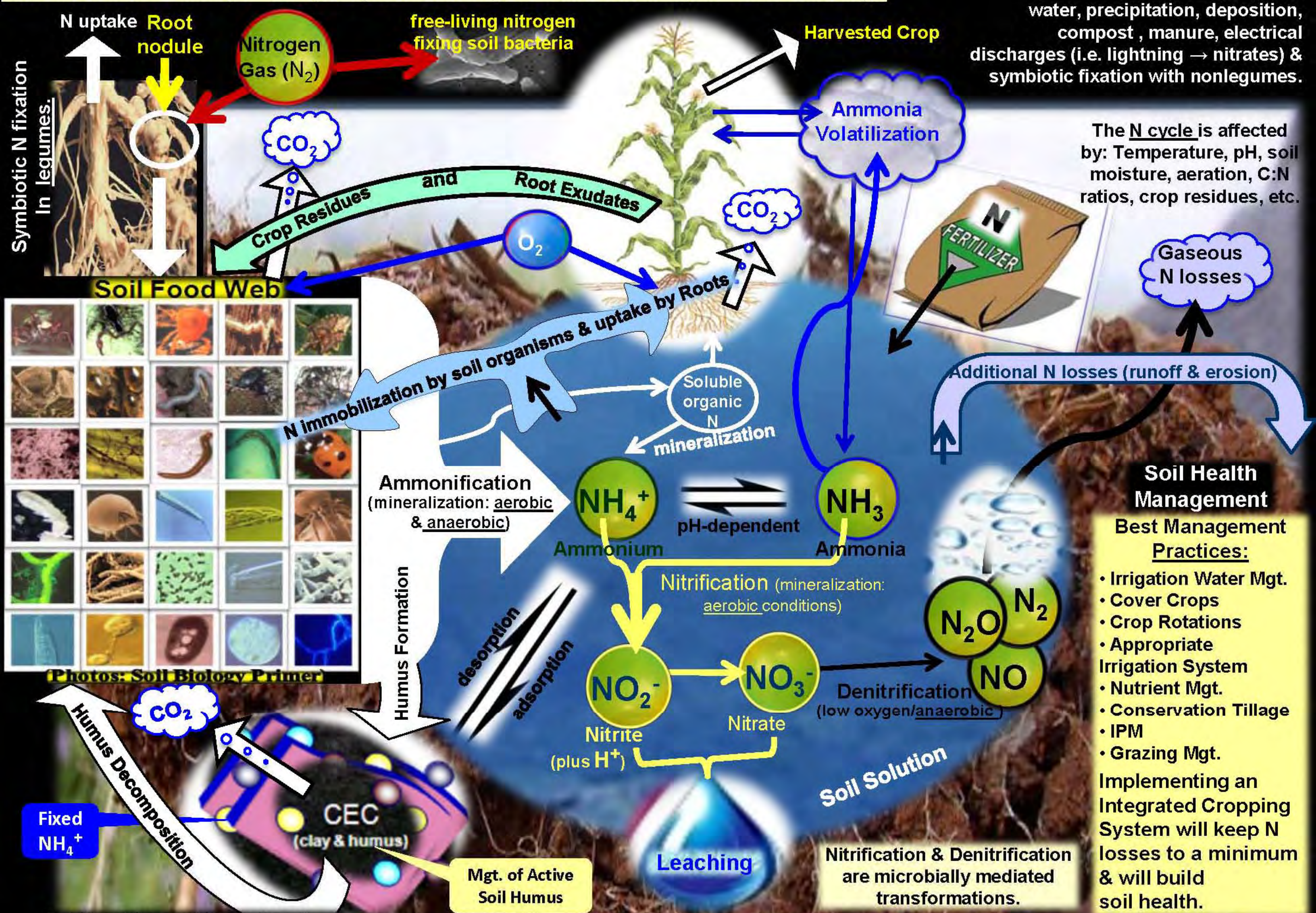
*Example: Rhizobium*, Actinomycete *Frankia*

Mineralization

Ammonia/Ammonium

$NH_3$ $NH_4^+$

Introduction to Section 1 (1d – Nitrogen Cycle: Best Management Practices to improve N use efficiency)




Ref. The Nature and Properties of Soils, 13th Edition (Chapters 11, 12 & 13)

Agronomy Tech Note 76 (http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html)

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# Soil Nitrate $NO_3^-$

# and Nitrite $NO_2^-$

# Soil Nitrate Testing

Note: Soil nitrates are a good measure of plant available nitrogen, but they can be readily lost from the soil by leaching and denitrification.

This test strip is quick but the Soil Lab Test is more accurate.

# Soil Nitrate Testing

Measured by dipping nitrate test strips into the solution filtered from a 1:1 ratio soil/water mixture. Soil nitrate levels are important for plant growth and water quality.

Insert filter paper into subsample.

Collect several drop of  liquid

Place drops on the nitrate strips. Measure and Record after 60 sec.  Max reading is 50 ppm strips.

# Soil Nitrate Test

## Calculations

- Example Estimated: 50ppm x 4 = 200 **(**lb $NO_3^-$ N/Ac.**)** **approx.**

  4 = 4 million pounds of soil dry weight per acre foot. This is a fast, easy way of estimating nitrate – nitrogen. The common person can understand this simple equation.

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- Estimated: **(**lb $NO_3^-$ N/Ac.**) =**

  (ppm extract NO3-N) x (depth of soil sampled in cm) x bulk density x 0.89

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- **Exact (**lb $NO_3^-$ N/Ac.**) =**

  (ppm NO3-N) x (volume water used) x (depth of soil sampled, cm) x bulk density x 0.89

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  (dry weight of soil) x 10

# Fate of Nitrate Nitrogen

Any amount of nitrate in the soil that is not used by the crop may potentially be leached from the root zone and become a pollutant in the water and would be an economic loss to the producer.

# Interpretation of N

## Proper fertilizer use.

- Fertilizers that enhance plant growth (in crop residue, manure, compost etc…). The best approach is to feed the soil biota, rather than feed the plant.
- Don’t over do it with fertility amendments such as compost and manure (follow a nutrient management plan).
- A healthy soil will grow healthy crops (Nutrient Cycling).
- Note: use compost and manure as primary source of fertilizer and not a major source of organic matter.

# Don't Guess - Test

What are your inputs from the Soil and Water
and
What is going to be absorbed into the plant.


- Tissue,
- Water,
- Soil

## Testing Procedures

Irrigation Water Quality sampling – 2h.

How to Collect Soils for Analysis – 16a.

Plant Tissue Analysis – 5e.

http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html

**Irrigation Water, Soil and Plant Tissue Analysis Interpretation Guide for Onion Crop (Hatch, NM Workshop)**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Producer:** Chile River Farm | | **Crop:** Fall Onions | | **Yield:** | | **Irrigation Water:** 48" (surface furrow irrigation) | | | |
| 2 | **Tillage Operations:** conventional tillage - from chile 2010 to onions 2011 | | | | | | | | | |
| 3 | **Soil Texture:** Clay Loam | | | **Soil Structure:** to be determined at field | | | | **Aggregate Stability:** to be determined at field | | |
| 4 | **Nutrients** | Irrigation Water Analysis (ppm x 0.227 x 48 " = lb./ac.) | | Soil Analysis 0-6" depth ppm x 1.795 = lb/ac (0 - 6" depth) | | Nutrient Inputs (recommend-ations) | Plant Tissue Analysis Note: N is kjeldahl nitrogen & Sulfur is total Sulfur | | Should I Apply Nutrients? | Conservation Practices to consider for achieving sustainability |
| | ON = Organic Nitrogen mineralized | ppm or mg/l | Pounds per Acre | ppm or mg/Kg | Pounds per Acre (VL, L, M, H, &VH) | Pounds per Acre | % or ppm & Rating (low - high) | Sufficiency Range (recently mature leaves) | - Yes (Y) No (N)<br>- Maintenance (M)<br>- Not Sure (?)<br>- Other (O) | |
| 5 | Organic Matter | | | OM % | Not analyzed | | | | | ♥ Cover Crops |
| 6 | N mineralized | | | Organic N | Est. 10 – 30 lb/ac | Manure? | | | | |
| 7 | Nitrate-Nitrogen | 0.5 | 5.45 | 11.0 | M | N | 4.1 % H | 3.10- 4.27 % | N | |
| 8 | Phosphorus | | | 11.0 | M | $P_2O_5$ | 0.35 % M | 0.26 - 0.48 % | N | ♥ Crop Rotations |
| 9 | Potassium | 11.0 | 119.9 | 370 | VH | $K_2O$ | 4.5 % H | 1.98 - 4.22 % | N | |
| 10 | Sulfate-Sulfur | 320.0 | 3,486.7 | 61.0 | VH | none | 0.65% H | 0.15 - 0.57 % | N | |
| 11 | Calcium | 350.0 | 3,813.6 | 7,600.0 | VH | none | 2.70 % H | 0.90 – 1.84 % | N | ♥ Manure or Compost |
| 12 | Magnesium | 51.0 | 555.7 | 590.0 | VH | none | 0.42 % M | 0.16 – 0.32 % | N | |
| 13 | Zinc | | | 0.74 | L | none | 19 ppm M | 16 – 45 ppm | N | ♥ Minimum-Till (No-Till); Residue mgt. |
| 14 | Iron | not | analyzed | 15.0 | VH | none | 110 ppm M | undetermined | N | |
| 15 | Manganese | not | analyzed | 12.0 | VH | none | 51 ppm M | 51 – 149 ppm | N | |
| 16 | Copper | | | 3.0 | VH | none | 7 ppm M | 5 – 28 ppm | N | |
| 17 | Boron | 0.44 | 4.8 | 0.58 | L | none | 39 ppm M | 6 – 15 ppm | N | ♥ IWM |
| 18 | Molybdenum | | | | | none | not | analyzed | | |
| 19 | Sodium | 340.0 | 3,704.6 | 300.0 (H) | Refer to SAR | | 1.0% (Toxic) | | | ♥ Soil Amendments (e.g. gypsum) |
| 20 | Chloride | 274.0 | 2,985.5 | | | | not | analyzed | | |
| 21 | Bicarbonate | 553.9 | 6,035.3 | | | | | | | |
| 22 | Carbonate | 0 | 0 | | | | | | | ♥ IPM |

**Free lime level is High. Sufficiency Ranges for plant analysis (Ref. SCSB #394) & Western Fertilizer Handbook, 9th edition.**

- Electrical Conductivity of Irrigation Water (ECiw) = 2.70 mmhos/cm
- SAR from water test = 4.49; Adjusted RNa = 7.46; pH = 7.40
- Refer to Irrigation Water Quality Guidelines (Sect.2) for infiltration assessment. Total Dissolved Solids = 1,900.92 ppm
- Soluble salts applied = 20,712.42 lb./ac./yr.

- ECe (EC of Soil Saturation extract) = 1.6 mmhos/cm (low) & pH = 8.0
- Exchangeable Sodium Percent (ESP) = 2.9 low
- Crop Salt Tolerance for Onions: 0% yield reduction at ECe of 1.2 mmhos/cm; 10% yield reduction at ECe of 1.8 mmhos/cm; and 25% yield reduction at ECe of 2.8 mmhos/cm.

Refer to the NRCS Nutrient Uptake Tool: http://npk.nrcs.usda.gov/ for calculating NPK removal by crop

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Agronomy Tech Note 76 (http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html)

Number Crunching

# Nitrogen: Comprehensive Nutrient Mgt.

Soil – Water – Tissue Testing

- Cover Crops
- Crop Rotations
- Minimum Tillage
- Manure Management / Composting
- Irrigation Water Management

**For more information Please Contact Your Local Office of the:**

Natural Resources Conservation Service

or

Soil and Water Conservation District

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