Nutrient Management in Walnuts

Katherine Pope
UCCE Sacramento, Solano & Yolo Counties
Sac-Solano-Yolo Walnut Day
Feb 23rd, 2016

Nitrogen Management Overview

- Why is nitrogen important
- Nitrogen in soil, plant uptake
- Science → Management
- Touch on Potassium

Walnut Nutrient Management Take Aways

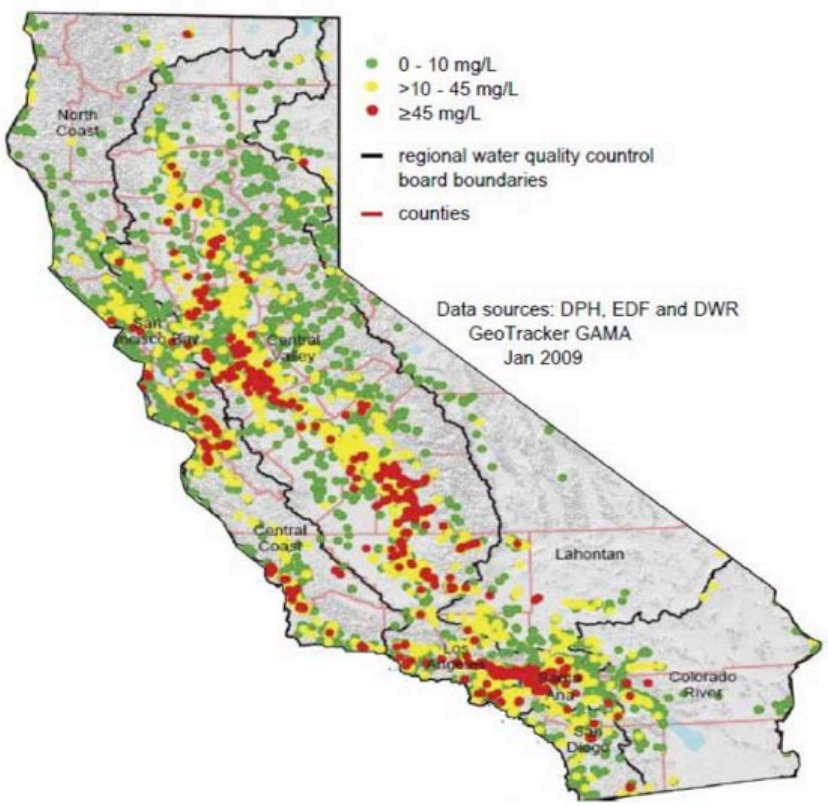
1) Minimum 29 lbs N / ton in-shell
2) Divide N evenly over growing season
3) Roots in top 2-3 feet
4) Check your leaf potassium, or let me. K < 1.5% is deficient.

Why N is Important to Plants

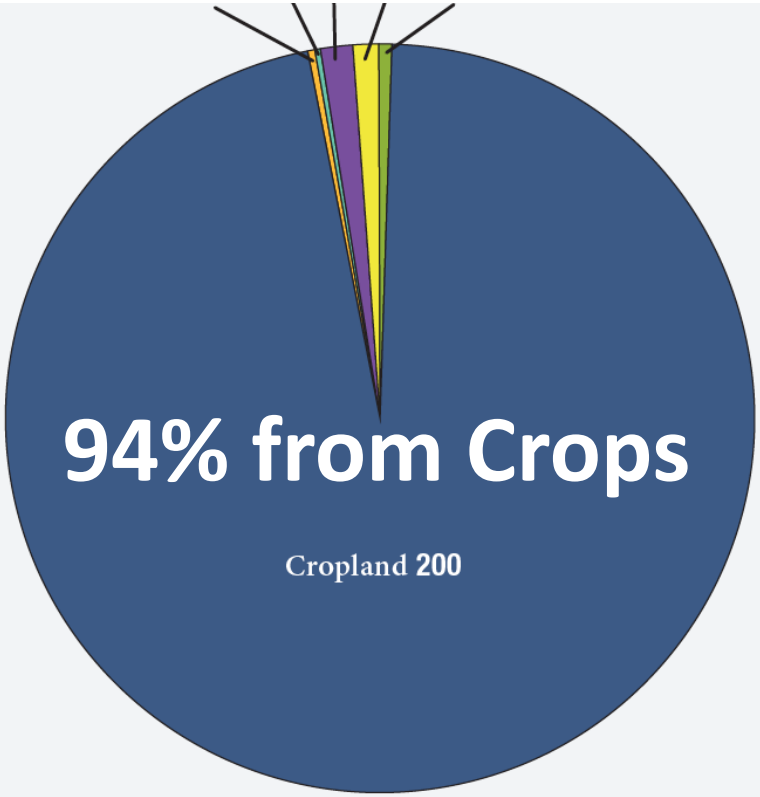
- Most Used Mineral
  - 80% → Proteins
  - Also amino acids, DNA, hormones, chlorophyll, defense compounds

Why N is Important to People

30+% of wells over EPA limits



Ag → 94% groundwater N



Images: Harter et al, 2012

*To know **When** and **How** N is available to tree roots, need to understand*

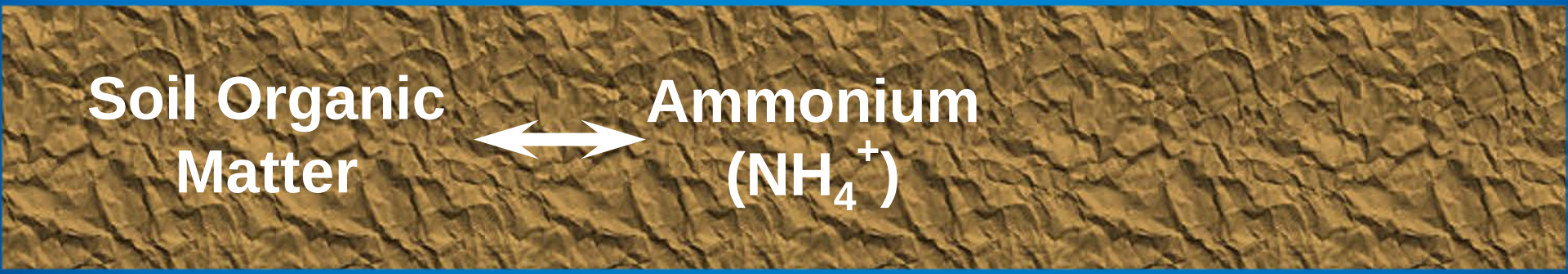
*The **Different Forms** of N &*

***How N is Taken Up** by the Plant*

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
Nutrient storage vault	Positively charged – can stick to the soil	Negatively charged – will not stick to the soil → can easily LEACH

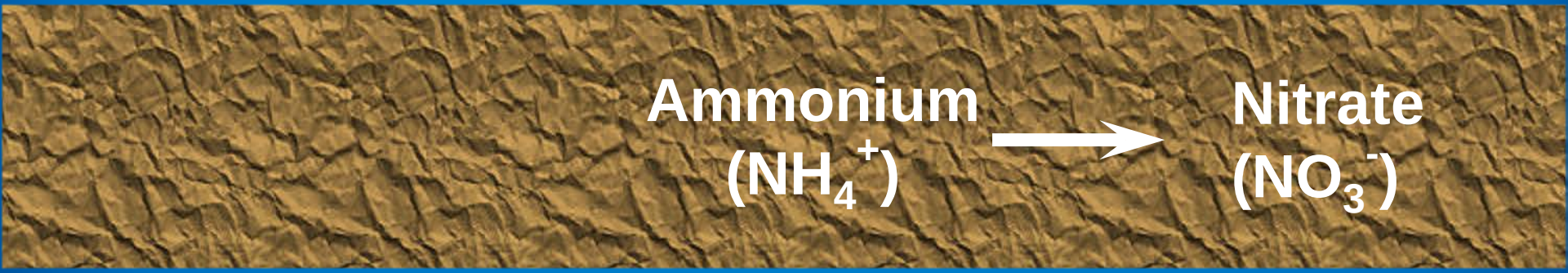
The Nitrogen Cycle in the Soil



- CA soils, SOM → Ammonium: Weeks-Months
- Amendment <2% N → N into SOM

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

The Nitrogen Cycle in the Soil



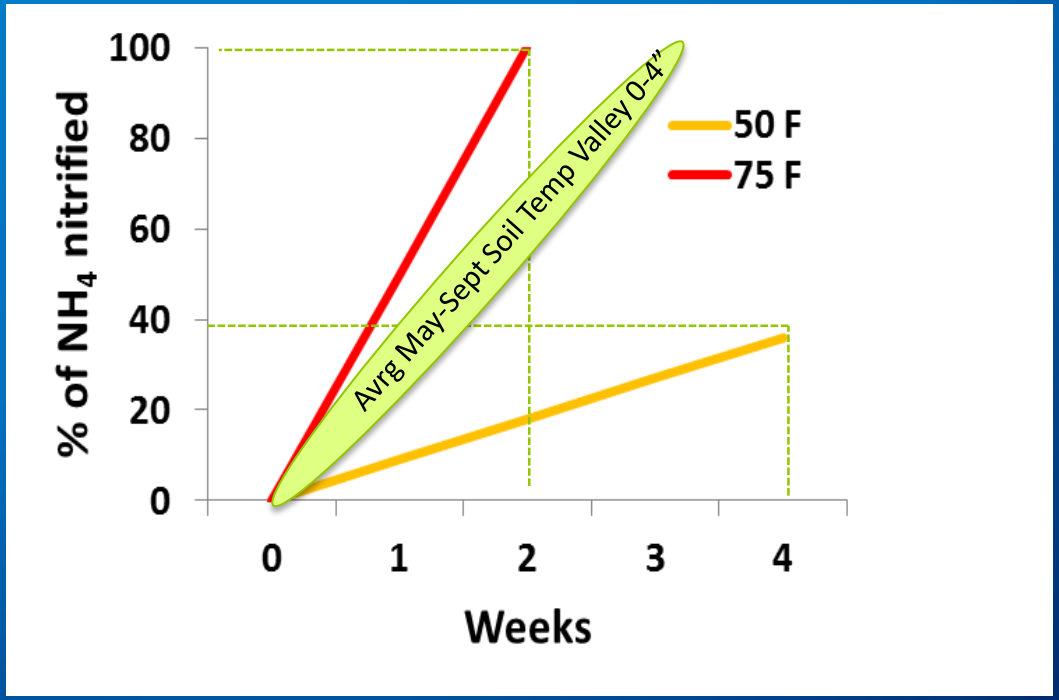
Nitrification →

- Rate depends on temperature
- Ammonium → Nitrate: Days-Weeks
- *CA soils, most N eventually turns to nitrate*

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

The Nitrogen Cycle in the Soil

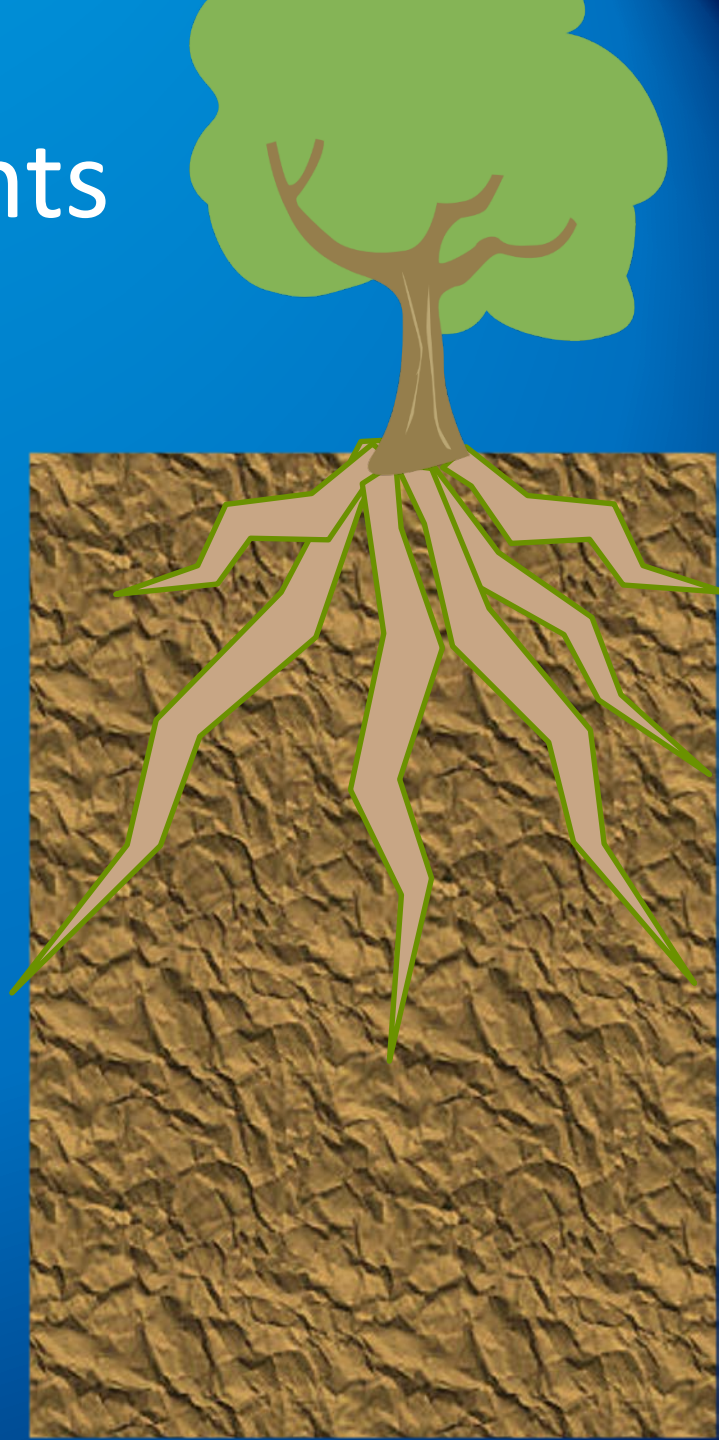
Soil Organic Matter ⟷ **Ammonium (NH_4^+)** ⟷ **Nitrate (NO_3^-)**



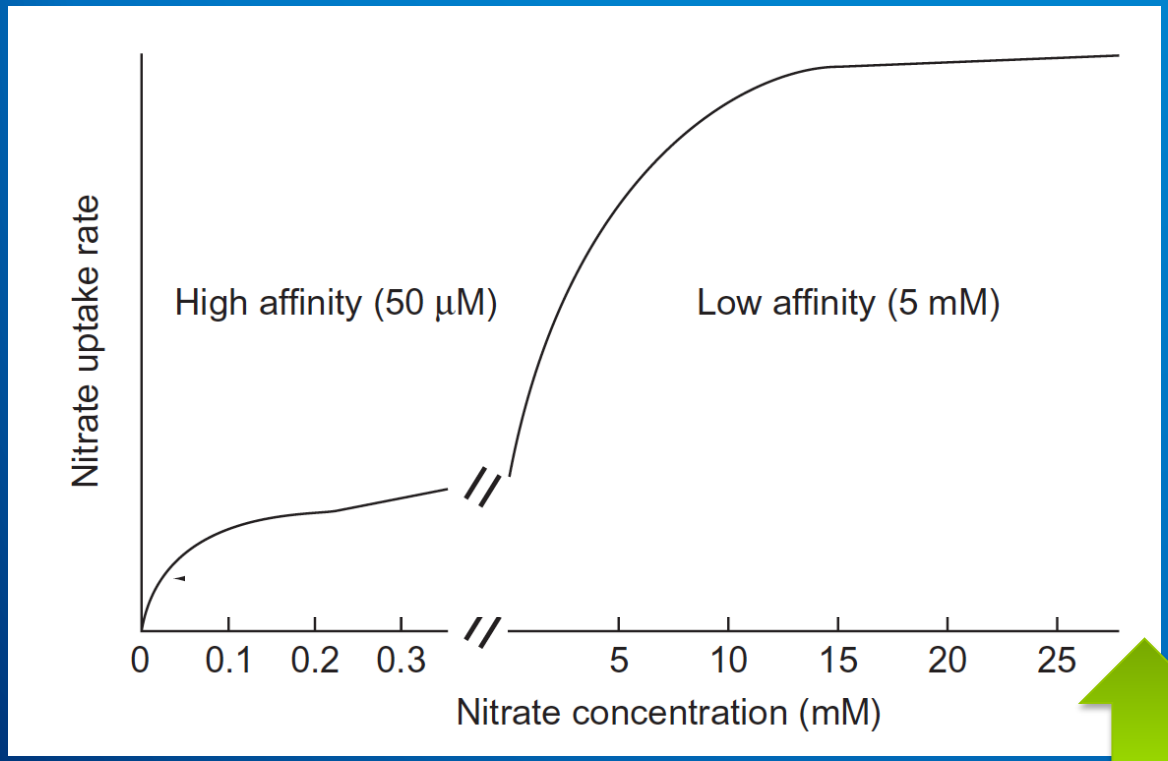
Elements of the Nature and Properties of Soils, 3/e by N. Brady and R. Well

Nitrogen Uptake by Plants

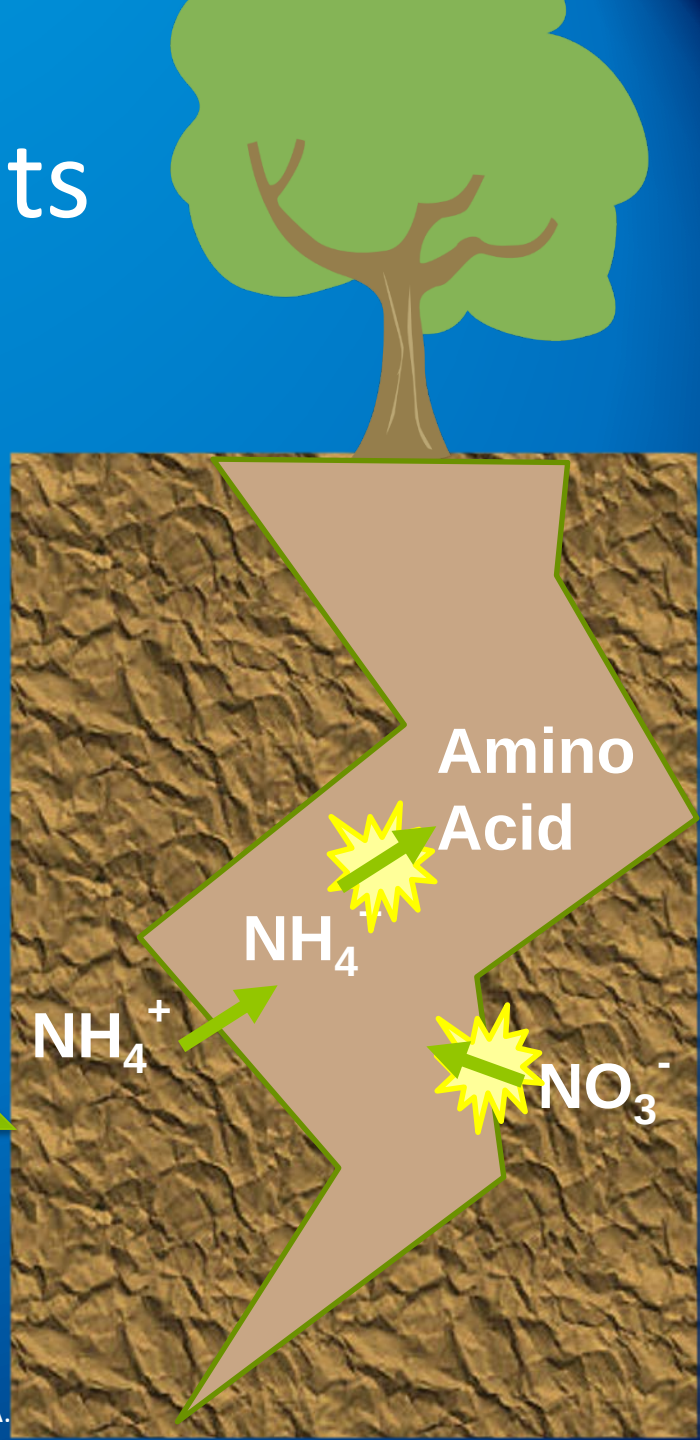
- Most Important to Know:
  - Nutrients move in soil solution – no water, no uptake
  - N is taken up as ammonium or nitrate
  - N goes through transporters to get into roots – *This limits uptake*.



Nitrogen Uptake by Plants



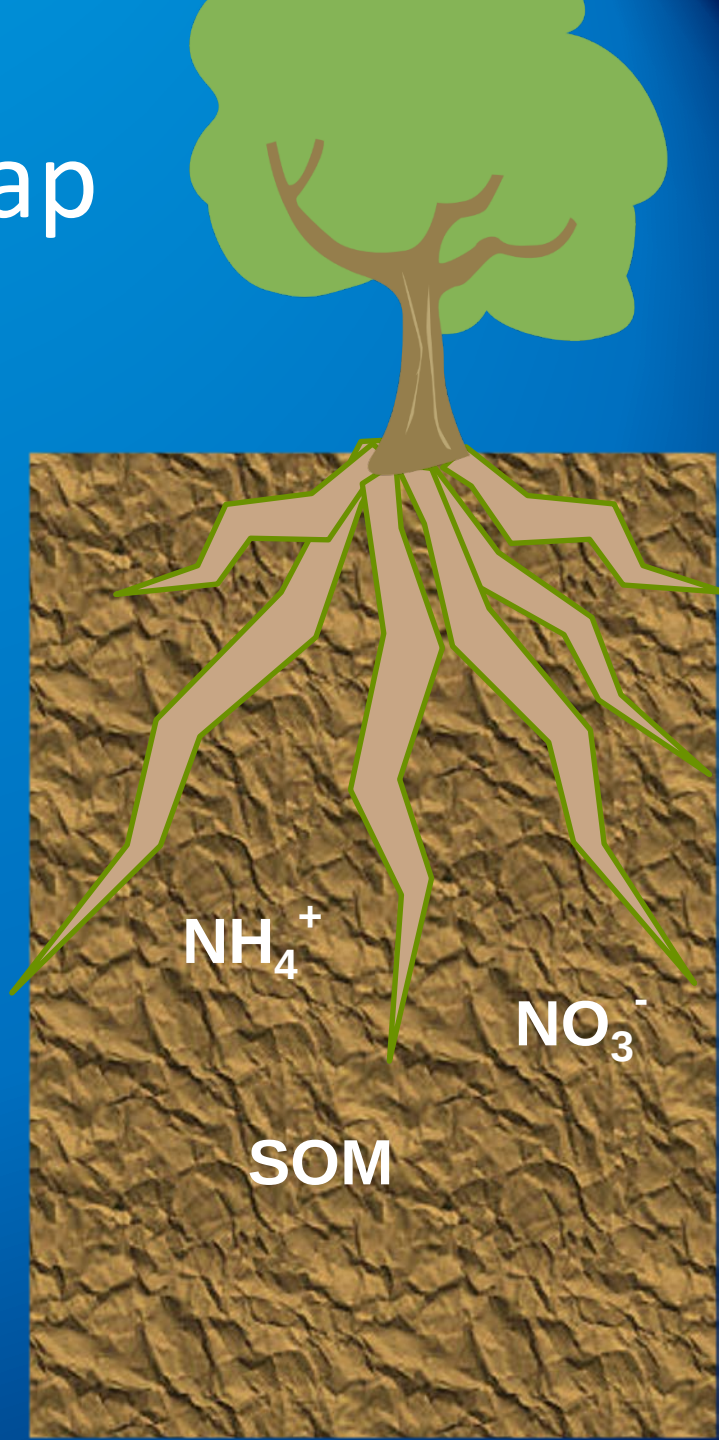
Nitrate concentration in a typical fertigation event



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 taken up as ammonium or nitrate.
  - Nitrate doesn't stick in the soil
- N must got through transporters. More N applied ≠ More N uptake



4 R's of N Management

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

N Management in General

- Apply the ***Right Rate***
  - Don't overload transporters
- Apply at the ***Right Time***
  - Don't overload transporters
- Apply in the ***Right Place***
  - Keep it where roots can get it
- Using the ***Right Source***
  - Keep it where roots can get it

N Management in Walnuts

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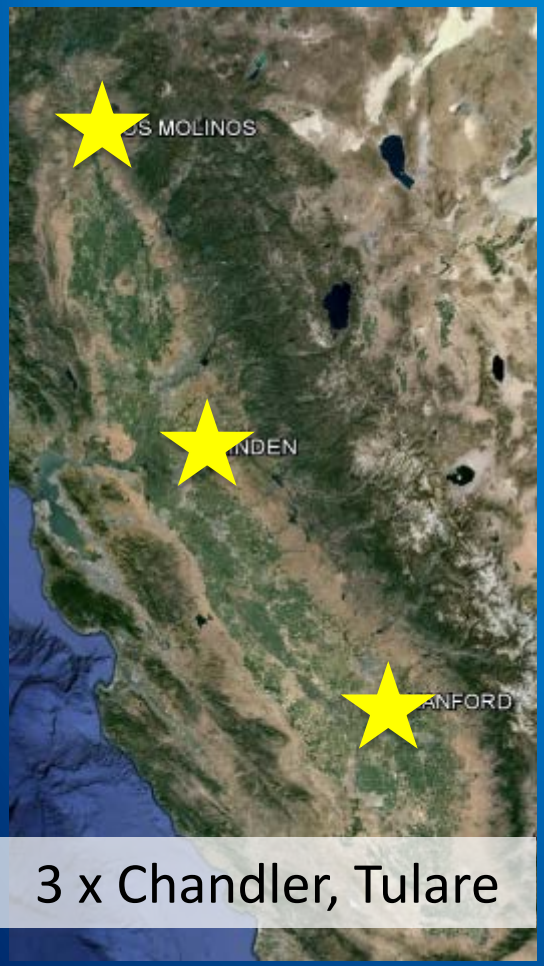
- Using the ***Right Source***
  -

Methods – NPK Demand Model



3 x Chandler, Tulare

Senescence

Apr– Nov

May – Sept/Oct

Jan, Apr, May, Jul, Nov

10 trees / site

Right Rate

N / ton of nuts (in-shell, 8% moist)

Site	2013	2014
N Chandler	26 a	25 b
D Chandler	31 a	31 a
S Chandler	25 a	25 c
N Tulare	25 a	24 c
D Tulare	32 a	33 a
S Tulare	27 a	28 c
GRAND MEAN	**27**	

Meat & Shell: 24-33 lbs

Hulls: 0.5-2 lbs

Other Scraps: 0.5-2 lbs (???)

New Growth: 4-8 lbs**(???)

=

29-45 lbs N / ton in-shell

*Letters show dif's w/in cv.

** Based on Weinbaum's 0.13 lb N/tree, 50 trees/acre, 16 year old Hartleys

N Management in Walnuts

- Apply the ***RIGHT RATE***
  - ***Minimum 29 lbs/ton***
- Apply at the ***RIGHT TIME***
  -
- Apply in the ***RIGHT PLACE***
  -
- Using the ***RIGHT SOURCE***
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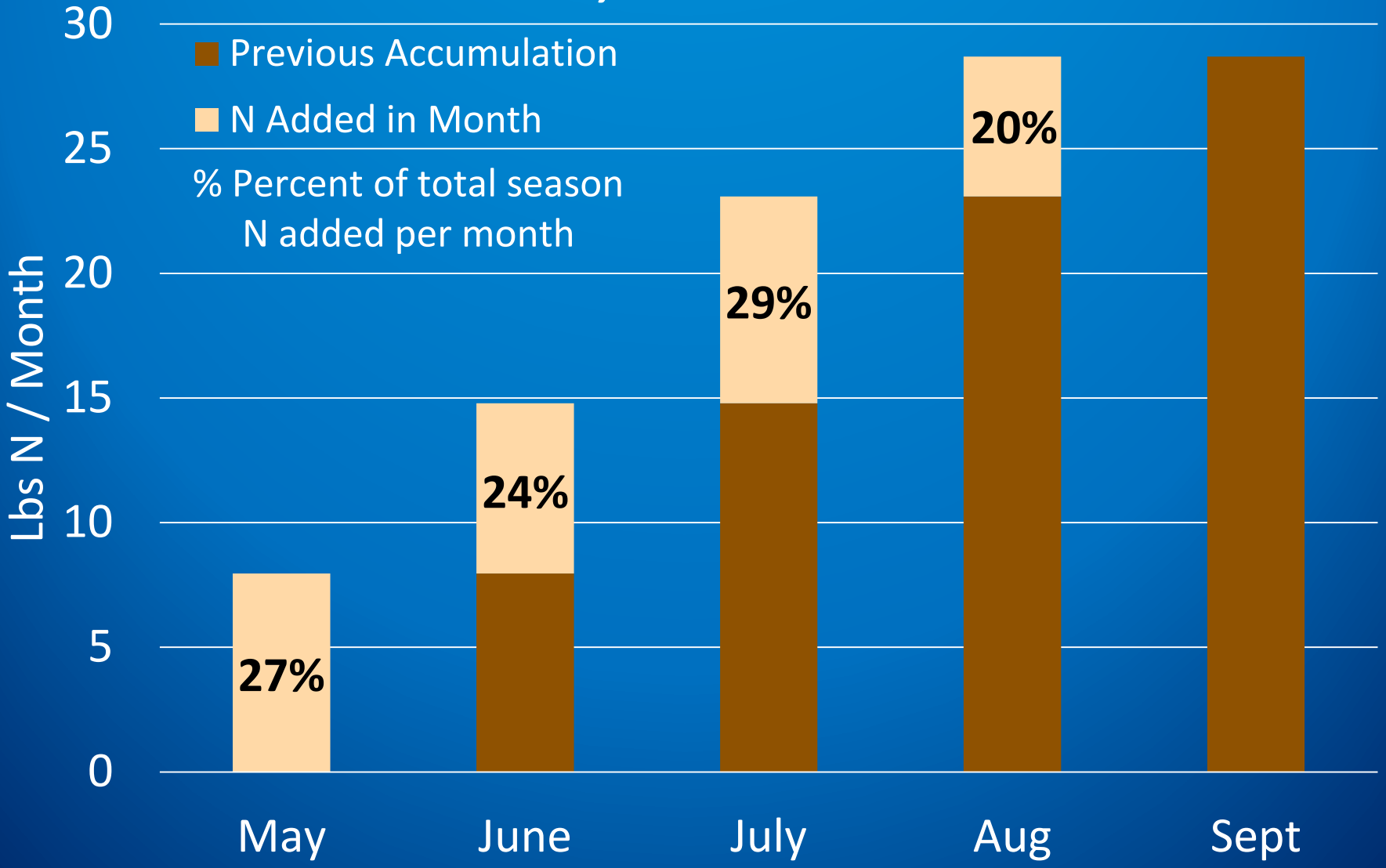
Nitrogen Added per Month 2013 & 2014, Chandler & Tulare



N Management in Walnuts

- Apply the ***RIGHT RATE***
  - ***Minimum 29 lbs/ton***
- Apply at the ***RIGHT TIME***
  - ***Even split May-Aug***
- Apply in the ***RIGHT PLACE***
  -
- Using the ***RIGHT SOURCE***
  -

Roots in Top 3 Feet

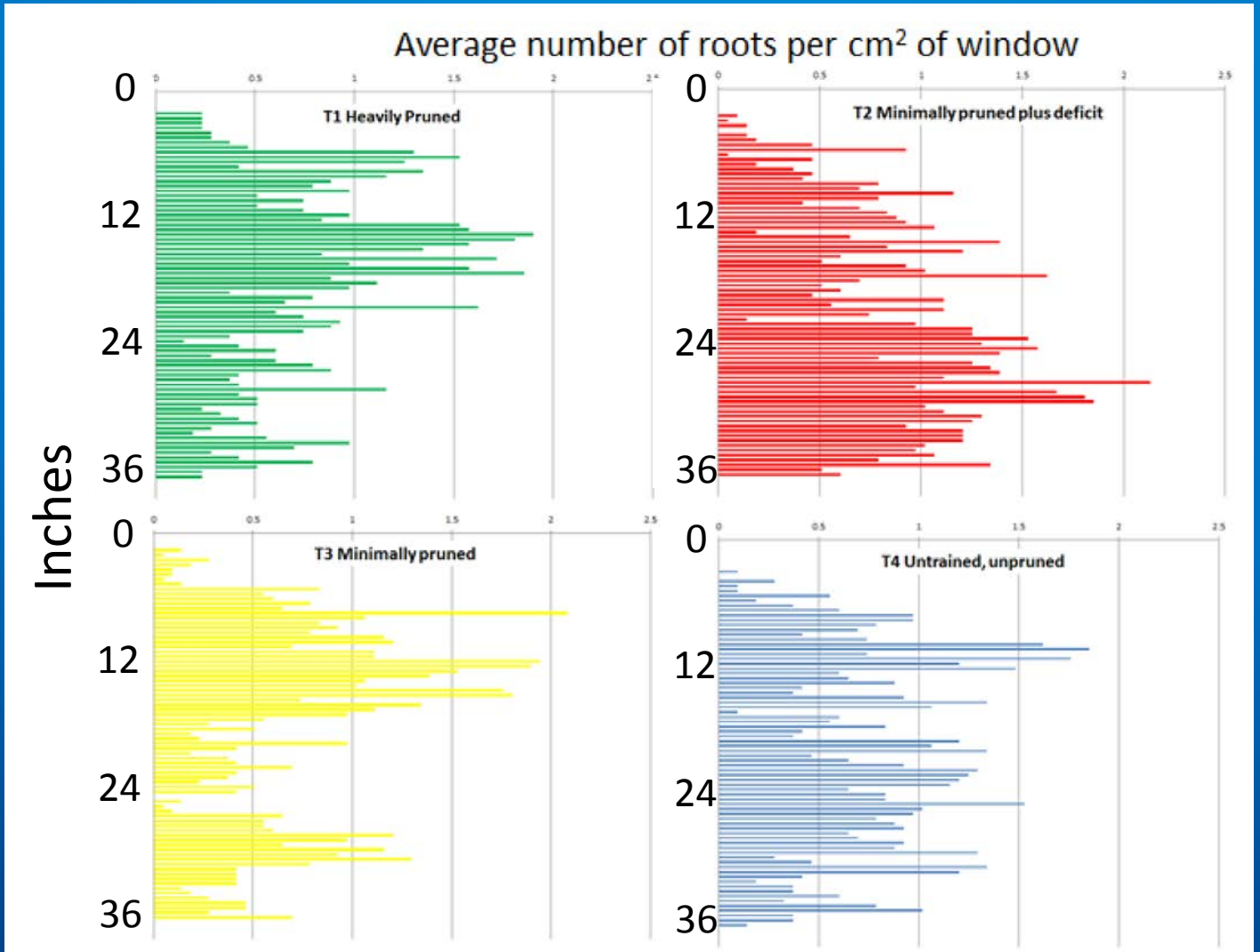


Fig. 3. Total number of roots per cm^2 of window area for the 2012 season by treatment.

Lampinen et al

N Management in Walnuts

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  - ***Minimum 29 lbs/ton***
- Apply at the ***RIGHT TIME***
  - ***Even split May-Aug***
- Apply in the ***RIGHT PLACE***
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N Management in Walnuts

- Apply the ***RIGHT RATE***
  - ***Minimum 29 lbs/ton***
- Apply at the ***RIGHT TIME***
  - ***Even split May-Aug***
- Apply in the ***RIGHT PLACE***
  - ***Roots in top 3 feet***
- Using the ***RIGHT SOURCE***
  - ***Most becomes Nitrate with time.***

Stay Tuned…

- Working on last year of N Budget data
- Leaf sampling – How many, how far apart
- May leaf sample to predict July N status

Potassium Management Overview

- Why is potassium important
- Potassium in soil
- How to manage potassium efficiently

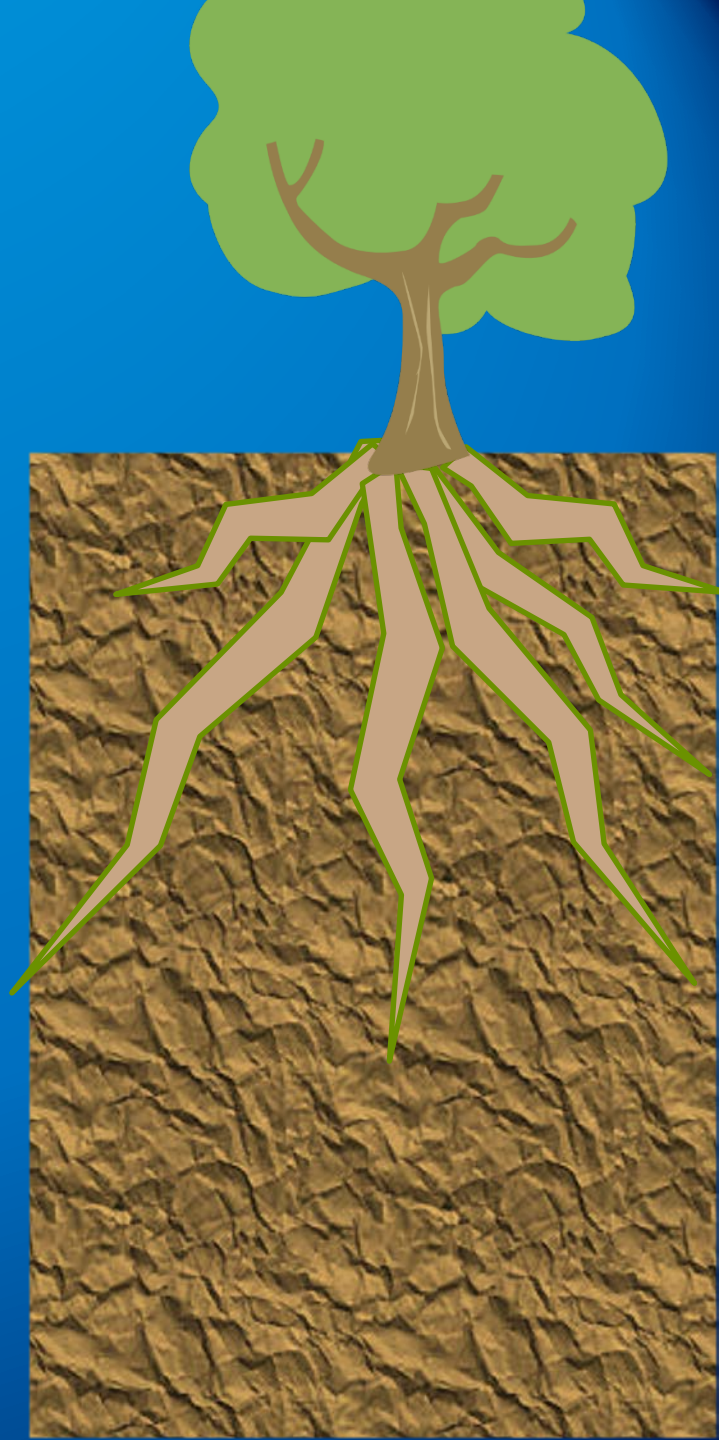
- Take-Aways:
  - Potassium sticks to the soil, so should band it
  - Potassium is important for water stress, canopy fill
  - Hulls use lots of potassium

Why K is important to plants

- 2nd most abundant mineral element (1-3% Dwt)
  - Signals stomata to open & close
  - Allows cells to expand
- Deficiency: cupping or curling of older leaves; bronze or gray at curled edges
- In prunes, low K → weak canopy fill → sunburn. Maybe same is true with walnuts? Could → Bot vulnerability. Need more research.

Potassium in the Soil

- Potassium → K+
- + ions stick to – clay particles
- Doesn't stick much to sandy & gravelly soils
- Banding overloads K+ attachment sites

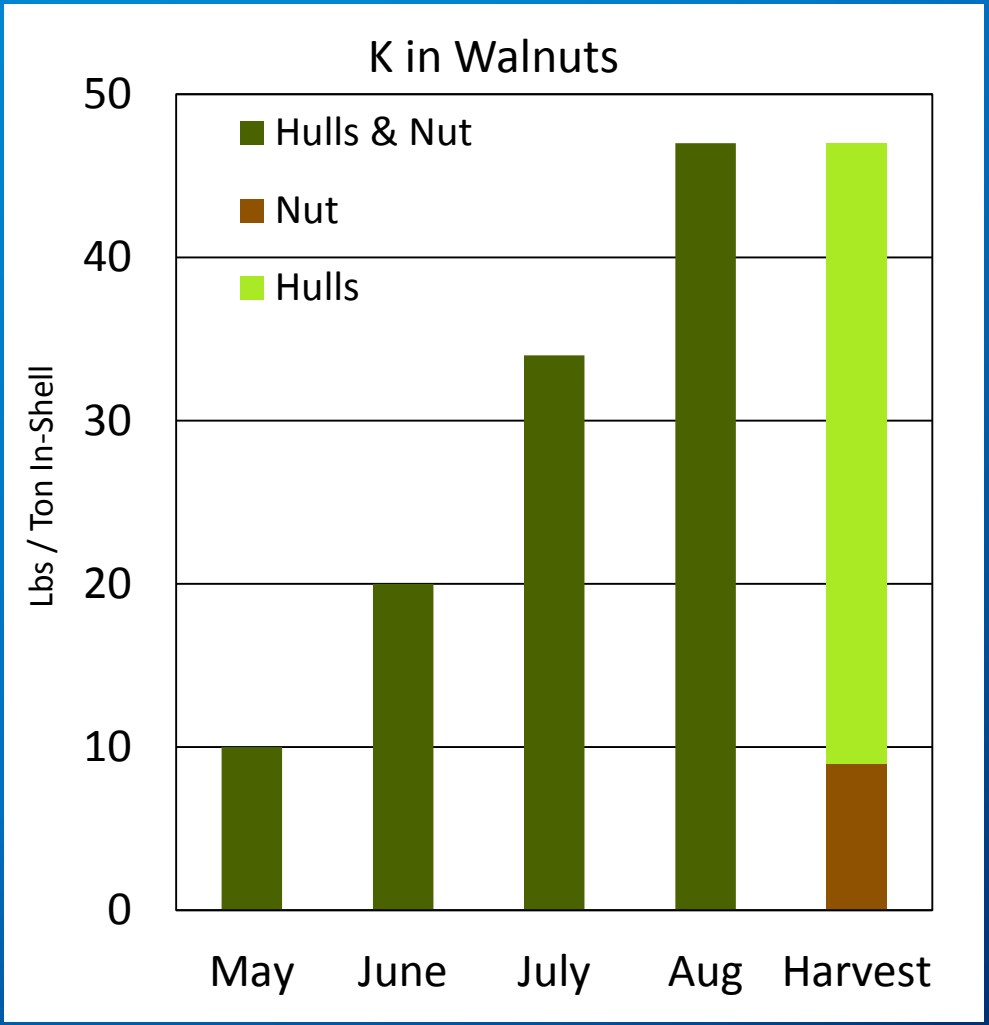


How to Manage K Efficiently

- How much do walnuts use?
- How to recognize deficiency?
- How to replace K as it is used?

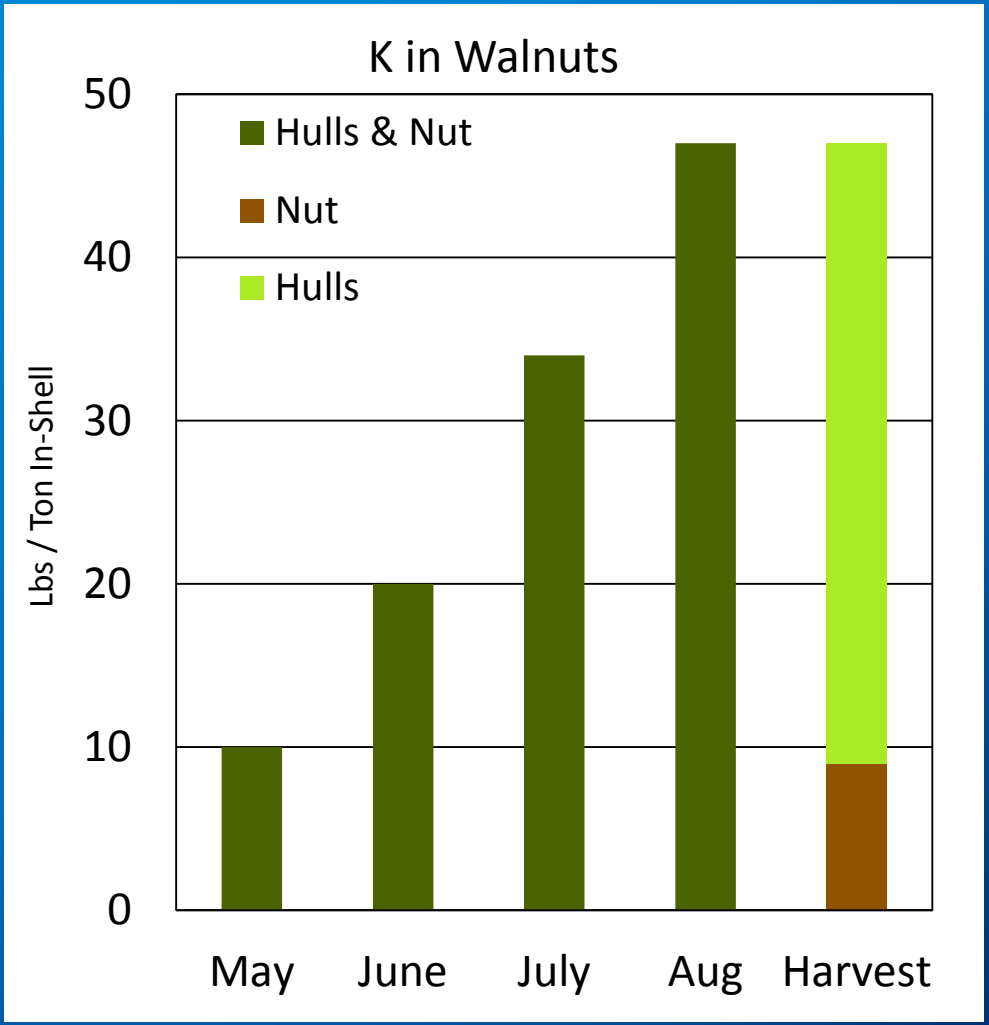
How Much K Do Walnuts Use?

- Vast majority of K is used in HULLS
- ~40 lbs K / ton in hulls
- ~10 lbs K / ton in meat+shell



How Much K Do Walnuts Use?

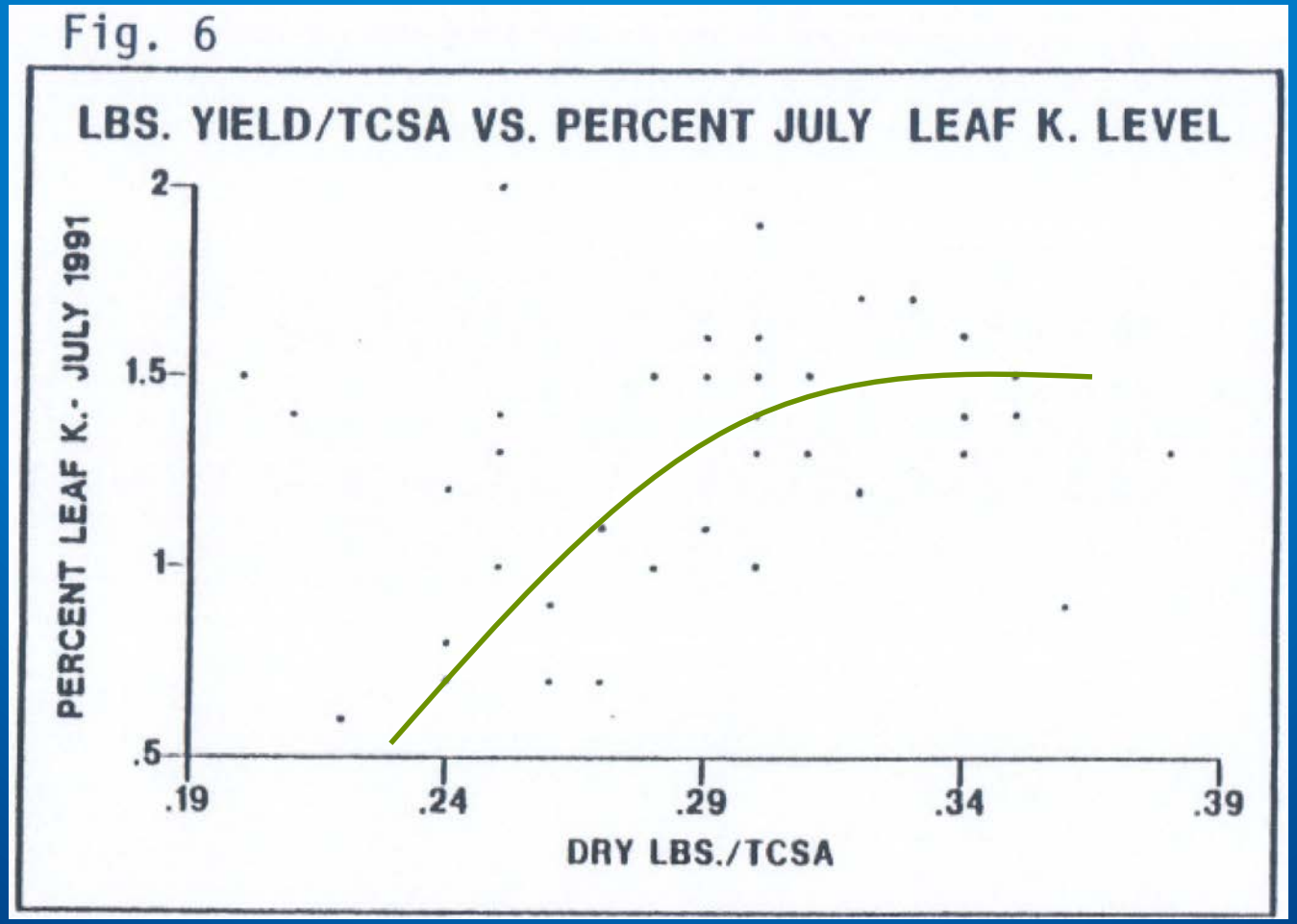
- Green years → more K removed from orchard
- But good hull split year, K stays the orchard for later use, right?
  - Hulls left in field are spread or windrowed in middle.
  - Effect = Broadcasting hull K *or* Banding far from most roots.



Extreme Potassium Deficiency

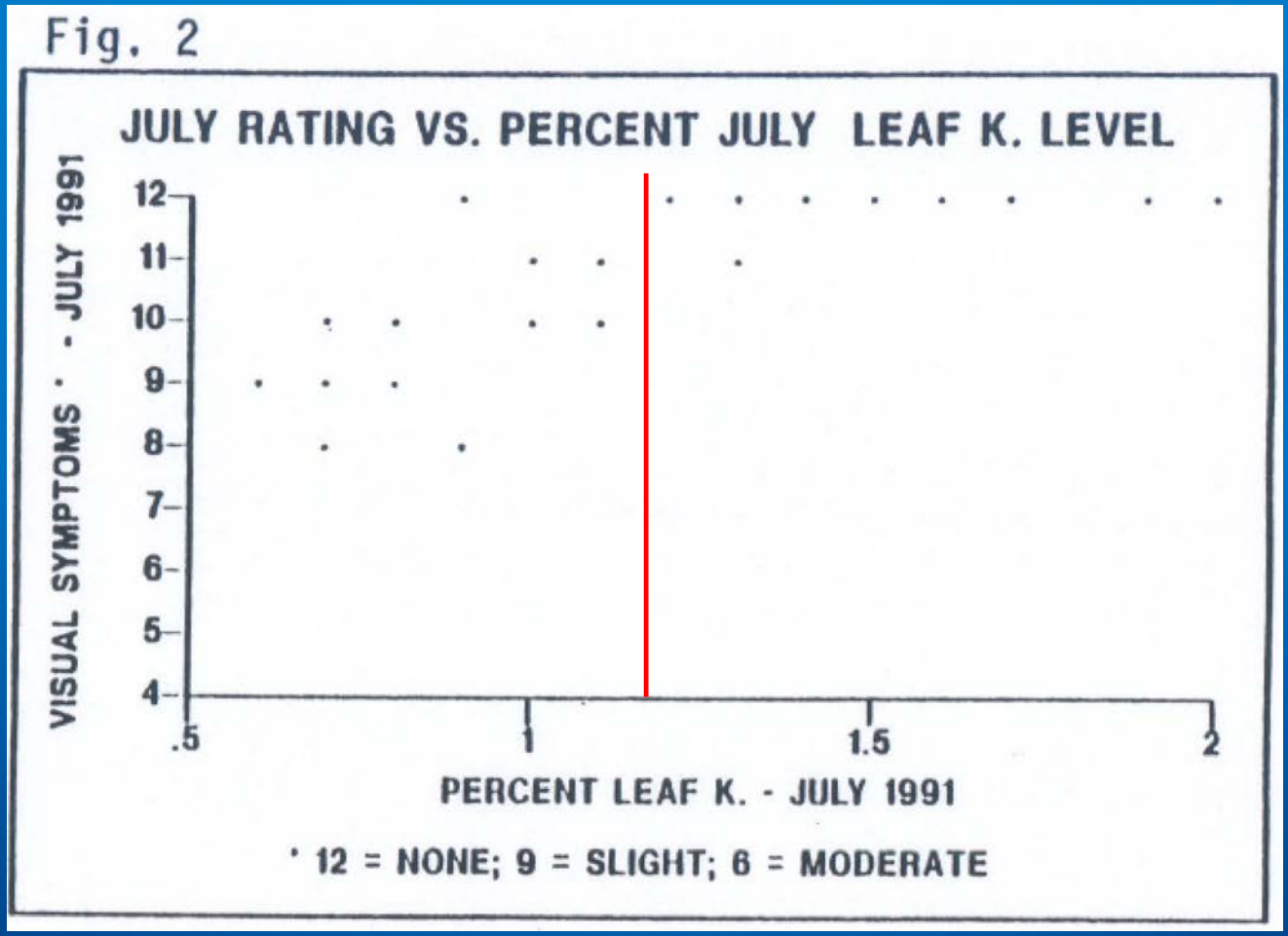
- Less extreme deficiency → less severe symptoms.
- Cupped, not rolled. Bronze, not silver.
- But, by the time you see symptoms, yield is already suffering

Increased leaf K increased yield until 1.5%



Olson 1991

Leaf symptoms of low K don't show until ~1.2%



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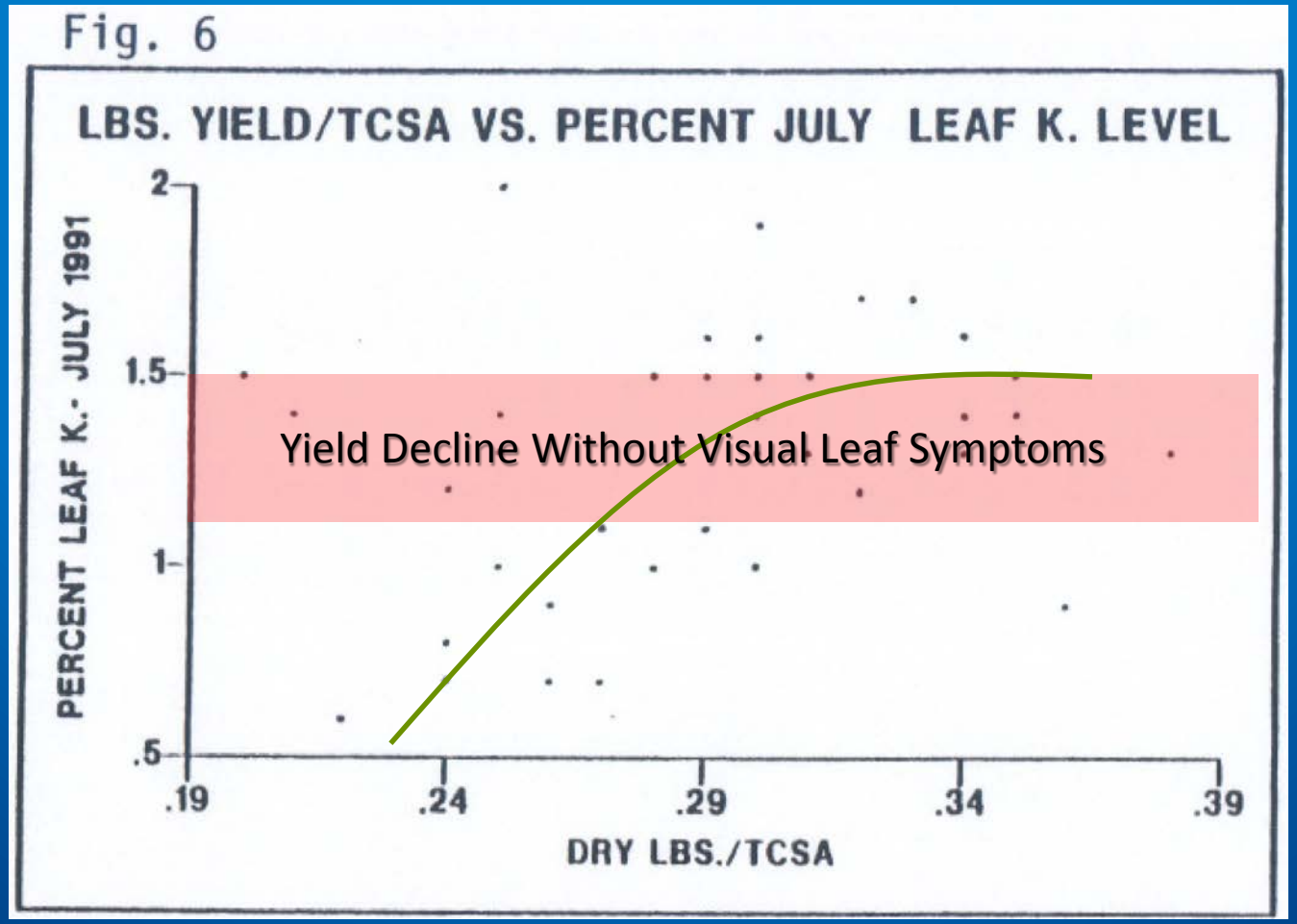

Olson 1991

Walnut Nutrient Management Take Aways

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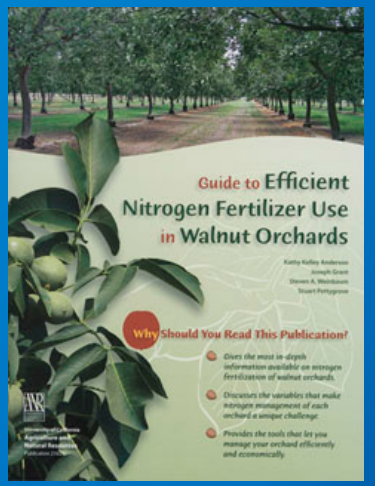
2) Divide N evenly over growing season
3) Roots in top 3 feet
4) Check your leaf potassium, or let me. K < 1.5% is deficient.

Resources

- Guide to Efficient Nitrogen Fertilizer Use in Walnut Orchards, ANR 21623
- kspope@ucanr.edu
- More to come…



Contributors

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- Patrick Brown, Ted DeJong, Sebastian Saa, Andres Olivos, Kathy Kelley, Joe Grant, Janine Hasey