Organic Orchard Nutrition

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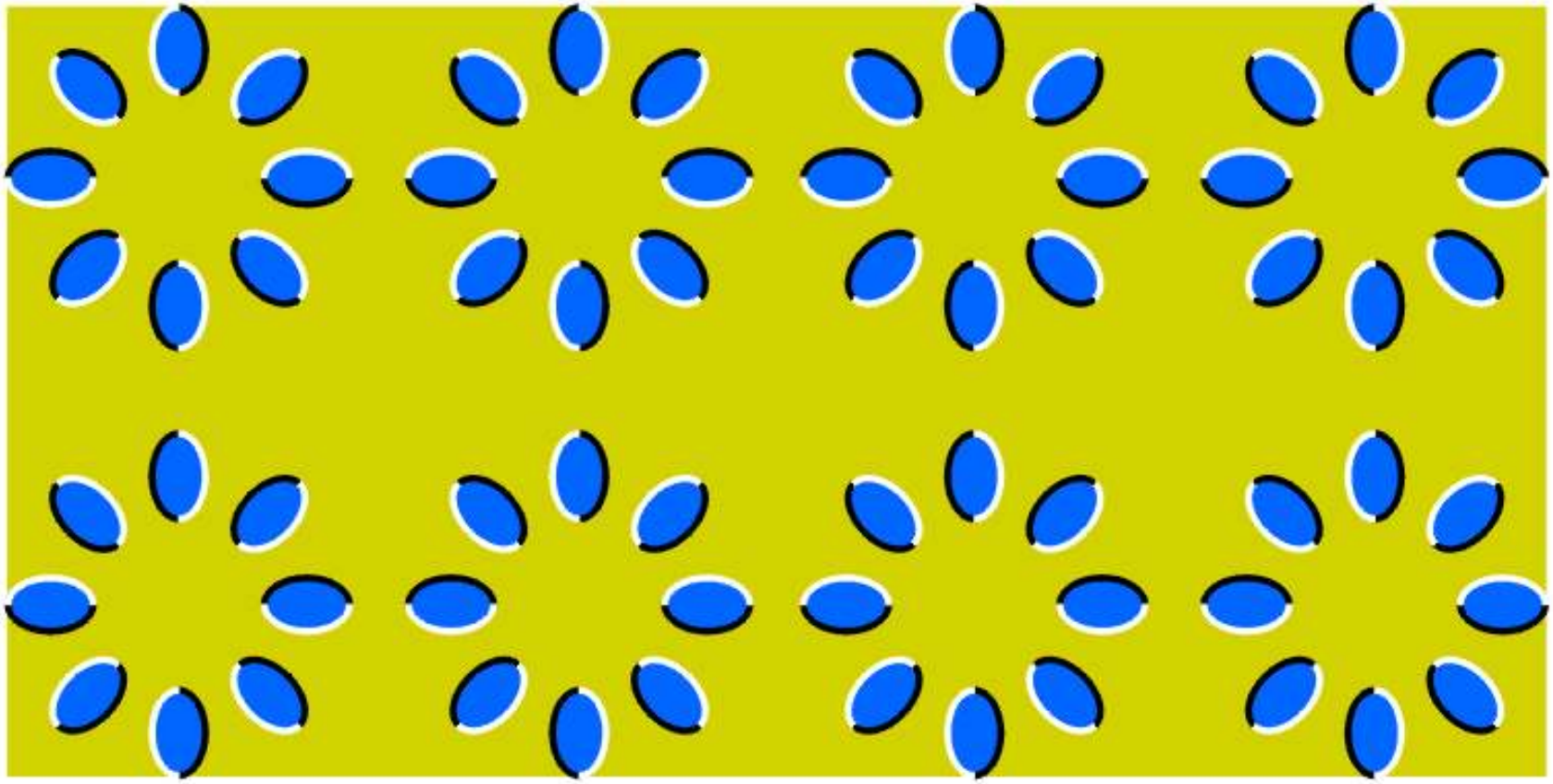
Gracias!

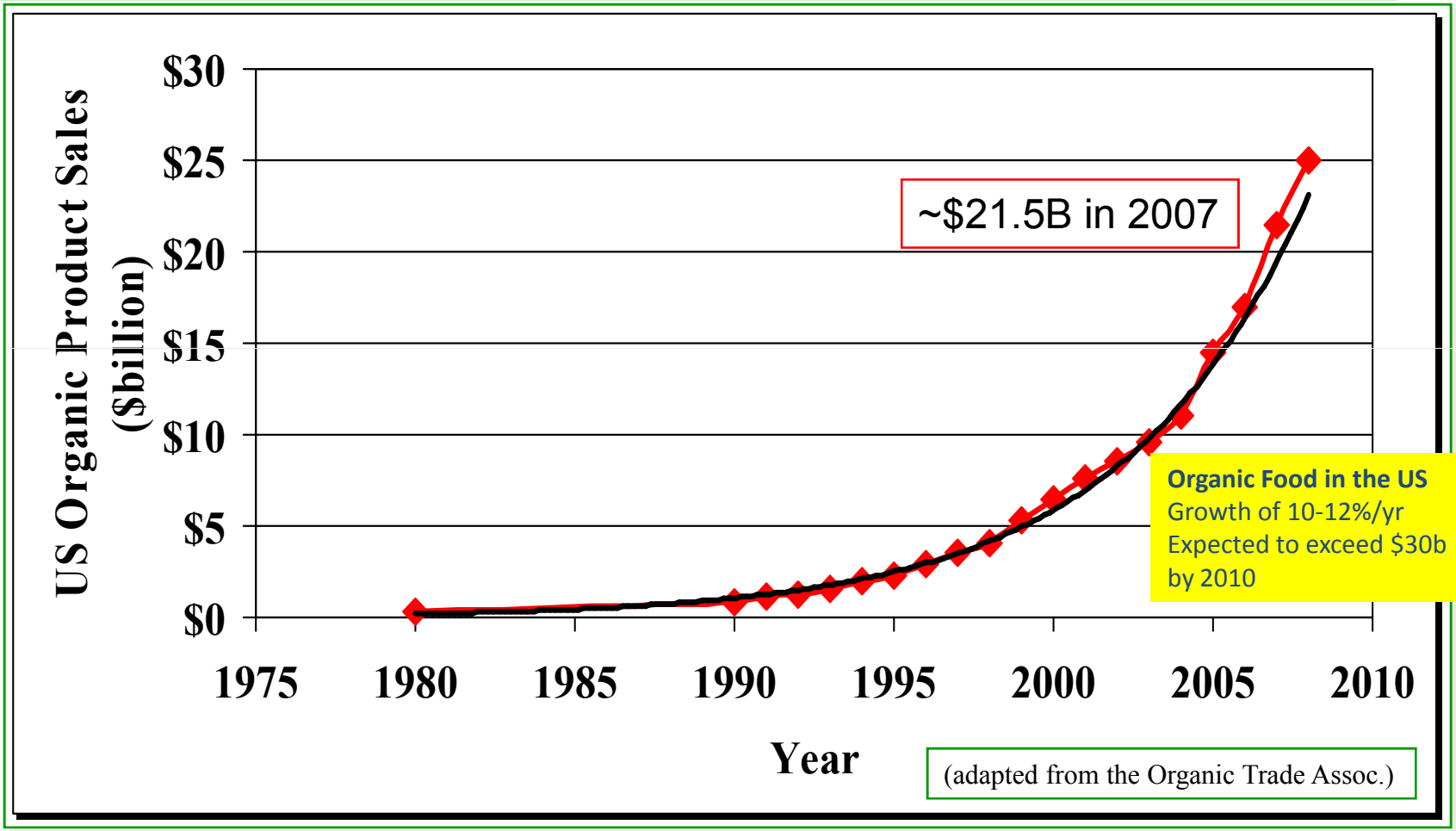


Why Organics?

1. Economics
   - -to capture market
   - -to make greater returns

2. Environment
   - -to minimize impact on the environment and ecosystem
   - -to minimize agriculture contribution to global climate change

US Organic Product Sales



Organic Food in the US
Growth of 10-12%/yr
Expected to exceed $30b by 2010

Fruits and Vegetables are largest product category

Organic Orchard Nutrition

Economics of Organics

- Price margin has been 20-80%

But,

- Must produce high quality, high value fruit
  - High Packout
- Must still optimize annual yield
- Must be a product the consumer wants and for which they will pay
- A "Healthy" product

Environment

To forget how to dig the earth and to tend the soil is to forget ourselves.

Mohandas K. Ghandi

- **Minimize non point-source pollution from fertilizer and pesticides**
- **Minimize production of greenhouse gases**
- **Maximize sequestration of carbon and nitrogen in the soil**
- **Sustain and/or increase system biodiversity**

Consumer Expectations

- **Healthy, Nutritious fruit product**
  - Safe
- **High Quality**
  - Meets traditional quality standards
- **Value**
  - They get value for their dollars
- **Environment Impact**
- **Supporting Farmers**

Mineral Nutrition in Organic Orchards

- Conventional versus Organics
  - Somethings are the same
  - Somethings are different

Convential versus Organics

- The Same
  - Same mineral elements are necessary
  - Same means of determining nutrient needs

Conventional versus Organics

- Somethings are different
  - Not "*Input Substitution*"
  - Nutrient Sources are different
  - Timing of application is different
  - Responses are different
  - More interactions with the orchard system, especially soil and ground covers

Observations

In a conventional orchard

- Rapid seasonal shifts in soil pH
- Cation exchange and buffering capacity may be reduced
- Nutrient reserves in soil tend to decrease
- May be rapid on-set of deficiency or toxicity symptoms
- May correct problems quickly

Fundamentals of Organic Nutrition

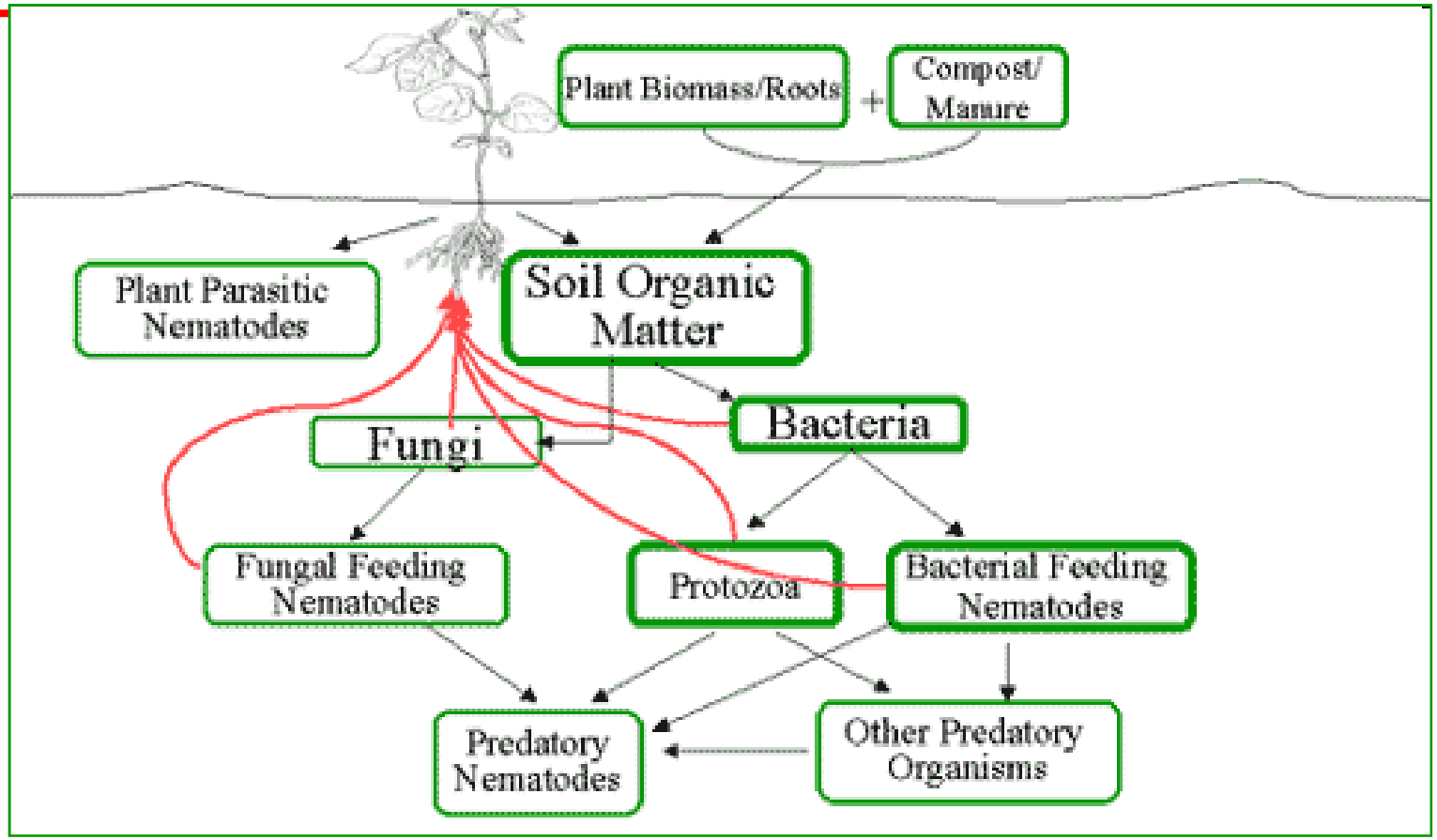
- Soil Quality and Health are key!
  - Organic matter and humus
  - Nutrient balance
  - Appropriate soil pH
- Nutrients need to be managed within normal ranges for adequacy
  - Organic orchards tend to be at the lower level of nutrient ranges… not much research on this subject

Philosophies

Feed the soil

Let the soil feed the tree

Soil Food Web



Soil Health Indicators

- Soil Organic Matter
- Soil Aggregation
  - Good soil aggregates; air space
- Good water holding and water drainage
- Earthworms
- Soil fungi:bacteria balance

Review Nutrition Basics

- Essential Elements
- Soil and Foliar Nutrient Levels
- Law of Limitations of the Minimum
- Determining System Need
- Understanding methods of evaluation

Essential Nutrient Elements

- **Required** for healthy tree growth and cropping

- **Categories of Essential Nutrients**
  - Categorized by Tissue Concentration
    - **Macro-elements: 0.1 to 10% tissue concentration**
    - **Micro-elements: 0.1 to 1000 ppm**

Nutritional Requirements

- **Essential elements**
  - **<u>Macronutrients:</u> 0.1 to 10% concentration**
    - **N, P, K, Ca, Mg, S**
    - **Found in the highest quantities in foliar samples**
    - **<u>Most Commonly Applied Fertilizers/Nutrients</u>**
    - **Deficiencies occur in tree fruits**
      - **Problems can be very regional**
      - **Can be created horticulturally by mismanagement**
    - **Toxicities usually do not occur naturally except due to imbalance of soil pH or misapplication of fertilizers**

Nutritional Requirements

- Essential elements
  - <u>Micronutrients</u>: 0.1 to 1000ppm (mg/L)
    - Fe, Zn, Mn, B, Cu, Mo
    - Found in the small quantities in foliar samples
    - Applied in fertility programs on a limited basis but usually due to a diagnosed deficiency
    - Toxicities can occur with some of these

Fundamentals

- **Determining NEED is important**
  1. **Soil Analysis**
  2. **Foliar Analysis**
  3. **Horticultural Observation**

-Must be a combination of all 3

Determining Fertility Needs

Step 1. Soil analysis

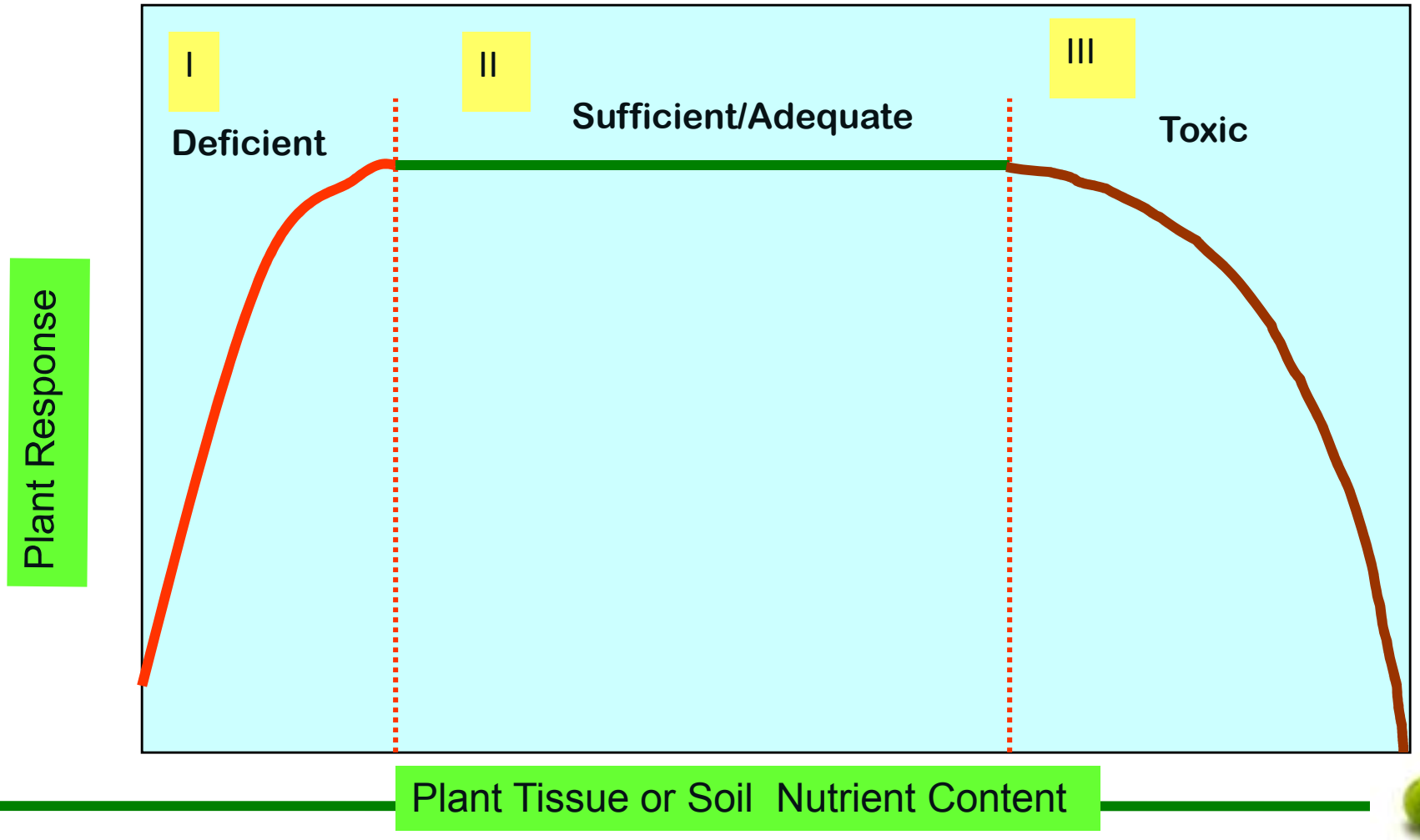
- Should be done before planting
- Annually during conversion and first 1-3 yrs of certification
- Periodically (2-3 yrs) afterward
- The key points evaluate are:
  - Soil pH
  - P and K levels- since these are our most common elements that we apply
  - Soil salts – indicated by EC and nitrate levels and if high can reflect too high fertilizer levels; especially if using fresh manures
  - Other elements generally of concern for the soil or location; calcium, minor elements, etc.

Determining Fertility Needs

Step 2. Foliar analysis

- Gives a precise measurement of what is actually in the plant
- Standards exist for conventional systems
  - Not well understood in organic systems
  - It is "accepted" that we use same standards
- May not be necessary in a noncropping orchard or newly planted orchard
- Annually with good records in a productive orchard.

Nutrient Content in Plants



Fundamentals

- Good Horticulture:
  - Grower must be involved with the orchard
  - Make frequent observations of
    - Tree growth,
    - Cropping, and
    - Symptoms of deficiency and toxicity

Determining Fertility Needs

Step 3. Horticultural Observation

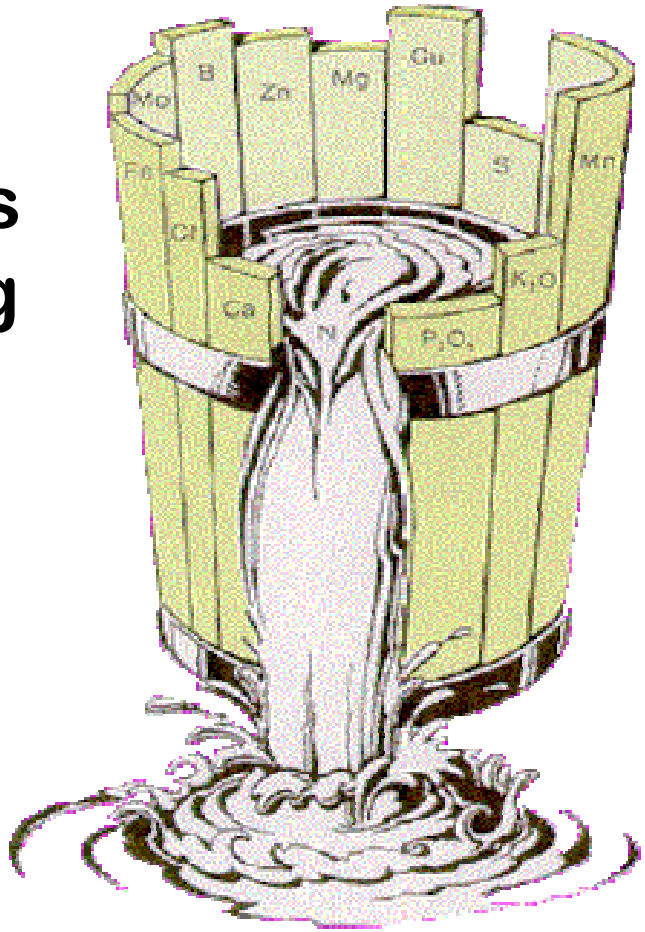
- Growth and Production
  - Record Keeping
    - Annual growth
    - Cropping (yield) records
    - Product quality assessments
- Symptomology
  - Deficiencies
  - Toxicities

Limitations

- Soil test is limited to tell you what is in the soil, not necessarily what is available or usable
- No common tests for soil quality and health
  - No common tests for soil micro-organisms
- Foliar tests are a “snap shot” and really what has already happened
- Observations of symptoms mean you have a problem… may take a time to correct.

Law of the Minimum

- Growth and Plant Response is Limited by the ***most*** limiting element
  - Which ever element is at the minimum – most deficient
  - Regardless of the concentration of other nutrients in the soil or plant



Applying Nutrients

Soil pH -

- ***First Critical Step*** in Nutrition Management
- Dwarfing rootstocks (B9, M9, M26, CG13, CG30 etc.) tend to be more sensitive to nutrient problems brought about by pH
- Either low or high soil pH can reduce microbiological activity of the soil
- Annual pH adjustment; slow process

Applying Nutrients

Manage pH as the 1st Step: Optimum 6.0 – 7.2

- If pH is >7.5 - 8.0
  - Sulfur applications (some restrictions)
  - Potassium sulphate
  - Magnesium sulphate

  - In high pH soils, sometimes there are benefits to S materials although only very small pH changes occur

- If pH <5.8 – 6.0
  - Agricultural lime; dolomitic lime, rock phosphates, ground oystershell, ground eggshells, bone meals, etc.
  - Calcium hydroxide (hydrated lime) typically not allowed

Applying Nutrients

Nutrient Sources

- **ALWAYS check all nutrient sources with your certifier!**

- **Organic (chemically) Materials**
  - **Manures, composts, certified fertilizers, extracts, teas**
- **Inorganic/Rock Materials**

Applying Nutrients

- Should be based upon the combination of soil and foliar analyses and croppping records
- Generally, very slow response to nutrients
  - Organic nutrients have to “cycle” through a system to become available to the tree
  - May take several years for “stable” nutrient balance and nutrient release from the system
  - Nutrients may be released at a time the tree cannot absorb them
  - Lack of knowledge:
    - Time of soil nutrient release and uptake in the organic system
    - Lateral movement of nutrients from cover-crop row middles to the tree
- The amount of nutrients from organic sources may not be readily available to the tree compared to synthetic fertilizers
  - Becomes incorporated in the organic matter and mineral cycles in the soil system.

Nutrient Availability

Plant Health

- Stresses, pest/disease damage, winter injury, crop load
  - "Unhealthy" plants cannot completely absorb and utilize nutrients, even if they are available
- Plant factors such as, adaptation to the site, cultivars, rootstocks
- Cultural components
  - Plant nutrient status
  - Cultural care, such as mulching, pH adjustment, pesticide use
  - Irrigation practices and water content

Application Rule of Thumb

- Nitrogen (N) – most needed nutrient to be applied
  - Unless others are limiting
- Application Rate
  - 40-50g/tree/year tree age – up to 500g/tree
  - Examples:
    - 1 year old tree – 50 g/tree
    - 3 yr old tree – 150g/tree
    - 10 yr old tree – 500g/tree
    - 12 yr old tree – 500 g/tree

Application Rules of Thumb

- Apply uniformly over the rooting area

- If spring applied, apply early
- If autumn applied, apply late

Foliar Applications

- Algae extracts, fish emulsions, teas, etc.
- Foliar applications are a supplement
  - Not meant to be “the program”
- Advantages
  - Supplement nutrient program
  - Can get relatively quick response
  - May compliment pest management
- Disadvantages:
  - difficult to use, smells, not predictable
  - May interfer with pest management

Organic Orchard Research

Project Goal:

- Develop best management practices for establishment of sustainable organic apple orchard for the south

Project Objectives:

- Evaluate tree, soil, system responses to:
  - Organic Ground Cover Management System
  - Organic Nutrient Sources

Treatments

Nutrient Sources (NS)

1. Untreated control (NF)
   Nutrients derived from Ground Cover Management
   Compost, Wood Chips, Paper, Vegetation
2. Composted manure (poultry litter) (PL)
3. Commercial Organic Fertilizer (poultry based) (CF)

Ground Cover Treatment (GT)

1. Municipal green compost (GC)
2. Mow-n-blow (MB)
3. Woodchip (WC)
4. Paper (SP)

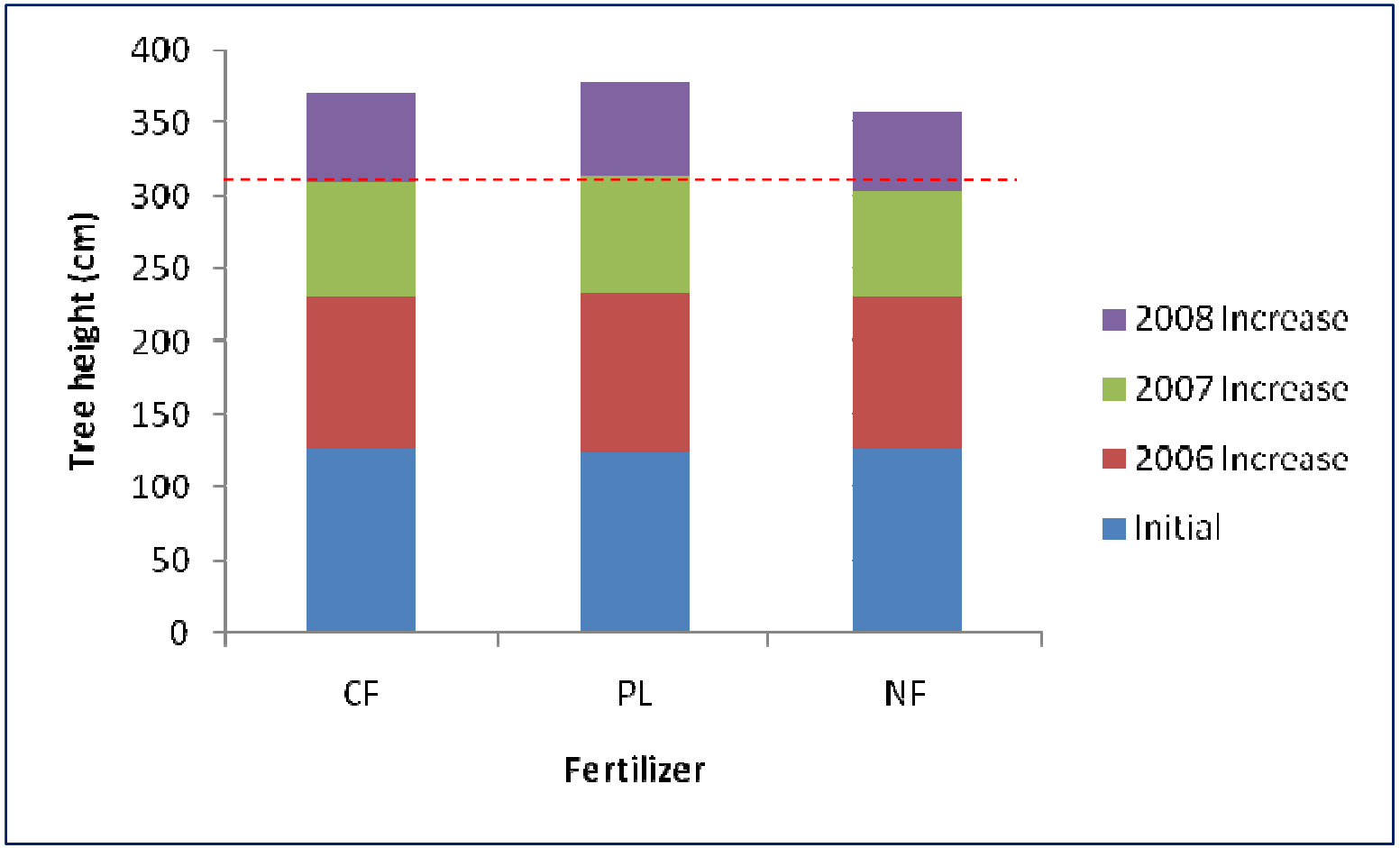
Plant Material and Management

- **Cultivar: Enterprise/M.26**
- **Tree training: Vertical axis**
  - **Tree support: 2 wire trellis system with vertical tree supports**
- **Management: Certified Organic**
  - **Land Prepared: 2005; Trees Planted: 2006**
- **Ground Cover; fescue (K-31) + white clover; nurse crop of winter wheat**

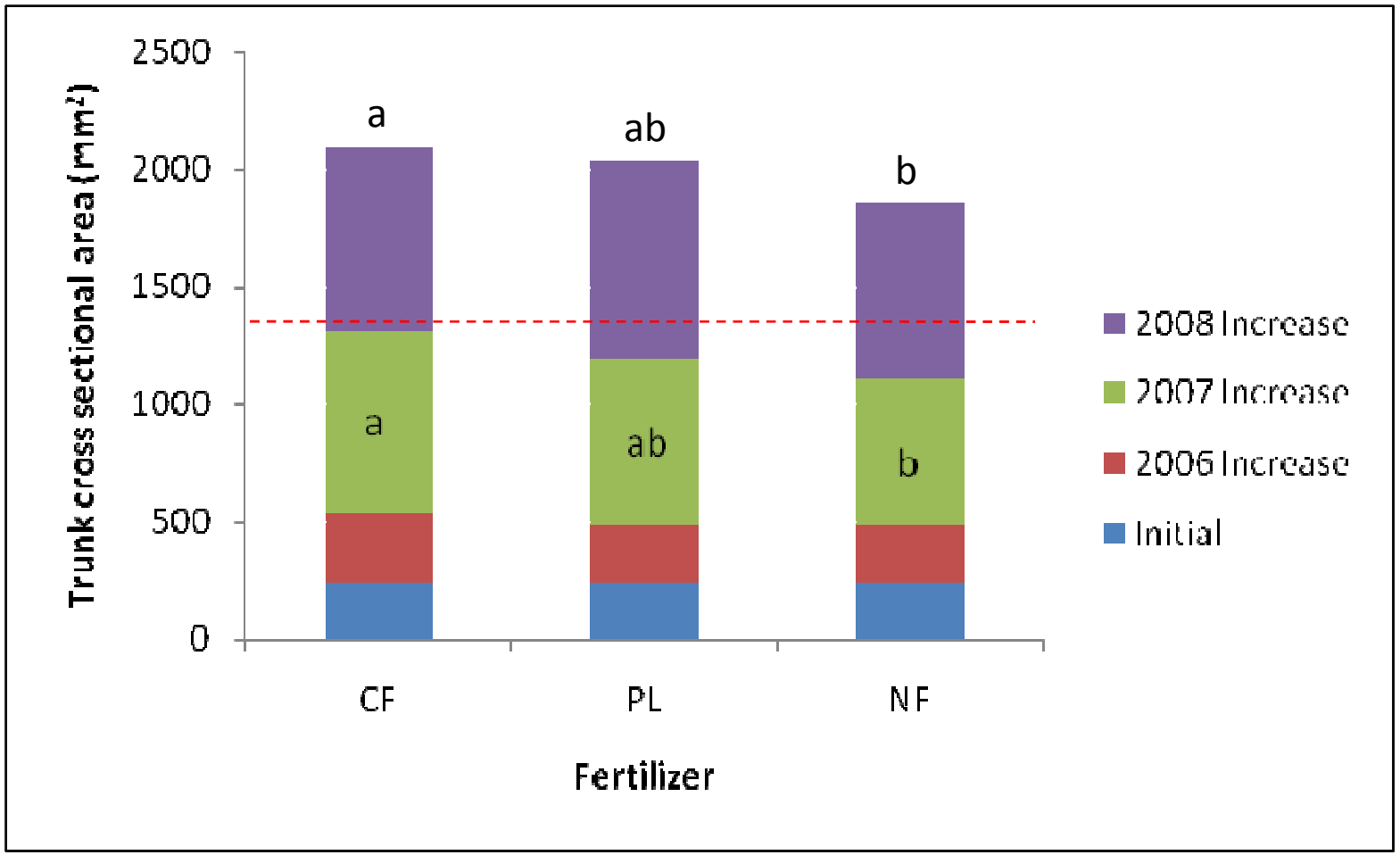
Nutrient Content

Treatment	N	P	K
Poultry Litter (PL)	1.2	1.1	0.47
Commercial Fertilizer (CF)	7.1	2.0	2.2
Control (NF)	0.9	0.21	0.45
GC	1.4	0.22	0.67
WC	.9	.07	0.36
SP	.22	.025	0.15
MB	1.1	.22	1.25

Tree Growth


400
350
300
250
200
150
100
50
0
Tree height (cm)
CF
PL
NF
Fertilizer
2008 Increase
2007 Increase
2006 Increase
Initial

Tree Growth


2500
2000
1500
1000
500
0
Trunk cross sectional area (mm²)
a
ab
b
a
ab
b
CF
PL
NF
Fertilizer
2008 Increase
2007 Increase
2006 Increase
Initial

Effects on Foliar Nutrients

Nutrient Source Treatments	N	P	K	Ca	Mg	S
2007 (2nd Leaf)						
CF	1.92 y	0.35 b	1.70 b	1.31	0.25 a	0.14 b
PL	1.92	0.39 b	1.75 b	1.33	0.25 a	0.14 b
NF*	1.99	0.49 a	1.85 a	1.29	0.22 b	0.15 a
	ns			ns		
2008 (3rd Leaf – First Cropping Year)						
CF	2.12	0.32	1.51	1.34 a	0.24 ab	0.18
PL	2.13	0.30	1.50	1.34 a	0.25 a	0.18
NF	2.15	0.35	1.53	1.22 b	0.22 b	0.18
	ns	ns	ns			ns

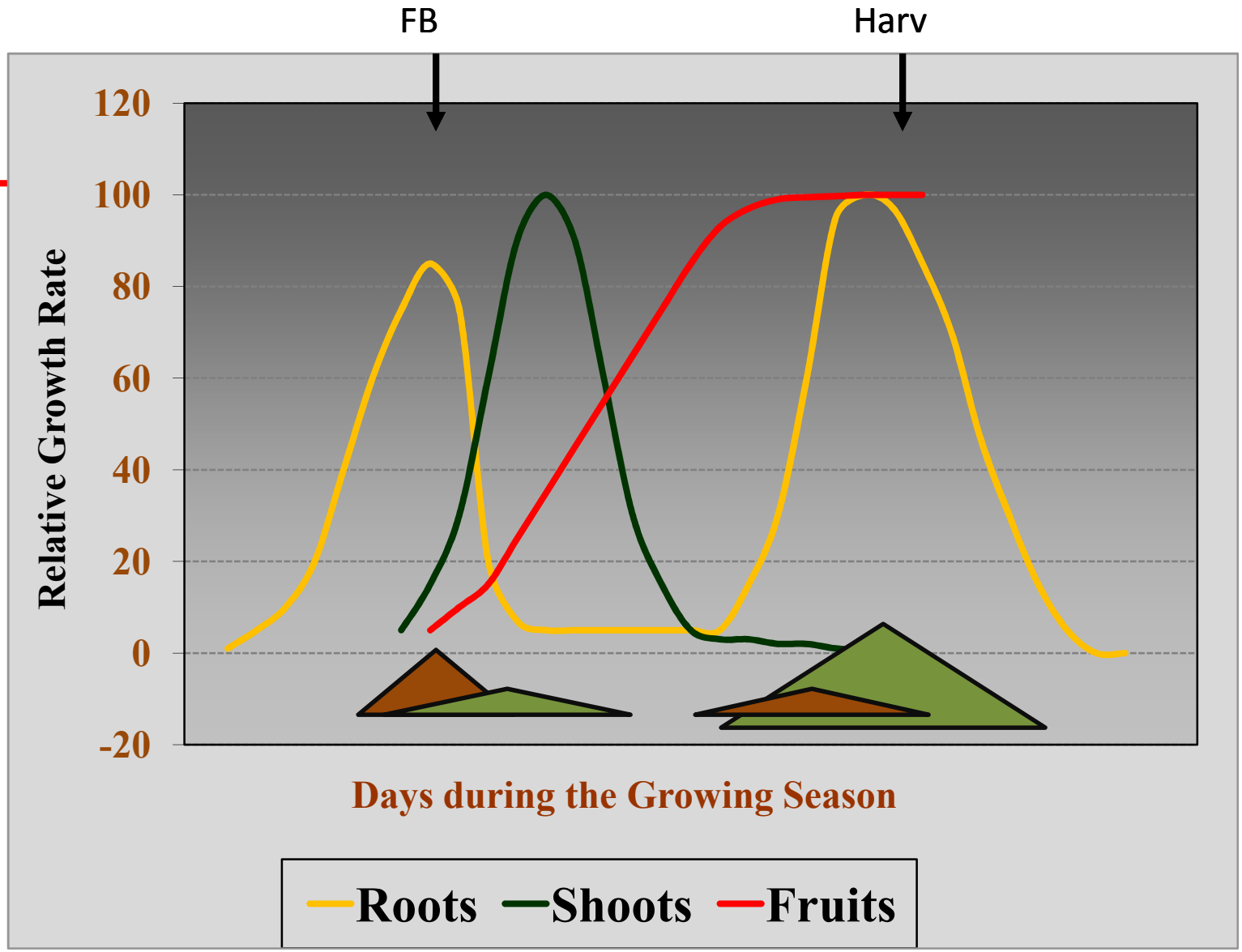
*NF = Control: Nutrients from Compost, Wood chips, paper, or vegetation

First Bloom and Cropping

Nutrient Source Treatment	Flowers per Tree (No.)	Fruitlets per Tree (No.)	Fruit Set (Frts/Flrs)	Fruit (kg/tree)	Yield (bu/acre)
Comm'l Fert (CF)	122 a	47 a	37 a	4.7	150
Poultry Litter (PL)	100 a	43 a	44 a	5.1	162
Control (NF) *	62 b	27 b	25 b	5.0	159

*NF = Control: Nutrients from Compost, Wood chips, paper, or vegetation ONLY trees treated with compost or woodchips allowed to crop; trees with shredded paper or vegetation (mow/blow) did not crop in 3rd leaf.

*NF = Control: Nutrients from Compost, Wood chips, paper, or vegetation



Poultry Litter N Release

Certified Fertilizer N Release
Green Compost N Release

Organic Orchard Nutrition

Summary of Our Experiments

- Nutrient source treatment did not significantly affect soil pH, OM, EC
  - CF and PL tended to increase pH
- Nutrient source did not significantly affect foliar nutrient content
  - All nutrients in "adequate" range
- Trees without additional nutrient sources were significantly smaller
- Lack of applied nutrient sources reduced flower number and fruit set, but did not affect total yield

Observations on our Nutrition Experiments

- The soil nutrient content and chemistry is still changing
- Nutrient source treatments (PL and CF) have tended to slightly increase biological activity in soil since beginning of the experiment while NF is less
- The Control treatment with nutrients from compost similar to fertilizers
  - Wood chips and shredded paper may have tied N
- The control with vegetation (MB) or paper did *not* provide adequate nutrition and had no cropping.
- PL and CF tended to increase weeds
  - Significant interactions with growth and cropping
  - Requires ground cover management

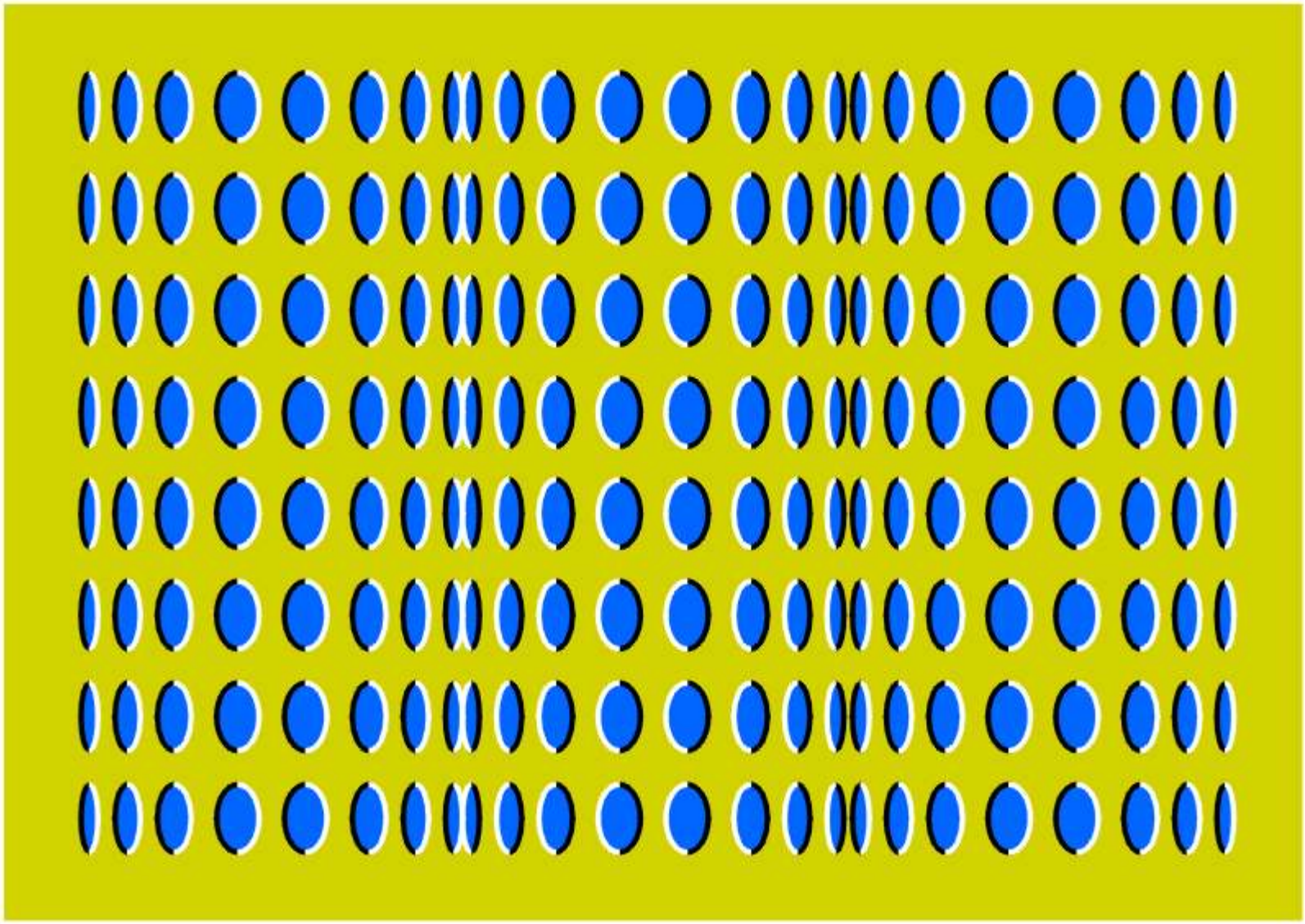
Conclusion

- **Growers can sustain tree growth and development in an organic orchard with a range of nutrient sources**
  - **PL and CF were similar to compost**
  - ***Source may not be as important as being sure that nutrients are provided***
  - **HOWEVER, doing nothing reduced tree size and cropping potential (NF-MB trt)**

Summary

- Nutrition in the Organic Orchard is a critical component of the management
- It is a slow process
- We are trying to “build” soil health and quality as a resource for tree nutrition

- Not a fertilizer “application” – but a nutrient maintenance philosophy

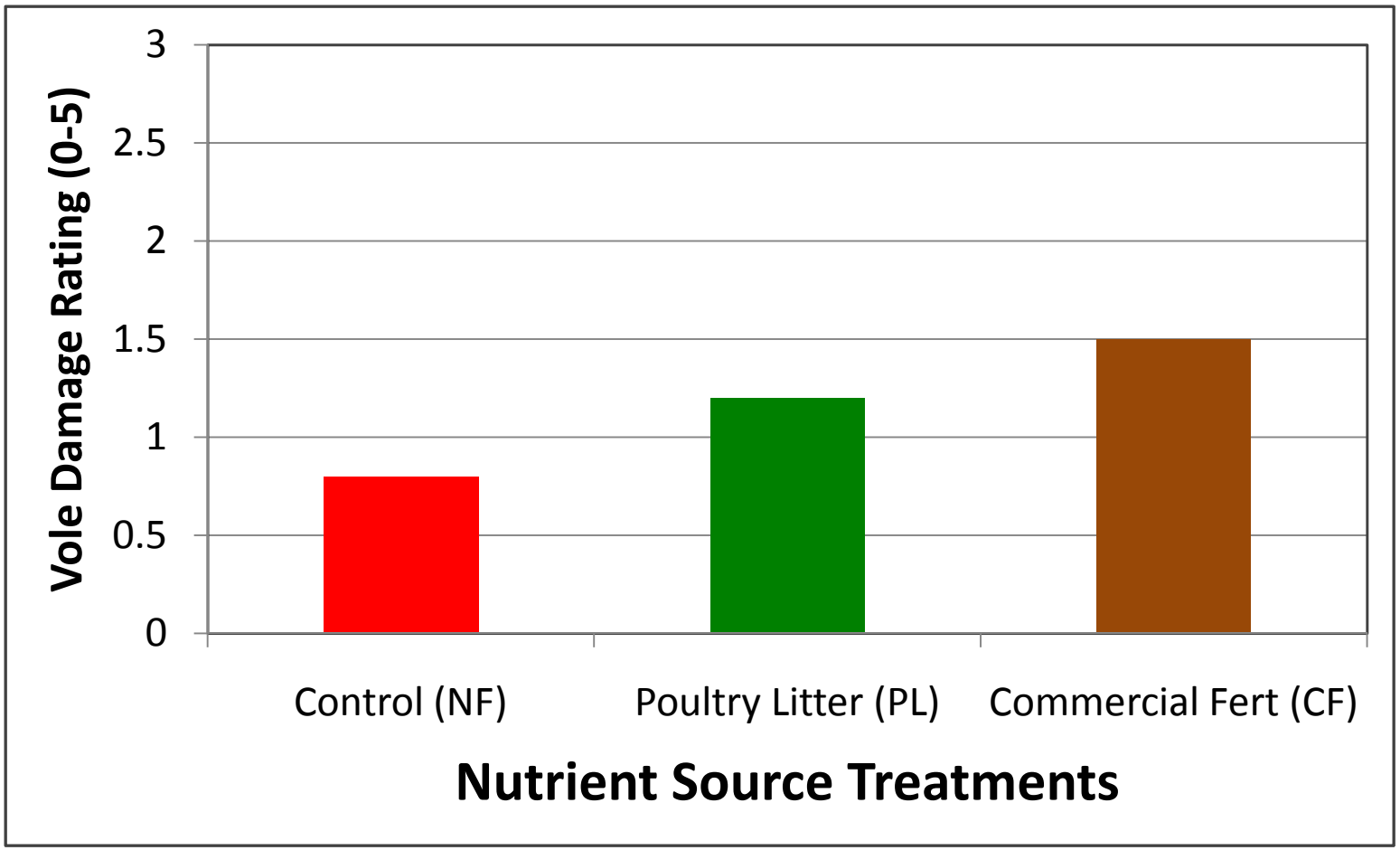


Gracias!

Nutrient Source Treatment	Na	Fe	Mn	Zn	Cu	B
2007 (2nd Leaf)						
CF	28 y	67 b	96 a	13 b	4.2 b	34 a
PL	32	67 b	81 b	13 b	4.3 b	31 b
NF*	31	71 a	79 b	19 a	4.8 a	35 a
	ns					
2008 (3rd Leaf – First Cropping Year)						
CF	43	61 a	58 a	16 b	5.6	30
PL	45	57 ab	50 b	16 b	5.6	29
NF	41	50 b	51 ab	19 a	5.8	30
	ns				ns	ns

*NF = Control: Nutrients from Compost, Wood chips, paper, or vegetation

Vole Damage


Vole Damage Rating (0-5)
3
2.5
2
1.5
1
0.5
0
Control (NF)
Poultry Litter (PL)
Commercial Fert (CF)
Nutrient Source Treatments

Planting Design

- Orchard spacing
  - Distance between rows: 2m
  - Distance between trees: 4m
- Plot Size: 3 trees, multiple plots; 1 acre
- Completely Guarded
  - Guard rows were planted on each side of the orchard
  - Guard trees were planted at the end of each plot