



Nutrient Management in Subtropical Tree Crops

The avocado model

Avocado Fertilization



<u>Tissue</u>	<u>%Dry Wt</u>
New shoots	36
Leaves	40
Fruit	33
Small branches < 1 in	38
Small branches 1-2 in	55
Scion trunk	48
Rootstock trunk	41
Scaffolding roots	37
Small roots	35
New roots	4.6

Figure 1.

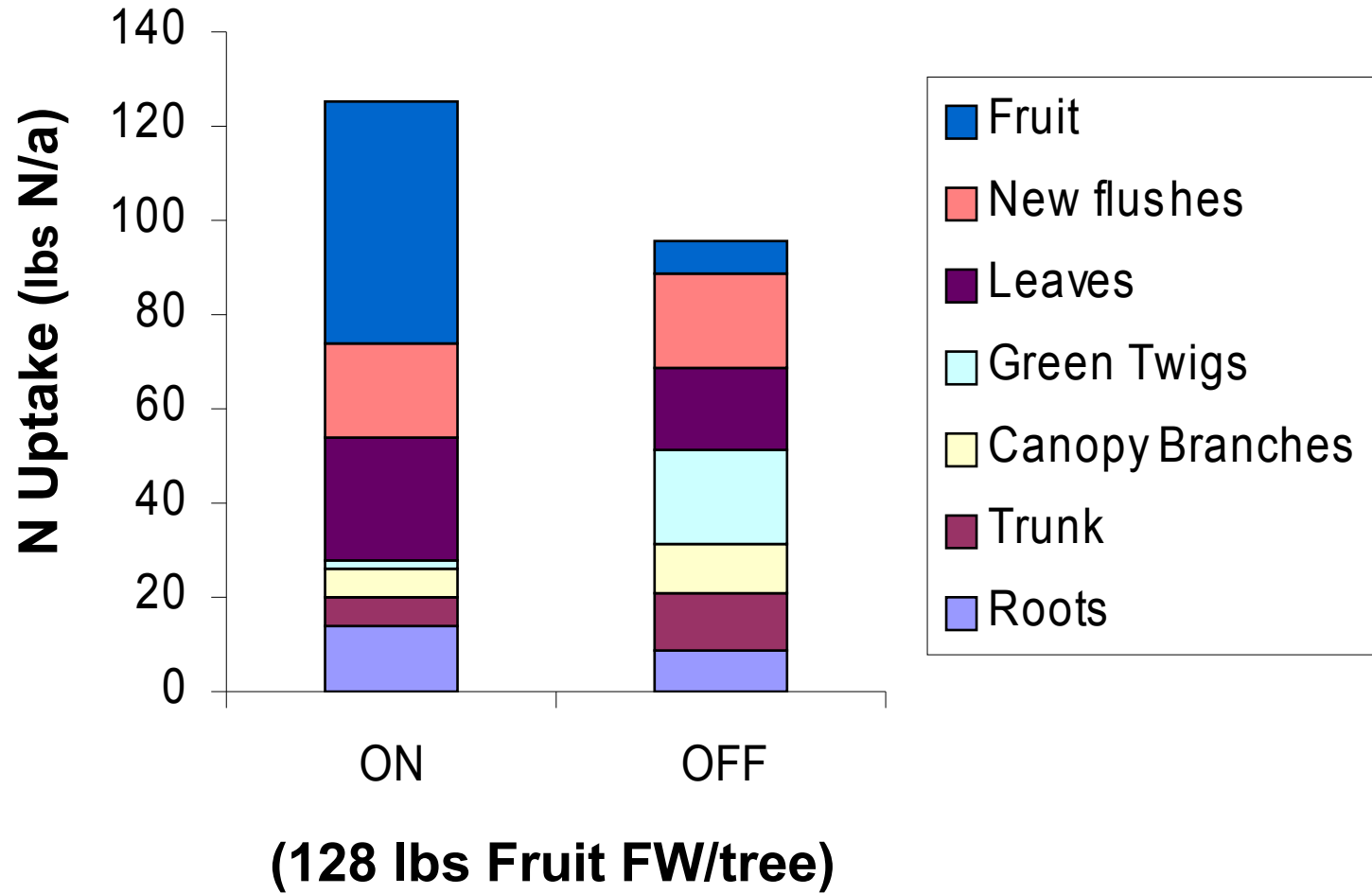


Figure 3.

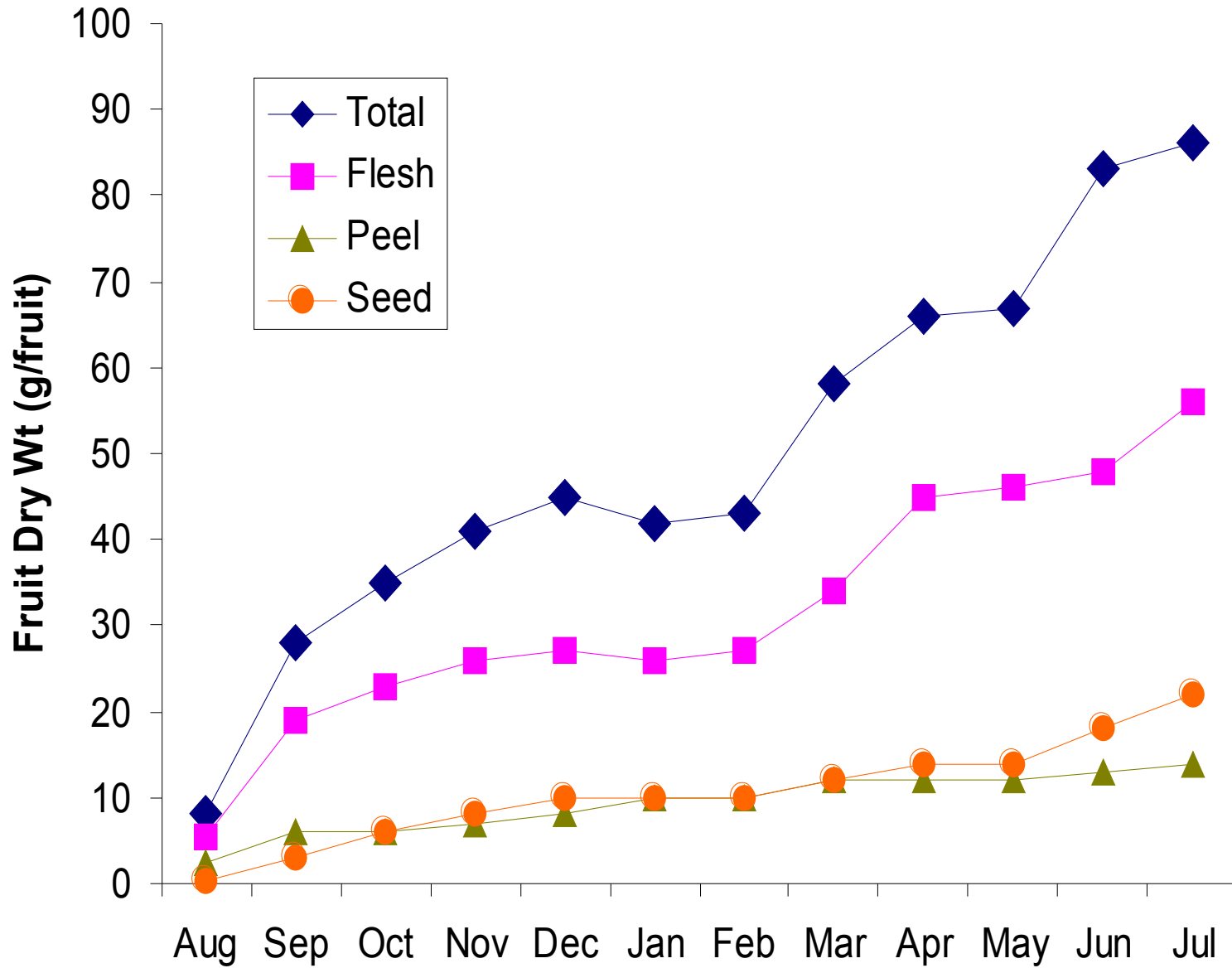
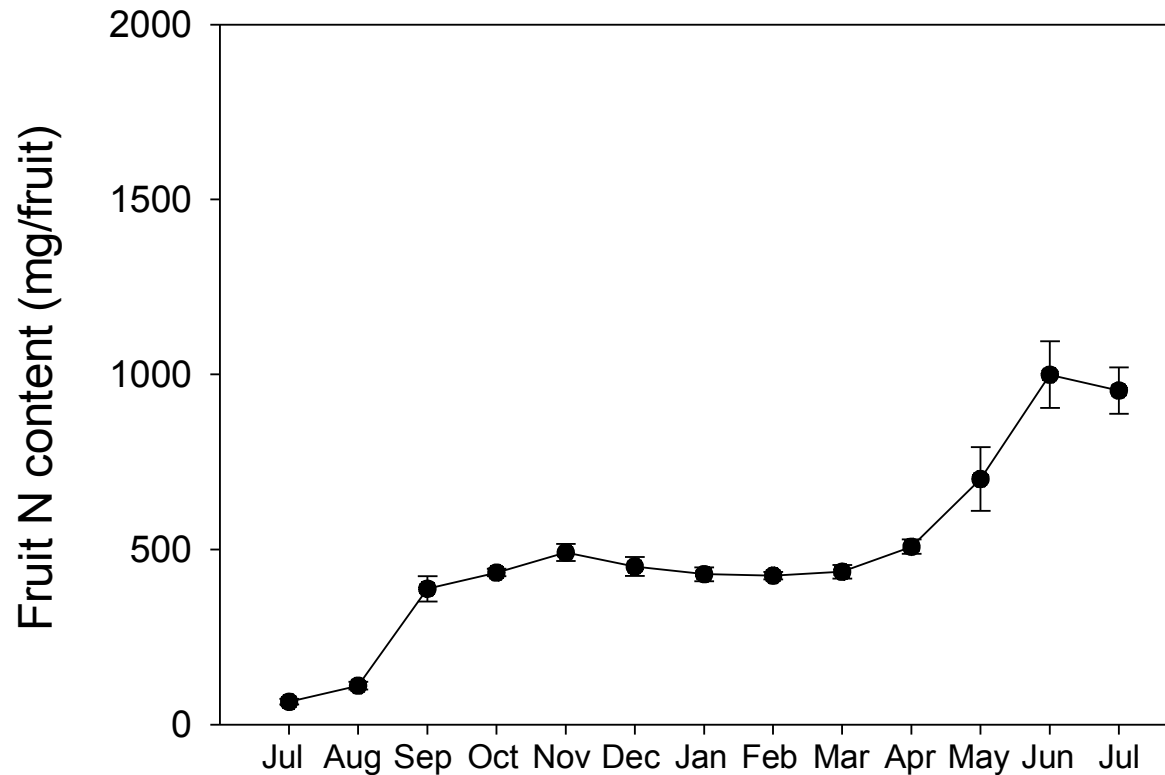
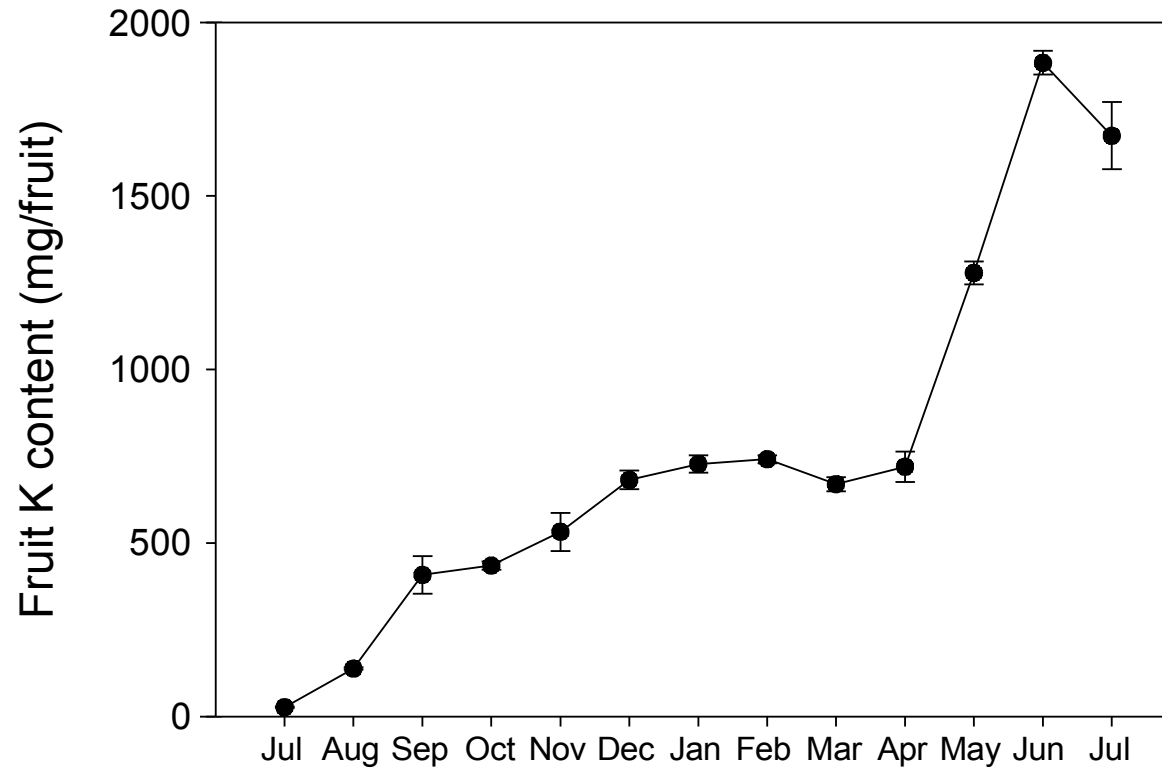


Figure 4. Nitrogen content of 'Hass' avocado fruit.



Each point is the mean between 5 and 12 fruit, with standard error bars.

Figure 5. Potassium content of 'Hass' avocado fruit.



Each point is the mean between 5 and 12 fruit, with standard error bars.

Table 1. Mineral balance (g per tree) of 20-year-old 'Hass' avocado in California.

	Leaves & twigs	Branches	Trunk	Roots	Fruit	Total	Proportion removed by fruit (%)
N	559	657	34	293	191	1734	11.0
P	118	129	13	85	53	399	13.3
K	373	610	56	251	377	1665	22.6
Ca	575	1093	95	317	6	2086	0.3
Mg	183	471	12	61	16	742	2.2
S	101	120	14	65	45	345	13.2
Al	1.1	4.4	0.7	32.7	0.0	39	0.1
B	1.8	3.6	0.4	1.7	1.4	9	15.9
Fe	3.4	6.4	0.9	22.0	0.3	33	1.1
Mn	3.0	3.6	0.3	1.3	0.1	8	1.1
Na	9.8	23.9	9.2	85.8	1.8	131	1.4
Zn	2.1	3.9	0.8	7.6	0.5	15	3.3

In a 10,000 pound crop this translates into 30 # N and 50# K

So how do you manage these nutrients?

Every year is going to be somewhat different, according to yield.

Over application can lead to too much vegetative growth and contamination.

Too little can result in lower yields.

Start with the fall leaf analysis.

Are you within the recommended range?

Look at crop load, is it higher or lower than last year.

If higher bump up N from last year by 20%, if lower drop it by 20%. K does not leach and does not need to be changed as long as within range.

Avocado Nutrition

- Avocado is unique in that it is very efficient in recycling nutrients from the leaf mulch
- Generally, nitrogen should be applied every year
- Occasionally Zinc should be applied
- Phosphorous? Potassium? (maybe)
- Iron in calcareous soils

Citrus is similar

How much to apply?

N and K should be based on leaf analysis in later summer, fall.

NOT soil analysis

Because of high pH soils north of San Diego, not a good idea to apply Ca and K nitrate, which raise pH. Stick with ammonium based materials. Organics have slight acidifying effect, as well.

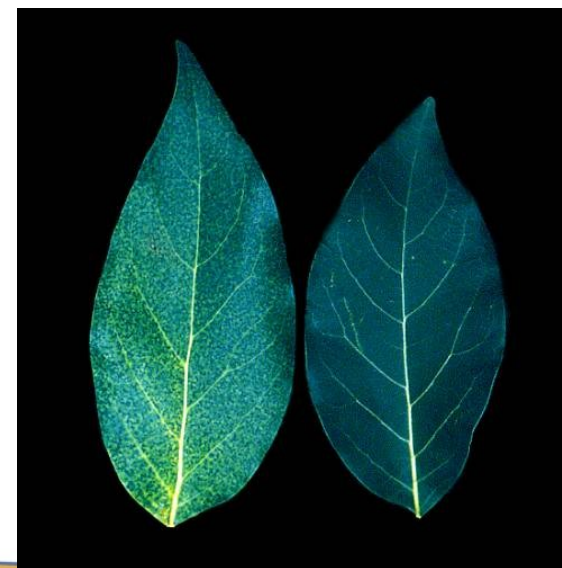
Organics cost at least 10 X more than synthetics. And in coastal California release N in about 2 months. Warm soils.

Fertilizers

- N-P-K ratio is the “grade” and is required to be on all bags of fertilizer
- 21-7-14 means that in 100 lbs of fertilizer you will get 21 lbs on N, 7 lbs of phosphate (P_2O_5) and 14 lbs of potash (K_2O)

New Grower's Quick Guide - Nitrogen

- 0.5-1.0 actual pounds of nitrogen required per tree, per year
- Usually divided into 8 or 9 applications to be injected into the irrigation system
- Or, use this suggested hand application
 - 3 lbs triple 15 in early March/April
 - 0.5 lbs urea in June
 - 0.5 lbs urea in September

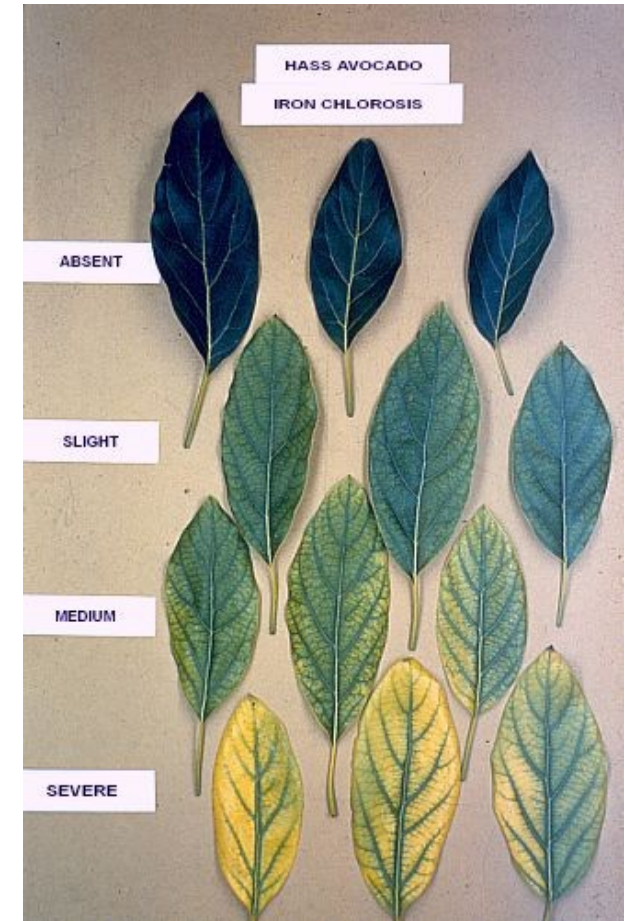


When to fertilize? An Experiment

- Experiment conducted: “control” treatment was fertilized at 25 lbs N per acre in each time period (late January, mid April, mid June, mid July, late August and late October)
- An extra 25 lbs per acre was applied in January, or February or April or June or November
- April gave increased yield of 31% over control, and November gave increased yield of 39% over control (4 years of data)

New Quick Growers Guide – Iron

If interveinal yellowing of leaf, most commonly is iron deficiency, caused by high pH or waterlogging. Gradually acidify soil, review irrigation program. Start iron chelates in the meantime



New Growers Quick Guide - Zinc

- Yellow mottling between the veins of the leaves, small leaves, short internodes, rounded fruit, apply zinc sulfate
- Hand, 3-5 lbs zinc sulfate per tree, every 3-5 years
- Irrigation with liquid zinc, 1-2 gallons per acre



New Growers Quick Guide – Potassium

- Leaf tip and marginal burn, starting on mature leaves, small brownish spots
- Small fruit, shriveled seeds
- Slow growth
- Thin twigs, dieback
- Confused with chloride tip-burn which is much more common



Salt/Chloride Tip-Burn

- Not a nutrient deficiency
- Caused by:
 - Saline water (from wells, ponds or reclaimed water)
 - Poorly leached soils that accumulate salts
 - Under-irrigation
 - Too much manure
 - Combinations of above



Application Methods

- Liquid application of fertilizers is best due to ease of application and reduction in labor costs.
- Hand application to soil - Many small groves still do not have fertilizer injection, Many growers still like to use triple 15 to get P and K, this is not water soluble
- Foliar, not suitable for Nitrogen or other materials due to thick waxy leaf surface in avocado, but very effective in citrus

Injection Equipment

- Backflow prevention device
- Injector
- Tank that will not corrode
 - Differential pressure tanks, or “batch” tanks
 - Venturi device
 - Positive displacement pump, gas, electric or water powered



Nutrient Availability and Uptake

- The atmosphere contains 78% N_2 gas
- Some soil organisms and root nodules on legumes convert N_2 to NO_2
- Lightning also converts N_2 to NO_2
- Fertilizer companies use natural gas to convert N_2 to NH_3 (under high temperature and pressure). Prices going up
- Organic manures are slowly converted to NH_4 and NO_3 for plant uptake

Nutrient Availability and Uptake

- Ammonium to nitrate takes 1-2 weeks at 75F
- Ammonium to nitrate takes 12 weeks or more at 50F
- Ammonium to nitrate is optimum at pH between 5.5 and 7.8
- Under anaerobic conditions, nitrate is lost from the soil as nitrous oxide, nitric oxide and N₂ gases

Nutrient Availability and Uptake

- Most of N is taken up as nitrate (NO_3^-)
- Some may be taken up as ammonium (NH_4^+)
- Nitrate is highly mobile in soil and moves to the roots quickly (and is leached out readily)
- Ammonium binds to soil particles and is converted to nitrate by bacteria
- Very poor uptake when soils are cold, and as nitrate readily leaches

Nutrient Availability and Uptake

- Phosphorus (P)
 - Most P in soil is tied up chemically, less than 1% may be available for uptake into plant. Mycorrhizal fungi help uptake
 - P taken up as phosphate ions: H_2PO_4^- , HPO_4^{--} , or PO_4^-
 - Note: phosphorous acid is a phosphonate, not readily used as a nutrient
 - Rare documentation of supplemental P in CA trees

Nutrient Availability and Uptake

- Potassium (K)
 - Taken up as K^+ ions and remains in ionic form in the plant
 - 90-98% of K occurs in primary materials and is unavailable to the plants
 - 1-10% is trapped in expanding lattice clays and is slowly available
 - 1-2 % is in soil solution and readily available
 - Does not readily leach
 - Most fruit trees require 2x as much K as N

Nutrient Interactions

- Excess K⁺ may compete with Mg and Ca uptake
- Excess P interferes with Zn uptake
- Excess Fe can induce Mn deficiency
- Increasing K fertilization can reduce B in the leaf analysis
- USE LEAF ANALYSIS

SUMMARY

Nitrogen applications are typically 1 lb of N per tree per year as an acid-based source, and best applied in spring – early fall

AVOID winter applications

Phosphorus is rarely called for

Potassium as hand or helicopter applied can go on anytime as K₂SO₄

Zinc and Iron as sulfate or chelate go on in the warm months