Nitrogen Management

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Nitrogen Management Overview

- Nitrogen in soil, uptake
- How to manage nitrogen efficiently

Take-Aways:

- N is dynamic, but can all → Nitrate
- N entry points easily overloaded → Leaching
- Match application with Demand Rate & Timing
- Irrigate to keep N in rootzone (top 3')

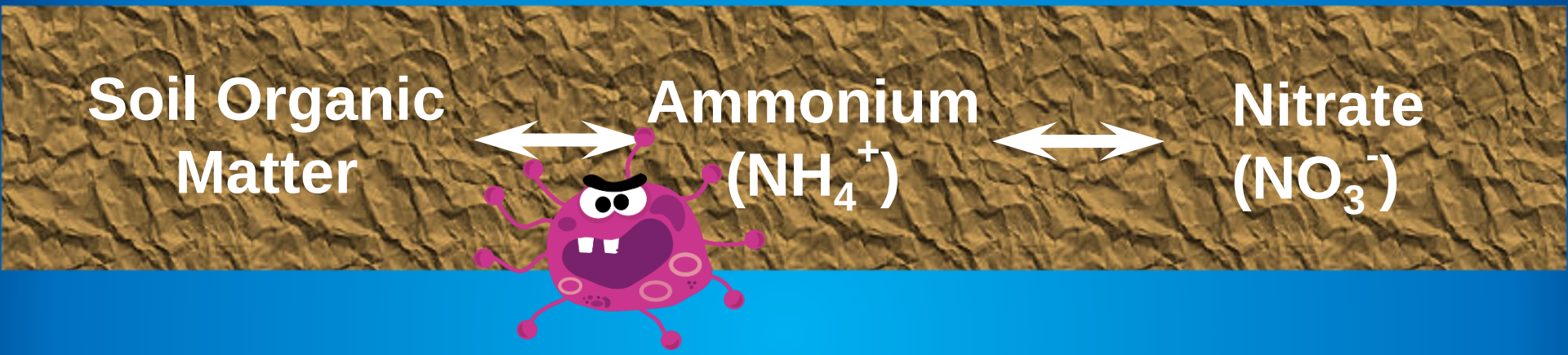
The Nitrogen Cycle in the Soil

*Need to understand the **different forms** of N to know **when** and **how** N is available to tree roots, vulnerable to leaching.*

The Nitrogen Cycle in the Soil

Soil Organic Matter	Ammonium (NH_4^+)	Nitrate (NO_3^-)
N tied up in organic molecules, not available to plants	Roots can take up N as ammonium	Roots can take up N as nitrate
Immobile carbon and nutrient storage vault	Positively charged – can stick to the CEC in the soil	Negatively charged – will not stick to CEC in the soil → can easily LEACH

The Nitrogen Cycle in the Soil



Rate depends on carbon, temperature, moisture, aeration

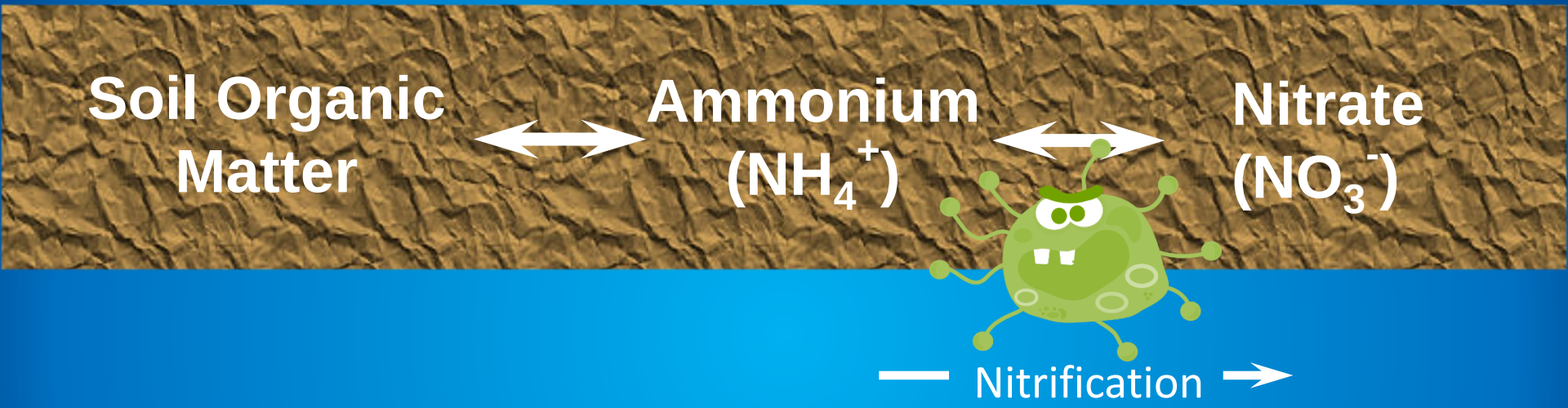
CA soils, SOM→Ammonium in weeks to months

Higher %N (lower C:N) → less immobilization.

Analysis of amendments C:N important: <2% → immobilizes

Elements of the Nature and Properties of Soils, 3/e by N. Brady and R. Well

The Nitrogen Cycle in the Soil



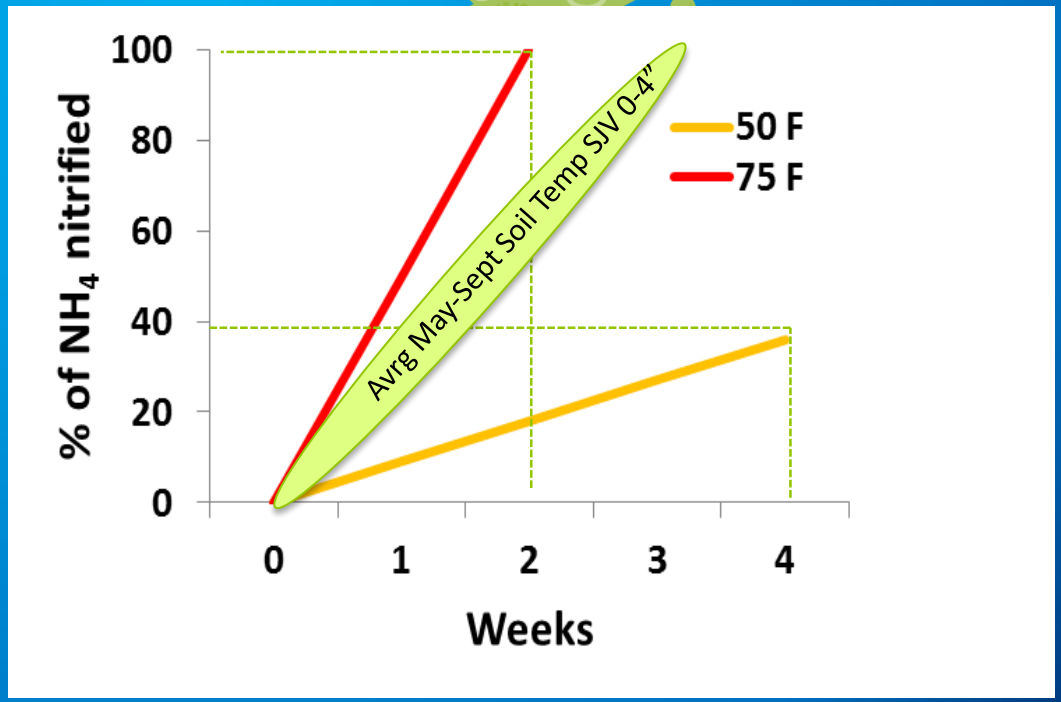
Rate depends on temperature

CA soils, Ammonium → Nitrate in days to weeks

CA soils, most N eventually turns to nitrate

The Nitrogen Cycle in the Soil

Soil Organic Matter ⟷ **Ammonium (NH_4^+)** ⟷ **Nitrate (NO_3^-)**



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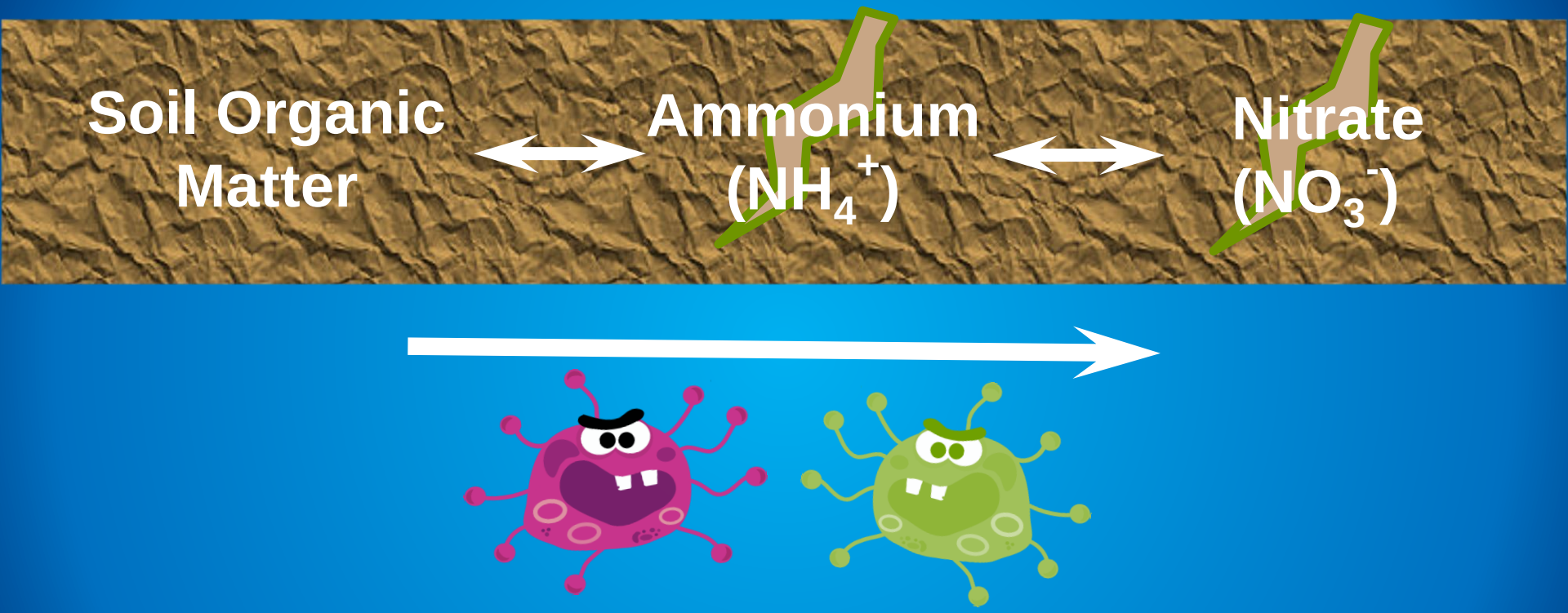
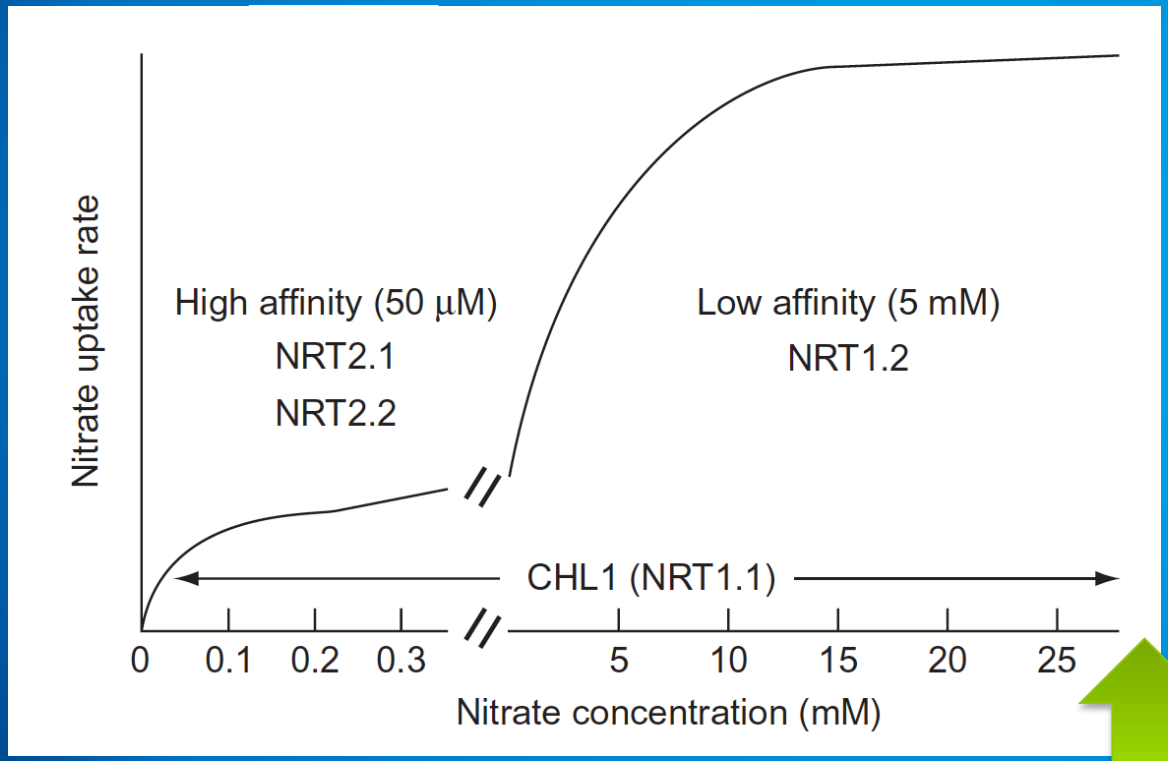
The Nitrogen Cycle in the Soil

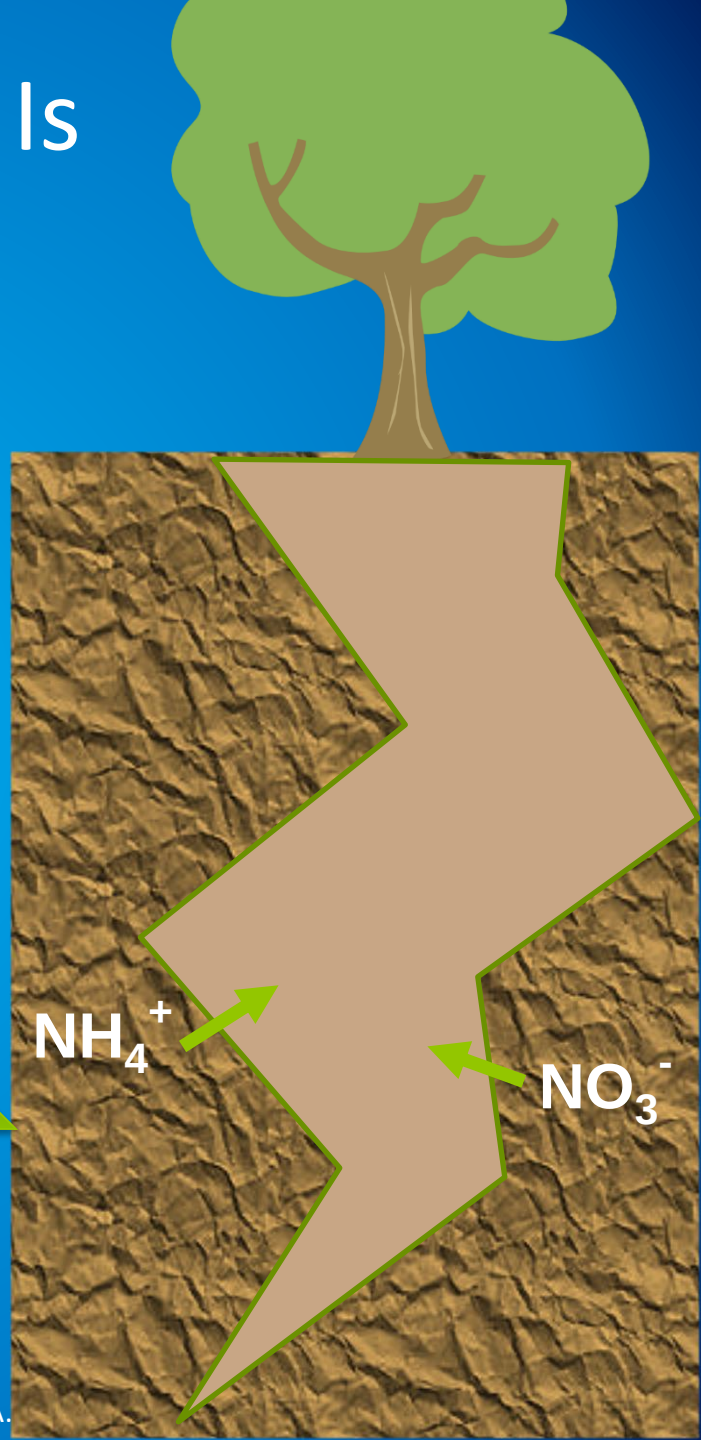


C:N
Temperature
Moisture
Aeration

Elements of the Nature and Properties of Soils, 3/e by N. Brady and R. Well

Nitrogen Uptake by Plants Is Limited by Transporters



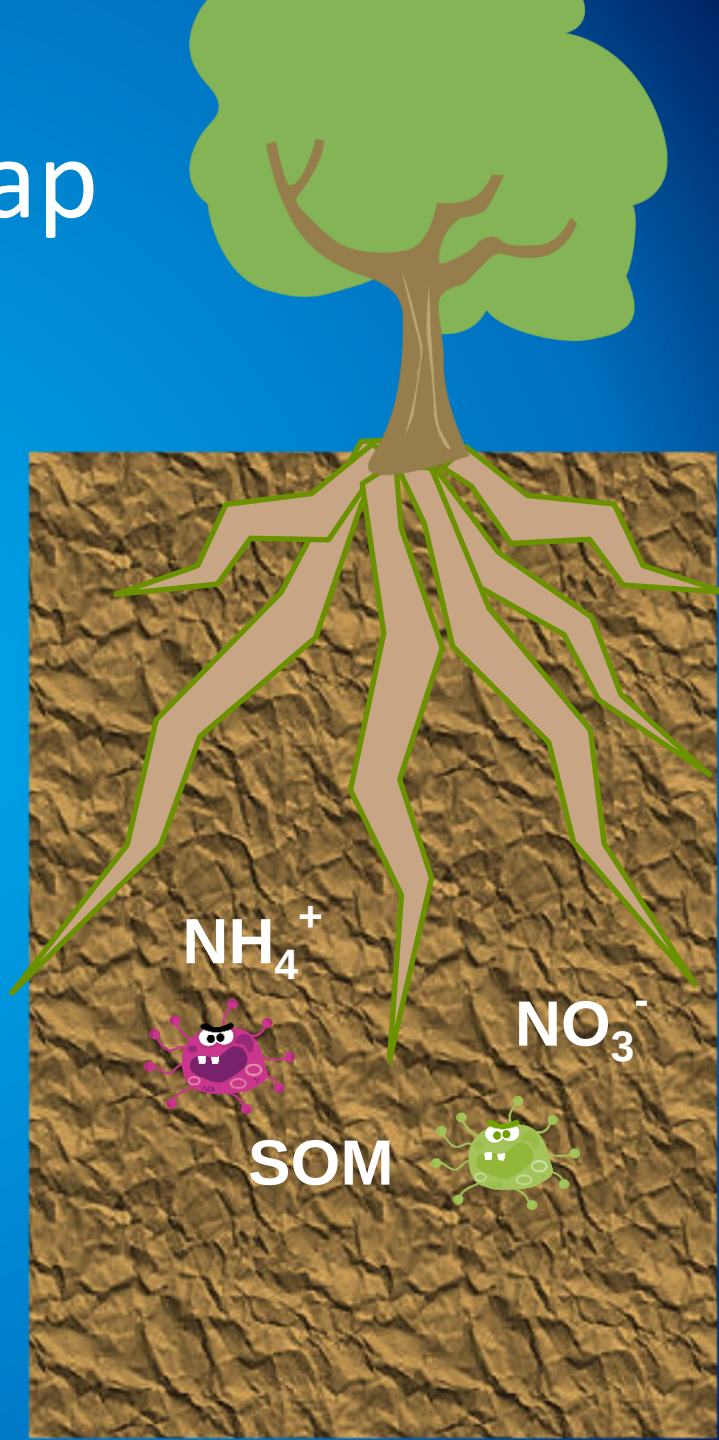


Nitrate concentration in a typical fertigation event

Marschner, P. (2012). Mineral Nutrition of Higher Plants. Academic Press. Waltham, MA, USA.

Nitrogen Dynamics Recap

- N in many forms in soil – SOM, ammonium, nitrate
  - SOM is N storage
  - N uptake: ammonium or nitrate
  - All N → Nitrate eventually
  - Nitrate doesn't stick in the soil
- N uptake is highly regulated. More N applied ≠ More N uptake, necessarily



Managing Nitrogen Efficiently

Take Aways

1) Demand depends on crop & yield

2) Demand is steady over growing season

3) Roots in top 2-3 feet

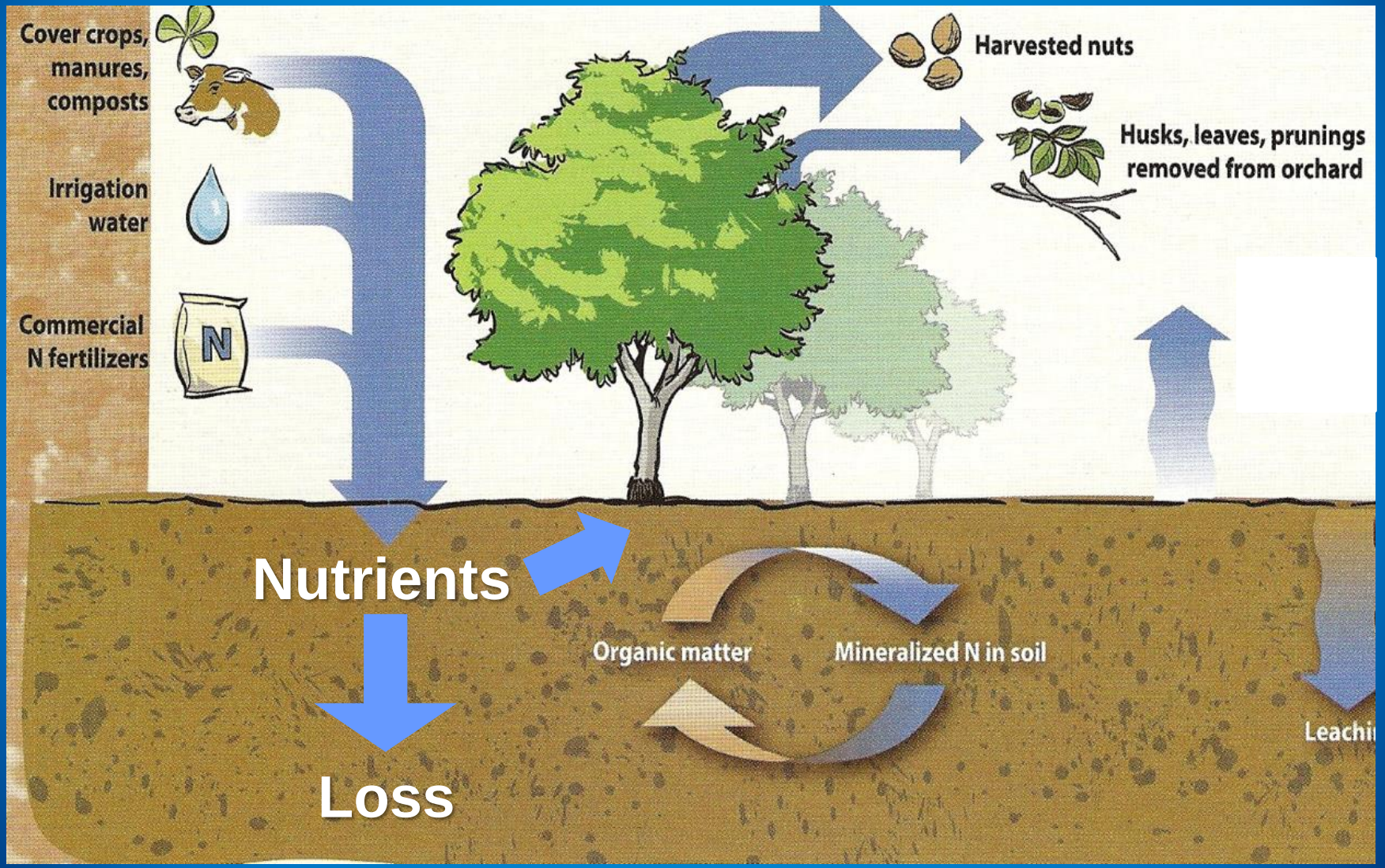
4 R's of N Management

- Apply the ***Right Rate***
- Apply at the ***Right Time***
- Apply in the ***Right Place***
- Using the **Right Source**

4 R's of N Management

- Apply the ***RIGHT RATE***
  - Match SUPPLY w/ tree DEMAND
    - *N uptake costs energy. Trees don't take up N if don't need.*
  - Fertilizer + Organic N + Water

Supply = Demand

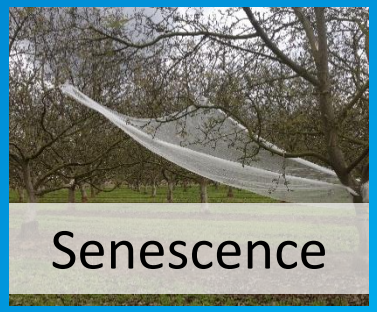


Kathy Kelley-Anderson et al: ANR Pub # 21623

How We Figure Out Rate

Almonds, Pistachios, Prune, Walnuts

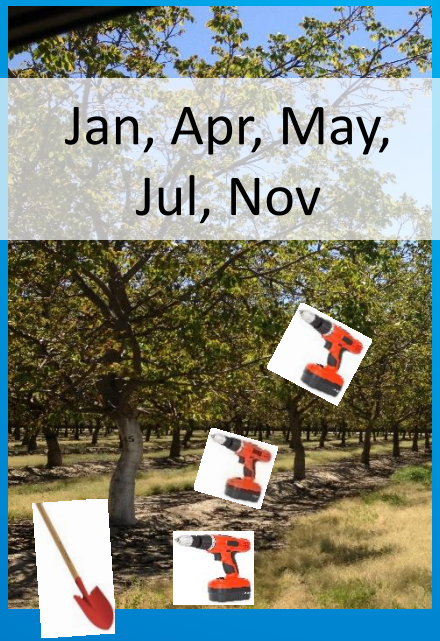
3 x Chandler, Tulare



Senescence

Apr– Nov

May – Sept/Oct



Jan, Apr, May,
Jul, Nov

10 trees / site

How We Figure Out Rate

Example: Walnut

N / ton of nuts (in-shell, 8% moist) and assoc. hulls.

Site	2013*	2014*
N Chandler	26 a	26 b
D Chandler	31 a	31 a
S Chandler	25 a	25 c
N Tulare	25 a	24 c
D Tulare	32 a	31 a
S Tulare	27 a	27 c
GRAND MEAN	27	

Meat & Shell: 25-32 lbs
Hulls: 0.5-2 lbs
Other Scraps: 0.5-2 lbs (?)
New Growth: 2-6 lbs**(?)

=

N / ton in-shell: 28-40 lbs

*Letters show dif's w/in cv.
** Based on Weinbaum's 0.13 lb N/tree, 50 trees/acre, 16 year old Hartleys

Nutrient Demand Rate by Crop

Species	N lbs / 1000 lbs Fruit	Source
Almond	68 (kernel wt)	Muhammad, Saa, Brown et al (2013)
Pome & Stone* Fruit	0.5-1	Apple: IFA, 1992;USDA,1963; Apple, Apricot, Peach, Pear, Plum: USDA, 1963; Peach: Maragoni and Rombola 1994; Pear: IFA, 1992
*Cherry	2-2.4	Huguet, 1980
Citrus	1.1-1.6	Rocuzzo, 2013; Krueger/Arpaia 2010
Grape	0.8-2	Coombe, 1992; Mullins, 1992
Pistachio	28 (CPC)	Siddiqui, 2014
Prunes	6 (dry)	Hidalgo, *In Press*
Olives	8	Angelo Rodrigues *et al.,* 2012
Walnut (In-shell)	14-20	Pope, 2014

Table compiled by Saa, Brown & Schellenberg, 2015

Demand for Growth Varies; Needs Much More Research.

Rough Estimate:

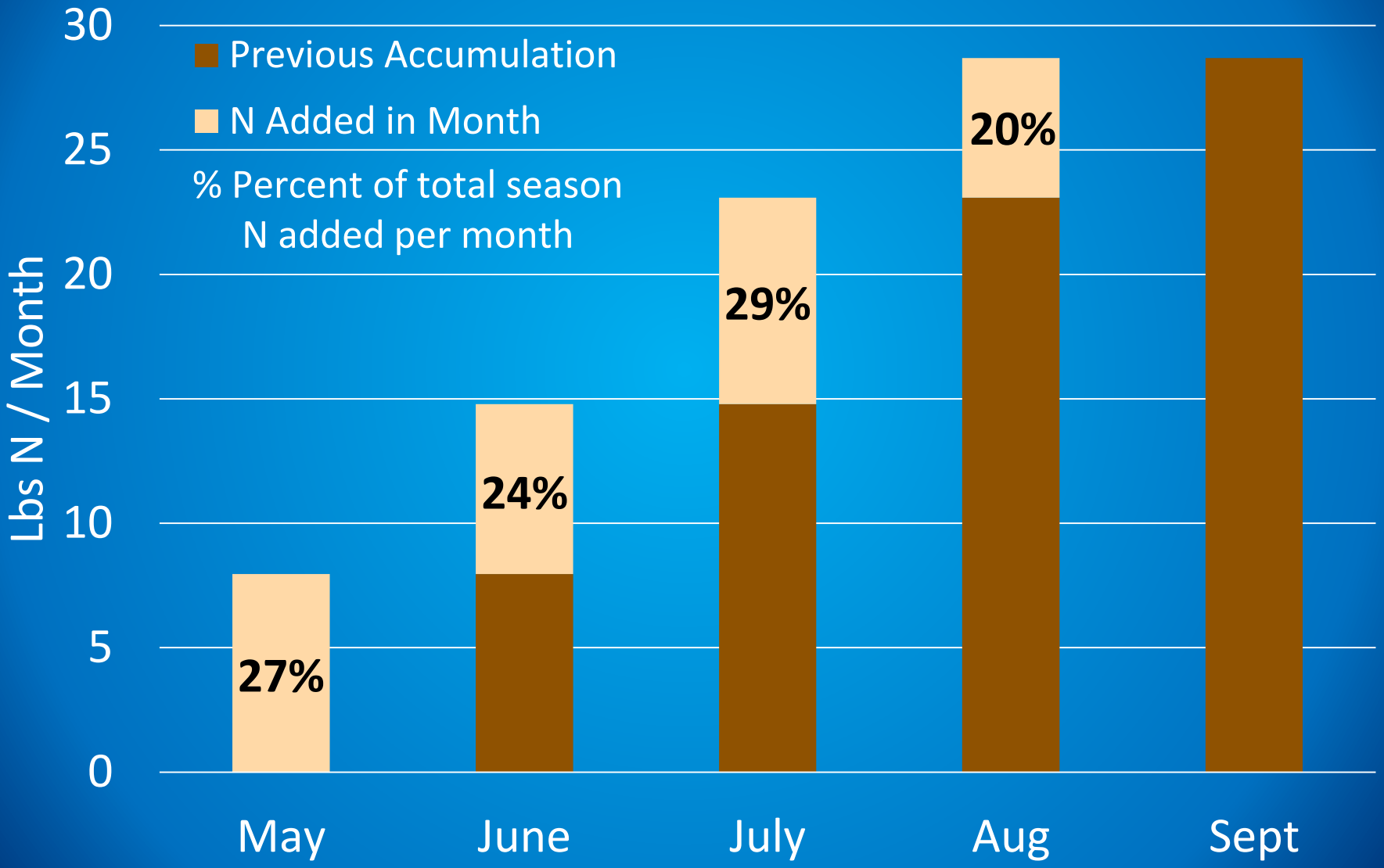
- 0-10 lbs/**ac** for established nut orchards
- Max 30 lbs/**ac** for frequently pruned stone fruit

4 R's of N Management

- Apply at the ***RIGHT TIME***
  - Match w/ timing of tree demand, root uptake
    - *Remember, limited number of transporters. Saturation → Leaching.*
  - Trees take up nutrients when needed, not when applied

How We Figure Out Right Time

Example: Walnut Monthly Fruit Nitrogen Added



Nutrient Demand Timing by Crop

Crop	N / 1,000 lbs	Feb-Mar	April	May	June	July	August/ early Sept
Almond	68	20%	30%		30%		20% Sept
Pistachio	28			30%	20%	30%	20%
Prune	6		30%	50%	20%		
Walnut	14-20			25%	25%	25%	25%

General Formula*:

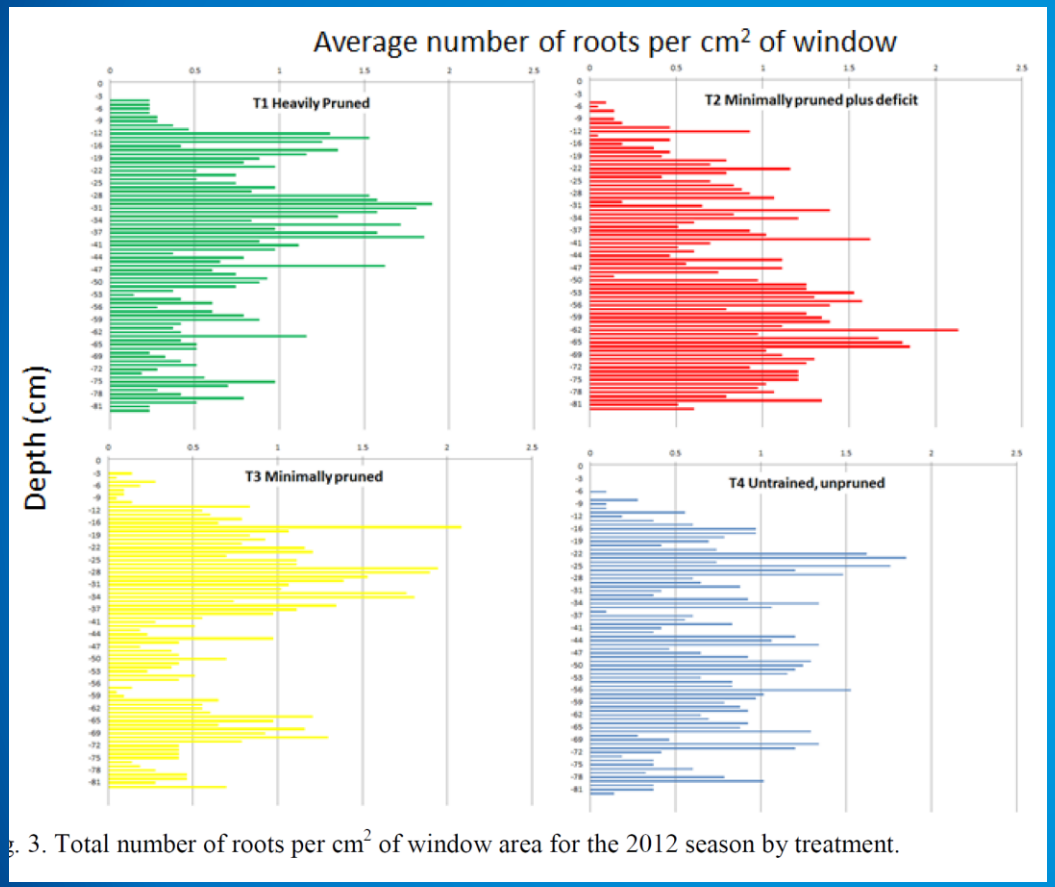
- No N application first month after bloom
- Divide rate over rest of growing season
- For early harvest, can add one post-harvest to refill reserves

*More research needed

4 R's of N Management

- Apply in the ***RIGHT PLACE***
  - Delivery to active roots
  - N moves w/ water
  - Minimize movement below root zone
    - *Remember, nitrate doesn't stick in the soil. Easily leached.*

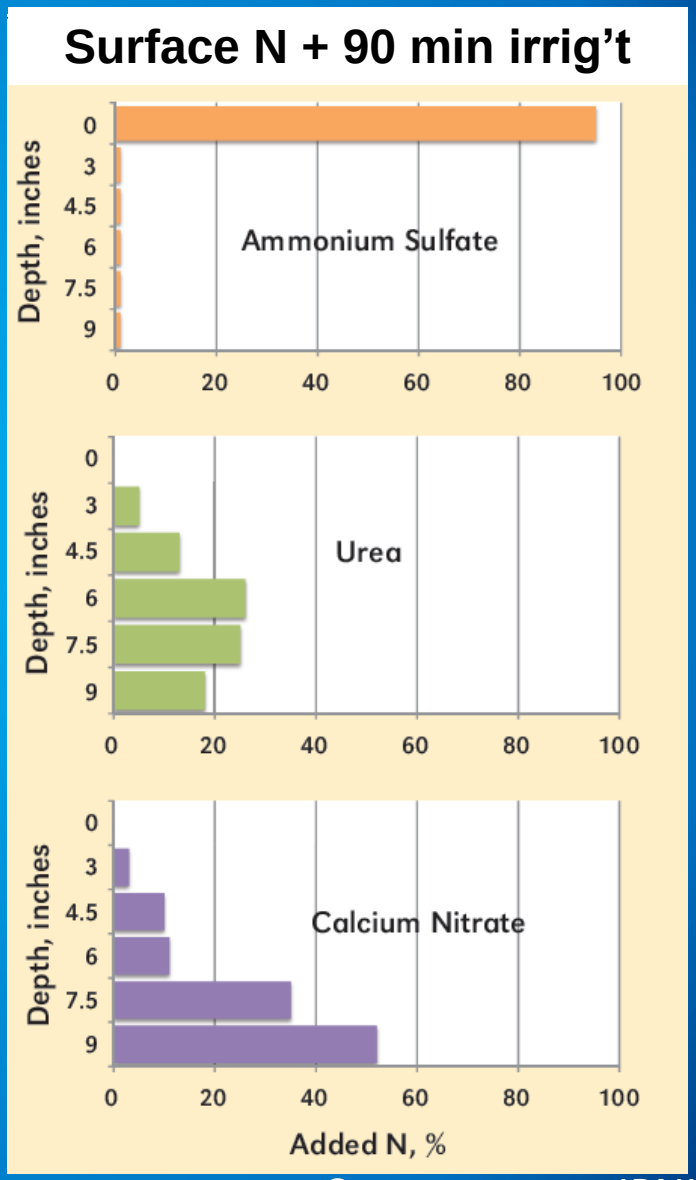
Roots in top 30”



g. 3. Total number of roots per cm² of window area for the 2012 season by treatment.

Walnuts, Lampinen et al

N moves 6-9” in 90 min



Courtesy www.IPNI.org

4 R's of N Management

- Using the ***RIGHT SOURCE***
  - –To the trees, Nitrogen is Nitrogen.
  - –Trees will happily take up ammonium or nitrate
  - –Difference = leaching potential, price, other soil considerations

4 R's of N Management

- Using the ***RIGHT SOURCE***

Fertilizer	Nitrogen (%)	Urea	Ammonium	Nitrate	Leaching Potential	Soil Acidifier	Comments
Ammonium Nitrate	34%		✓	✓	Medium	Medium	Nitrate N immediately available. Ammonium N half delayed.
Ammonium sulfate	21%		✓		Low	High	Source of sulfur
Calcium ammonium nitrate (CAN-17)	17%		✓	✓	Medium	Medium	
Calcium nitrate	16%			✓	High	No	Source of calcium
Urea	45%	✓		✓	Low	Low	
Urea Ammonium Nitrate (UN-32)	32%	✓	✓	✓	Medium	Medium	Nitrate N immediately available. Remainder of N delayed.

5th R – Leaf MonitoRing

- Monitor impact of changing practices
- Deficiencies decrease yield before visual leaf symtpoms
- Protocol:
  - Sample in July
  - 6-8 ft from ground, tree periphery
  - Area of interest, scattered

4 R's of N Management

- Apply the ***Right Rate***
  - ***Depends on Yield, Crop***
- Apply at the ***Right Time***
  - ***Steady May-Aug***
- Apply in the ***Right Place***
  - ***Irrigate to keep N in root zone***
- Using the **Right Source**

SUMMARY

- N is dynamic, but can all → Nitrate
- N entry points easily overloaded → Leaching
- Match application with Demand Rate & Timing
- Irrigate to keep N in rootzone (top 3’)