Nutrient Management for Tree Fruit

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UCONN
COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES
PLANT SCIENCE AND LANDSCAPE ARCHITECTURE

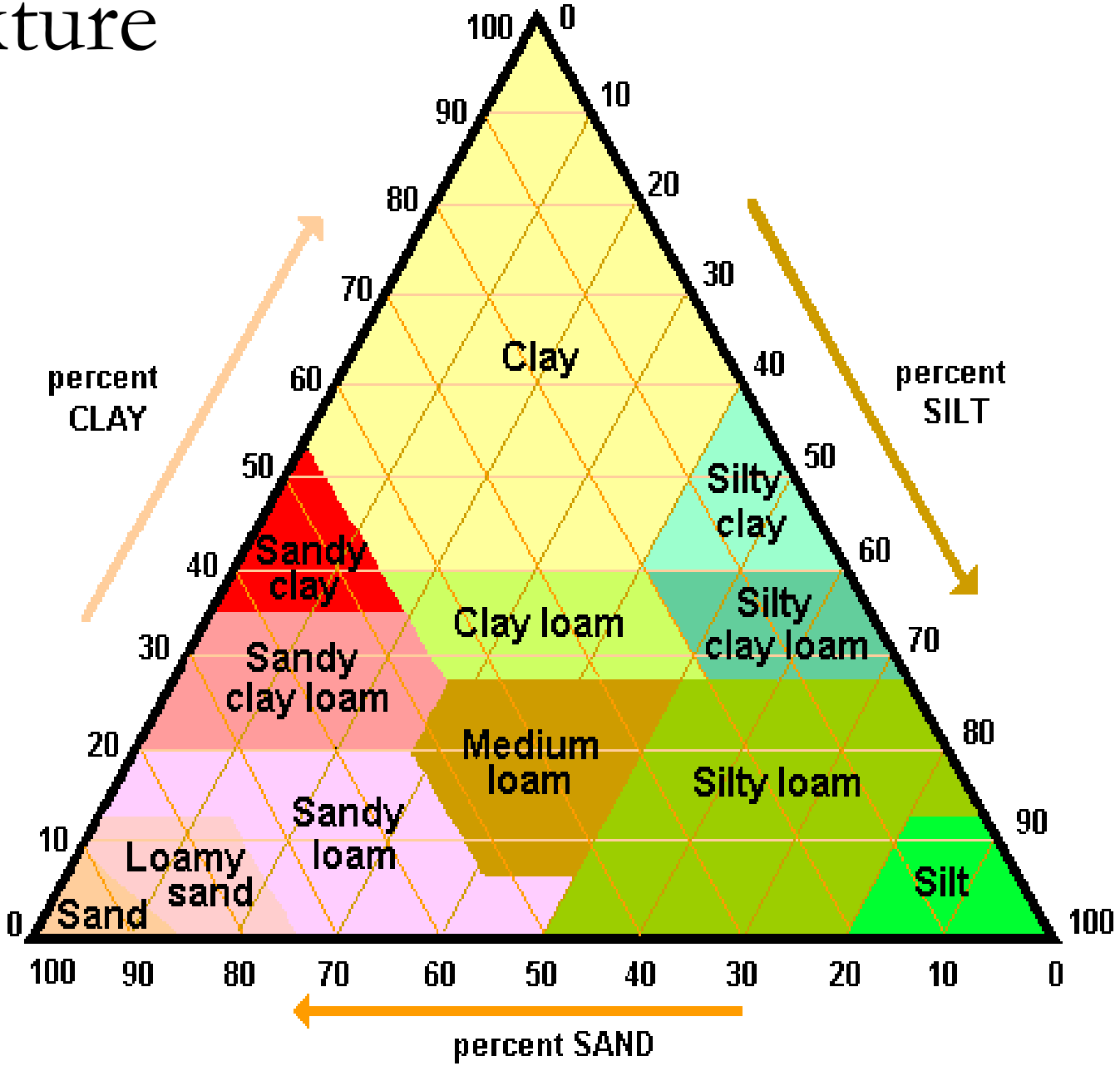
Covering:

- Availability of nutrients
- What is needed by the trees & its function
- Understanding soil test results
- Understanding Tissue analysis
- Nutritional corrections pre-plant & in established orchards
- When to fertilize
- Deficiency and toxicity symptoms
- Develop nutritional programs based on soil & tissue analysis

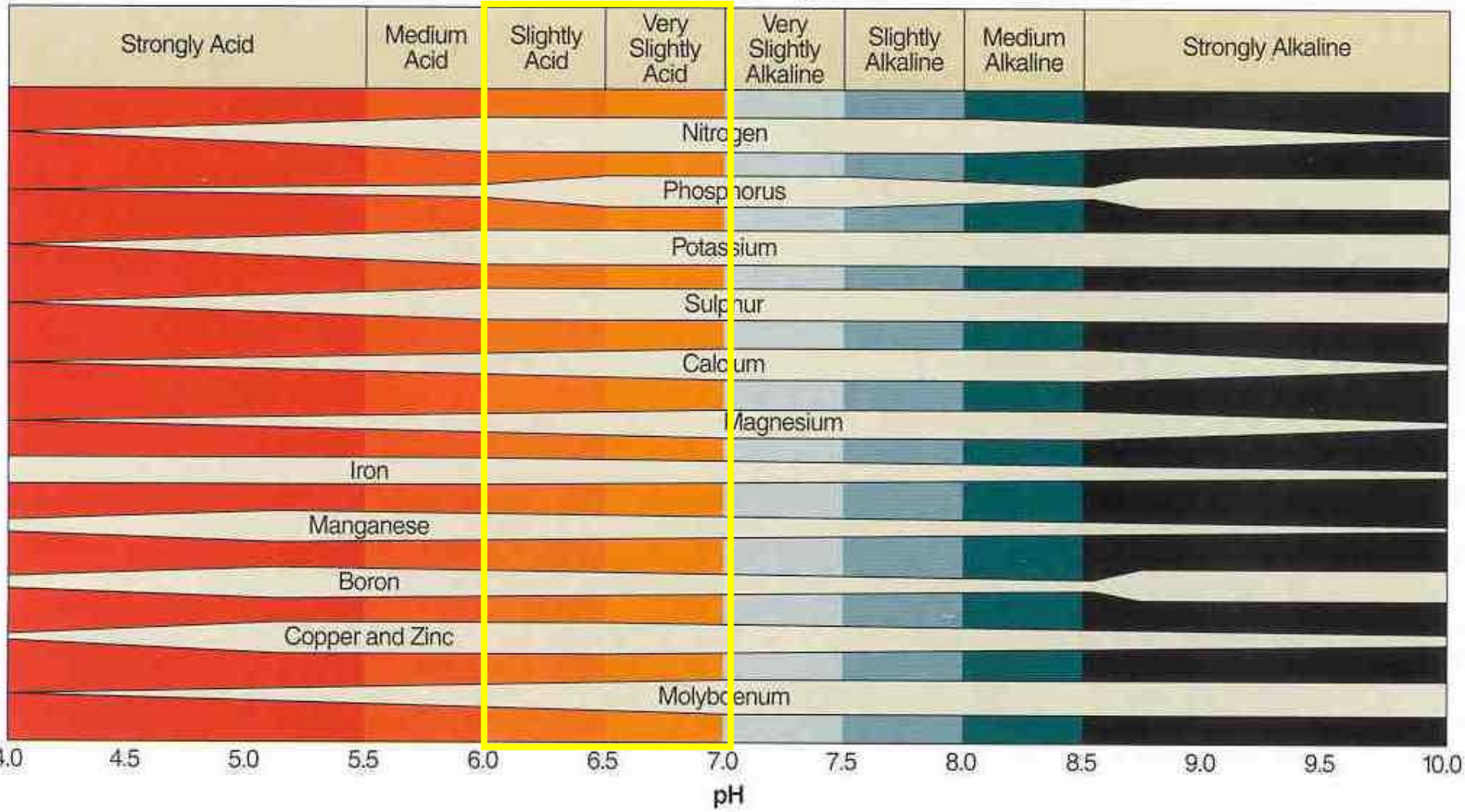
Nutrient Availability depends on:

- Soil texture
- Soil pH
- Existing mineral nutrients in the soil
- Available water
- Orchard floor management
- Climatic conditions
- Condition of the root system

Soil texture



How Soil pH Affects Availability of Plant Nutrients



Available soil nutrients dependent on:

- Soil texture
- Soil pH
- Existing mineral nutrients in the soil

Nutrient in excess	Induced deficiency
Nitrogen	Potassium

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Nitrogen	Potassium
Potassium	Nitrogen, Calcium, Magnesium

Nutrient in excess	Induced deficiency
Nitrogen	Potassium
Potassium	Nitrogen, Calcium, Magnesium
Phosphorus	Potassium, Copper
Sodium	Potassium, Calcium, Magnesium
Calcium	Magnesium, Boron
Magnesium	Calcium, Potassium
Iron	Manganese
Manganese	Iron
Copper	Iron

Available soil nutrients dependent on:

- Available water

Available soil nutrients dependent on:

- Orchard floor management
  - Mowed
  - Weeds

Available soil nutrients dependent on:

- Orchard floor management
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  - Weeds
  - Clean strip

Available soil nutrients dependent on:

- Orchard floor management
  - Mowed
  - Weeds
  - Clean strip
  - Soil compaction/aeration

Available soil nutrients dependent on:

- Climatic conditions
  - Moisture
  - Heat

> Soil microbial activity

Photo: appleman.ca

Available soil nutrients dependent on:

- Condition of the root system

Photo: R. Yip

Photo: M. Concklin

Soil Test Submission Form

The University of Vermont

Agricultural & Environmental Testing Laboratory
and UVM Extension

For vegetables, fruits, lawn/turfgrass, trees, shrubs, and flowers. Home and Commercial. See crop list on back.

Main Contact (mailing address):	Copy to (Extension, consultant, etc.) or Billing Info.
Name:	Name:
Farm/Company:	Company/Agency:
Address:	Address:
City, State, Zip:	City, State, Zip:
Phone:	Phone:
E-mail:	E-mail:
Send results by: Mail ___ or E-mail ___	Send results by: Mail ___ or E-mail ___

Vermont county where samples were taken: _____ **Check here if Commercial operation:** ___

The basic nutrient test costs $14 per sample (1 bag of soil = 1 sample), and includes pH, available P, K, Ca, Mg, S, micronutrients, CEC, organic matter, and fertilizer recommendations for **one** crop. Recommendations for additional crops **on the same sample** are $2 each. Add $16 for heavy metal analysis (**in addition to basic analysis, for a total fee of $24**). **Metals only analysis** (no nutrient test) is $15 per sample (Crop Code Z2). **One-half cup to one cup of sample required for all tests; any clean plastic bag may be used.** **Please print clearly.**

Lab ID (For lab use only)	Field or Sample Name	Approx. area represented by sample	Crop Codes (see back of form; 1 crop included in $14 fee; add'l crops $2 each)	Check here for metals test	Fee
1		___ sq. ft. ___ acres			$
2		___ sq. ft. ___ acres			$
3		___ sq. ft. ___ acres			$
4		___ sq. ft. ___ acres			$
5		___ sq. ft. ___ acres			$
6		___ sq. ft. ___ acres			$
7		___ sq. ft. ___ acres			$
8		___ sq. ft. ___ acres			$
9		___ sq. ft. ___ acres			$
10		___ sq. ft. ___ acres			$

Use additional sheets for more than 10 samples.

Please include payment, unless prior arrangements have been made. **Checks only**, payable to **UVM.** **Total fee $_____**

If this form came in a pre-addressed mailer, one sample can fit in it. Otherwise, use a box or large envelope.

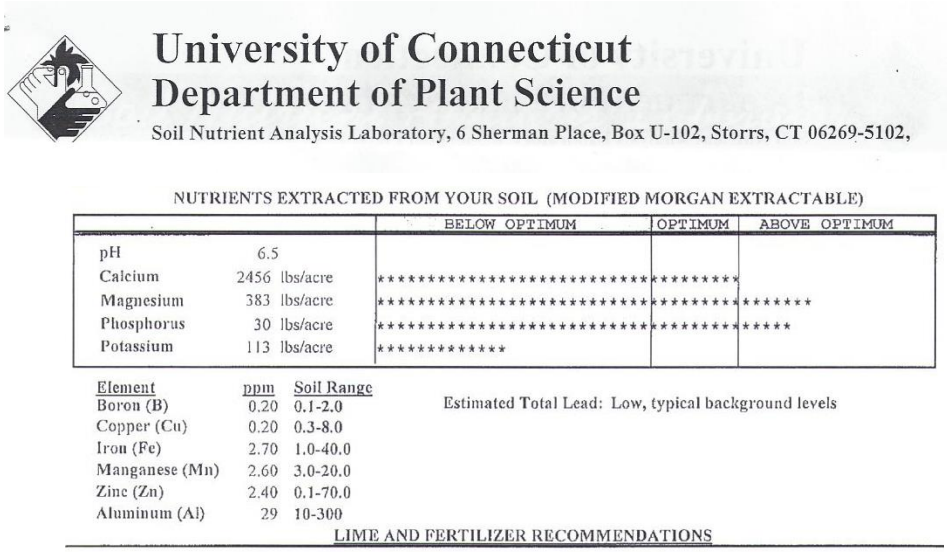
Send to: AETL, Univ. of Vermont, 262 Jeffords Hall, 63 Carrigan Drive, Burlington, VT 05405-1737

Other tests available on request. Email us at: agtesting@uvm.edu 802-656-3030 pss.uvm.edu/ag_testing
Test results are normally ready to mail/e-mail on the 2nd Monday after samples arrive at the lab.

Cost $14 per sample

Soil Testing

- Use same lab
- Will vary based on:
  - Topography
  - Cultivation practices
  - Time of year sampling
  - Pesticides influence?
- Pre-plant and throughout planting lifespan
- Compost testing



University of Connecticut
Department of Plant Science
Soil Nutrient Analysis Laboratory, 6 Sherman Place, Box U-102, Storrs, CT 06269-5102,

NUTRIENTS EXTRACTED FROM YOUR SOIL (MODIFIED MORGAN EXTRACTABLE)

		BELOW OPTIMUM	OPTIMUM	ABOVE OPTIMUM
pH	6.5			
Calcium	2456 lbs/acre	**********	*********	
Magnesium	383 lbs/acre	**********	*********	********
Phosphorus	30 lbs/acre	**********	*********	******
Potassium	113 lbs/acre	**********		

Element	ppm	Soil Range
Boron (B)	0.20	0.1-2.0
Copper (Cu)	0.20	0.3-8.0
Iron (Fe)	2.70	1.0-40.0
Manganese (Mn)	2.60	3.0-20.0
Zinc (Zn)	2.40	0.1-70.0
Aluminum (Al)	29	10-300

Estimated Total Lead: Low, typical background levels

LIME AND FERTILIZER RECOMMENDATIONS

Soil Analysis: Established Apple

Element	Level	Desired level
pH	5.9	6.5

2.25 tons lime/A needed

Mg	245 #	400 #

400-245 = 155 # Mg/A needed

12% Mg lime = 240 # Mg/ton

2.25 tons = 540 # Mg

Ca	1500 #	2400 #

2400-1500 = 900# Ca/A needed

21.4% Ca lime = 428 # Ca/ton

2.25 tons lime = 963 # Ca

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K	230 #	240 #

240-230 = 10 # K_20/A

Muriate of potash is 0-0-60

10 # K_20 = 16.6 # Muriate/A

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Muriate of potash is 0-0-60

10 # K_20 = 16.6 # Muriate/A

Sulpomag (K-Mag) is 0-0-21-11

10 # K_20 = 47.6 # Sulpomag/A

47.6 # Sulpomag = 5.23 # Mg

P	1 #	$\geq$ 1 #

University of New Hampshire
Cooperative Extension

Mail or Bring Samples to:

UNH Cooperative Extension
Spaulding Hall – Room G28
38 Academic Way
Durham, NH 03824

Questions? Call 603-862-3200
Email: soil.testing@unh.edu
Visit: http://extension.unh.edu/Soil-Testing

2015 Soil Testing Form - Commercial Plant Tissue Test

Instructions:

- Soil sampling instructions, and crop codes on page 2.
- Please print legibly.
- Please give each sample a unique name.
- Make checks payable to "UNH Cooperative Extension."
- Please allow 3 WEEKS for test results.

Name: _____ Business/Farm: _____ County: _____

Address: _____ City: _____ State: _____ Zip Code _____

Email: _____ Phone: _____ FAX: _____

Receive Test Results by (choose one): ☐ Mail ☐ Email ☐ FAX **Payment Type:** ☐ Cash ☐ Check ☐ Account

UNHCE ID# (leave blank)	Sample Name	**Crop Codes***	**Variety(s)**	**Apple Only - Root stock****	**Size of planting - (Acres or # bushes/trees/ vines)**	**Plant Tissue Test** $26	TOTAL Sample Cost:
* List codes for all crops for which you would like recommendations. See list on page 2. ** Root stock codes are on page 2						TOTAL COST:	

*If you have **recently applied** fertilizer, lime or wood ash, please specify the type, date and amount applied to each sample:*

Is this test for (check one) _____ routine fertilizer recommendations? _____ diagnosis of a problem?

If this test is being used to diagnose a problem, or if you have other comments, please explain:

Cost $26

Foliar Analysis

- Timing: 60-70 days after petal fall

Much earlier	60-70 days > PF	Much later
Higher Concentrations	**Most elements are stable**	**Higher Concentrations**
Nitrogen	Magnesium	Calcium
Phosphorus (slightly)	Iron	Manganese
Potassium	Copper	
Boron		

From Orchard Nutrition Management – W. Stile & S. Reid; www.smallfruits.org/BunchGrapes/production/TissueAnalysisforGrapevines.pdf

Foliar Analysis

- Timing: 60-70 days after petal fall
- Results will vary with tree stresses
  - Water
  - Crop load
  - Pest injury
- Will vary with pesticide use
  - Copper, sulfur, mancozeb
- Will vary from cultural practices

Foliar Analysis

- Troubleshooting visual or perceived problems
  - 2 samples

Photo K. Shackel

Foliar Analysis Standards

Nutrient	Apples	Stone Fruit
Nitrogen	2.2 - 2.4 % (Mac 1.8-2.2 %) 2.4 – 2.6 % nonbearing	3.0 - 4.2 % (non-peach 2.4 - 3.4%)
Phosphorus	0.08 - 0.33 %	0.08 - 0.33 %
Potassium	1.2 - 1.8 %	1.3 - 1.9 %
Calcium	1.3 - 2.0 %	1.3 - 2.0 %
Magnesium	0.35 - 0.5 %	0.4 – 0.70 %
Boron	35 – 50 ppm	25 – 50 ppm
Iron	60 – 400 ppm	80 – 500 ppm
Manganese	35 – 135 ppm	35 – 135 ppm
Copper	7 – 12 ppm	7 – 12 ppm
Zinc	25 – 50 ppm	25 – 50 ppm

Nutrient	Foliar Results	Sufficiency Range
N %	1.55	2.2 - 2.4
P %	0.08	0.08 – 0.33
K %	0.11	1.2 – 1.8
Ca %	1.21	1.3 – 2.0
Mg %	0.34	0.35 – 0.50
B ppm	21.9	35 - 50
Cu ppm	0.9	7 - 12
Fe ppm	39.8	60 - 400
Mn ppm	60.7	35 - 135
Zn ppm	27.3	25 - 50

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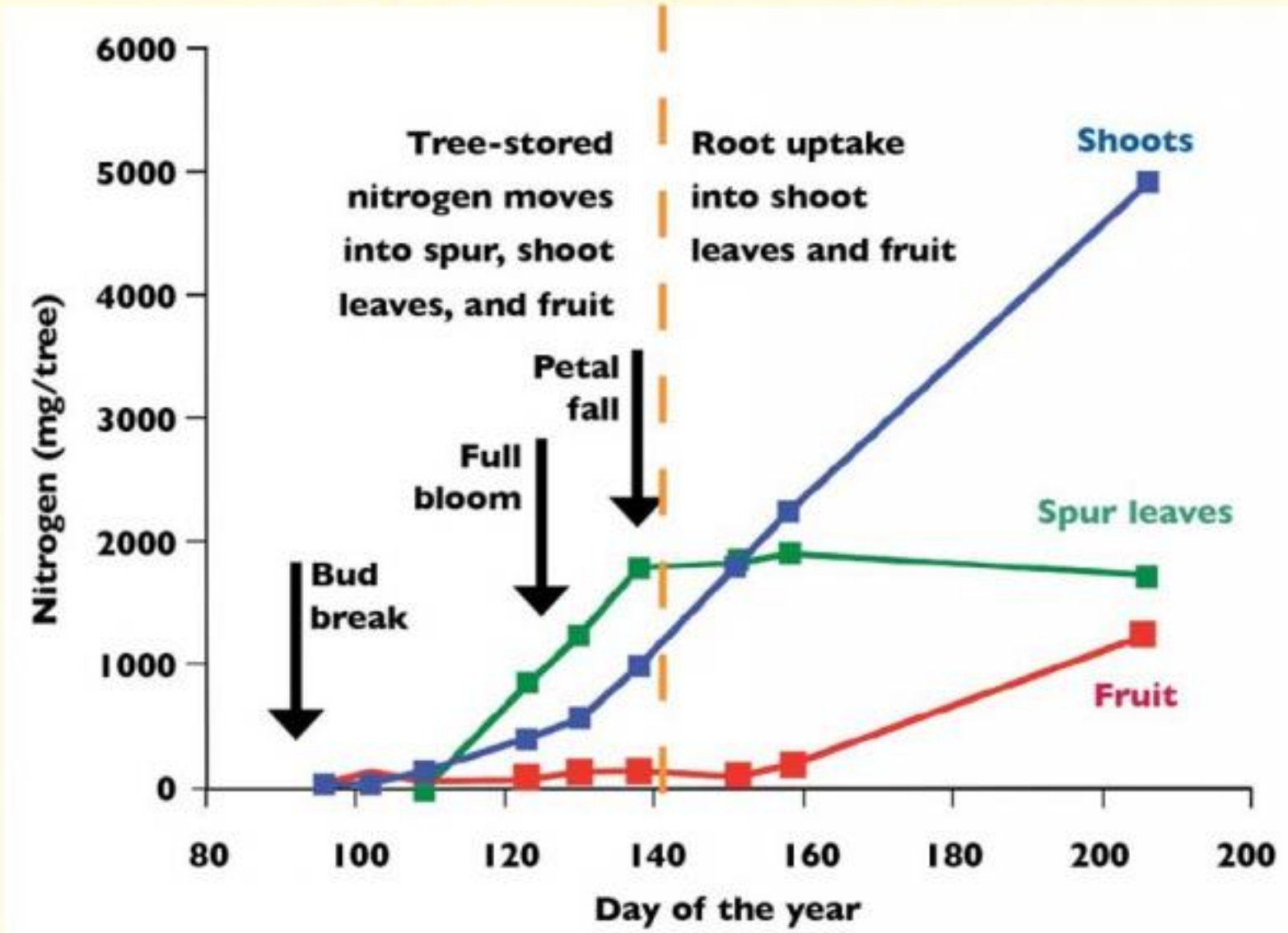
B ppm	21.9	35 - 50
Cu ppm	0.9	7 - 12
Fe ppm	39.8	60 - 400
Mn ppm	60.7	35 - 135
Zn ppm	27.3	25 - 50

	Soil Results	Sufficiency Range
pH	6.2	6.0 – 6.5
Ca lbs	2862	2400
Mg lbs	> 500	400
P lbs	18	≥ 1
K lbs	> 600	240

Nitrogen

- Mobile in the tree
- Vegetative growth
- Fruit set & size
- Cellular functions

When to apply nitrogen in spring



Dr. Denise Neilsen, British Columbia

Nitrogen

- Soil applications
  - New plantings after soil settles**
  - No later than early – mid July
  - Split applications
    - Dependent on crop load
    - Soil texture

Lailiang Chen, "Nutrient Management for Apple Trees on Dwarfing RS"

Return Bloom of Gala/M.26 Trees in Response to N Supply

2007

2008

Lailiang Chen, "Nutrient Management for Apple Trees on Dwarfing RS"

Nitrogen

- Soil applications
  - New plantings after soil settles
  - No later than early –mid July
  - Split applications
    - Dependent on crop load
    - Soil texture
- Foliar applications
  - Multiple applications
  - Urea
    - 3 #/100 at Pink
    - 5 #/100 at PF
  - Urea not for stones, pears

N Deficiency

- Intervienal on oldest leaves first
- Vegetative growth rate slows
- Impacts return bloom
- Fruit size smaller, color off
- Causes include
  - Low OM
  - Lack of N applications
  - Drought
  - Overcropping

Photo OMFRA.org

N Excess

- Dark green foliage
- Young trees - foliage burn, root tip burn
- Excess growth
- Delayed fruit maturity
- Reduction in fruit quality, storability
- Increased susceptibility to diseases, insects
- Increased susceptibility to winter injury
- Over applications may take years to correct

Potassium

- Mobile in tree
- Fruit size & color
- Winter hardiness
- Drought

- Soil applications
  - Whenever soil is not frozen
  - Muriate not for stone fruit
- Foliar applications

K Deficiency

- Oldest leaves first
- Marginal leaf scorch
- Entire leaf when severe
- Overall reduction of tree growth, yield
- Small fruit, failure to ripen
- Early fruit drop
- Worse with over-cropping, heavy crop, drought

Phosphorus

- Mobile in tree
- Root development & growth
- Early shoot growth

- Soil applications
  - Spring or Fall
  - Cold soils
- Foliar applications
  - No documented response

Photo: R. Yip

P Deficiency

- Usually not a problem
- Spring cold soils
  - purplish color
- Defoliation if severe
- Reduce Mg uptake
- Young trees: impact on root development

Photo: Johnson, Clemson

Photo: appleman.ca

Magnesium

- Mobile in tree
- Photosynthesis
- Reduced fruit drop
- Cellular functions
- Bud development

- Soil applications
  - -When soil is not frozen
  - -Dolomitic lime
  - -Epsom salts
  - -Sulpomag

- Foliar applications
  - Epsom salts,
    - 15 lbs/100 PF
    - 1st & 2nd covers
  - Avoid hi temperatures & poor drying conditions

Mg Deficiency

Photo: ipm.Illinois.edu

- Oldest leaves first
- Interveinal chlorosis
- Turns reddish
- Leaf margins
- Severe with heavy crops
- May look like early K deficiency

Mg Deficiency

- Oldest leaves first
- Interveinal chlorosis
- Turns reddish
- Leaf margins
- Severe with heavy crops
- May look like early K deficiency
- Blind wood

Photo: M. Concklin

Calcium

- Immobile in tree
- Winter hardiness
- Cellular functions
- Fruit quality, firmness

- Soil applications
  - Lime when soil is not frozen
  - Gypsum

- Foliar applications
  - Ca nitrate
    - 3-4 #/100 til mid-July
    - 4-5 #/100 after mid-July
  - Ca chloride
    - 2-3 #/100 June, July
    - 3-5 #/100 August, Sept

Ca Deficiency

- Bitter pit
- Dieback of leaf, root tips
- Leaf curl with necrotic edges
- Incomplete flower formation
- Fruit quality, yield reduced
- More common on sandy soils

Boron

- Immobile in tree
- Pollen tube growth
- Bud development
- Fruit set
- Uniform fruit maturity
- Root growth

- Soil applications
  - 2-3 # actual B/A
- Foliar applications
  - Solubor
    - 3 #/A, TC - Pink
    - 3 #/A, 1st & 3rd covers
    - Post harvest at 5 #/A

B Deficiency

- Death of growing tip
- Youngest leaves first
- Reduced shoot growth
- Misshapen fruit, corking
- Reduced fruit set
- Poor root growth

Zinc

- Immobile in tree
- Availability impacted by:
  - High P soil levels
  - High soil pH
  - High OM
  - Low soil temperatures
- Pollination
- Fruit set
- Early season shoot growth

Zinc

- Deficiency symptoms
  - Young leaves first
  - Rosette symptoms
  - Blind wood
  - Poor fruit set

Photo N. Childers

Photo M. Concklin

Photo M. Concklin

- Soil applications
  - Not effective
- Foliar applications
  - Zn EDTA
    - 3 qt or 3 #/A
    - TC, 2nd cover
  - Zn sulfates
  - Fungicides

- Zn toxicity may induce Cu deficiency

Copper

- Immobile in the tree
- Helps with fruit set
- Vegetative growth

Photo Clemson Univ

- Deficiency
  - Flowering, fruit set reduced
  - Fruit small, poor color
- Correct with
  - Copper fungicides, bactericide

Problems with guessing:

- Multiple deficiencies may exist
- Symptoms similar for deficiency & excesses
- Guessing may result in
  - Inadequate or excessive tree vigor
  - Over or under nutrient applications
  - Poor fruit set
  - Reduced fruit quality
  - Misdiagnosis
- Costs you $$$
- Visual symptoms = damage already done

Deficiencies confused with BMSB injury: Boron, Calcium

Photos D. Pfeiffer

Photos M. Concklin

Long Term Management Decisions

- Supplemental water during dry periods
- Foliar analysis annually
- Soil analysis every 2-4 years - same lab
- Combine both for fine-tuned fertilizer programs
  - Crop load
  - Cultural practices
- Past experience
- Comparing results from year to year will show a reliable trend

INFORMATION BULLETIN 219
Cornell Cooperative Extension

Orchard Nutrition Management

Warren C. Stiles and W. Shaw Reid

Questions?

Funding through USDA-NIFA-CPPM grant