

Successful Biological Orcharding

with

Michael Phillips

*author of “The Holistic Orchard”
and “The Apple Grower”*

from

Lost Nation Orchard, New Hampshire



Fascinating biological connections make for a healthy orchard ecosystem. All insect pests and fruit tree disease – whether fungal or bacterial – have launching points and particular timing. Healthy trees address these challenges first and foremost *from within*. Growers utilizing an ongoing investment in soil nutrition and biodiversity set the stage for gentler organic sprays to grow a successful fruit crop. The challenges you face at your locale will become far more manageable as you build a holistic system that keeps trees and berry plantings healthy from the get-go.

Healthy Plant Metabolism

Photosynthesis efficiency

Protein synthesis

Fats energy

Resistance metabolites (essential oils and phenolics)

Fungal Duff Management

Forest edge ecology

Mycorrhizal boon

Tree root cycles

Ramial wood chips

Rechargeable biochar

Biological mowing

Fungal design notions

Orchard Soil Health: Food Web Interaction & Fertility Ratios

Compost wisdom

Stocking the pantry

Nutrient density

Ecosystem Connections

Understory fertility loop
Root space, light space
Bridge trees
Biodiversity to the nth degree
 ...*Beneficial mathematics*
Pollinator habitat
Braconid inspiration
Spider glory

Disease Progression

Staging areas
Fungal strategies
Bacterial opportunists

Integrating Holistic Tenets into Orchard Practice

Phytochemical pathways
Stimulating induced resistance
Fatty acid nutrition
Competitive colonization
Cuticle defense
Genetic resistance mechanisms

Holistic Alternatives to Fungicides

Systemic acquired resistance
Mixing pure neem oil
Effective microbes
Windows of opportunity
Stirring the biological stew

Insect Challenges

Points of vulnerability
Nudging into balance
Organic tool box
Alternate inducements
No year will ever be the same

Community Marketplace

Fruit shares
Apple value add
Hard Cider prospectus

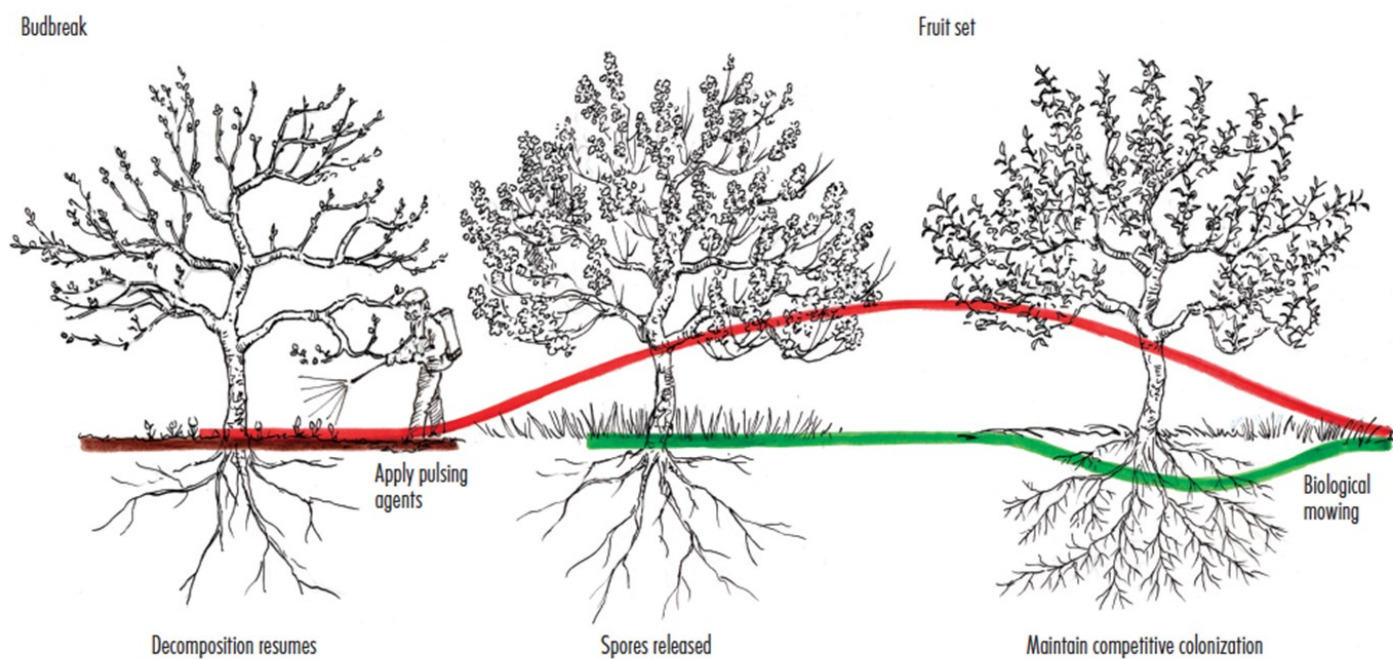
Your Turn

Ask those questions please!

The Fungal Curve

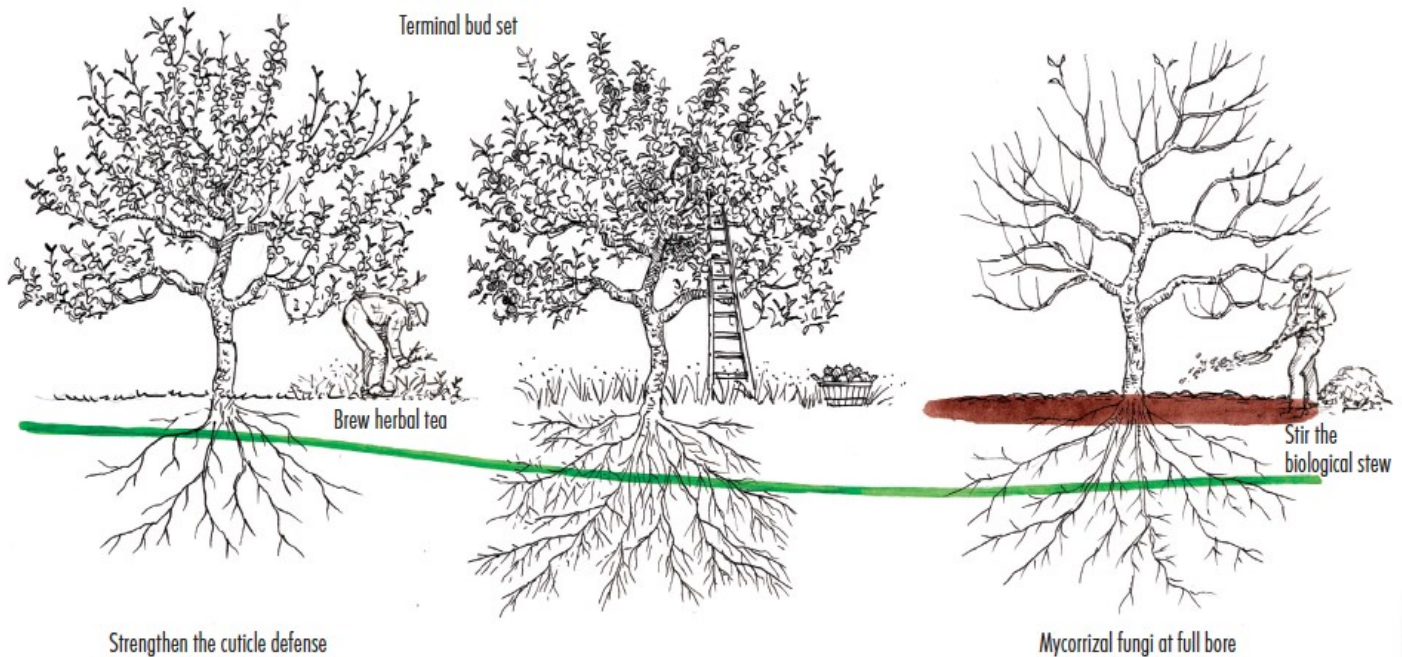
The growth cycle of feeder roots reveals the best timing for a number of orchard tasks. In a nutshell, the apple tree experiences two flushes of root growth that follows on the heels of observable green tissue growth above ground. The "**spring flush**" corresponds with soils warming up and the garnering of nutrients for fruit development and the formation of next year's flower buds. The "**fall flush**" kicks off terminal bud set, the expansion of the tree's permanent root system, and the all-critical storage of nutrients in bark tissues for spring.

Those wonderful drawings by Elayne Sears that show all this in the revised edition of the book are reproduced here so we can add yet another rhythmic layer to our understanding. The Fungal Curve is really a series of fungal happenings in the orchard that fruit growers need to recognize.



Bioactivity of numerous decomposers on the orchard floor is represented by the color brown - many of our practices aimed at reducing fungal disease inoculum in the understory are really about supporting the decomposers, which includes numerous species of beneficial fungi.

We address our "fungal fears" when we consider the red portion of the curve. Biodynamic orchardist Hugh Williams rightfully calls this space the "fungal zone" when describing how fungal disease spores arise from the ground surface to infect tender apple tissues. The primary infection period for diseases like apple scab, rust, and an assortment of rots corresponds perfectly with this red curve. Beneficial fungi and bacteria also arise and establish on the foliar surface during this outreach time of the "fungal being". The successful employ of biological reinforcement, induced systemic resistance, and minimal sulfur (on susceptible varieties) in holistic disease management all tie in directly to recognizing our allies.



The intricate interactions of the soil food web are what make animated life above the ground possible. The green portion of the fungal curve amounts to celebrating and abetting the role of mycorrhizal fungi in the orchard ecosystem. The fall flush of feeder roots is trumped a hundred times over by the hypha reach of these symbiotic fungi. Nutrient balance for the apple tree very much depends on the health of this life-support system.

Ramial Chipped Wood Primer

There are white rots and there are brown rots related to decomposition. The first support a deciduous environment; the latter deal with high tannin content and thereby define the evergreen forest. Let's talk about ramial chipped wood as the main course for feeding decomposition fungi in an orchard food web that in turn supports our trees.

Defining Ramial Wood

- Consists of twig wood less than 7 centimeters in diameter—being not much more than 2½ inches around at the large end of the branch.
- Species for chipping should mostly be deciduous, as here lays the soluble lignin advantage use by white rots to produce humic substances.
- Coarse pieces are preferable, including the prunings from fruit trees.

Understanding Ramial Nuance

The proportion of essential twig nutrients in wood chips increases as average branch diameter decreases. Nitrogen, phosphorus, potassium, calcium, and magnesium are found in the green cambium where leaf photosynthesis production and root nutrition come together to make a tree . . . which we in turn can redirect to build ideal soil in our own orchards to make fruit trees.

Size of the branches being chipped matters yet again when we consider the immediate impact on soil life. The carbon-to-nitrogen ratios in ramial-diameter wood averages 30:1, going no higher than 170:1 as we consider the larger end of the recommended branch. These ratios rise dramatically in stem wood, running 400:1 to as much as 750:1, thereby creating that soil dynamic where nitrogen becomes unavailable to the plant until such “log mulch” has significantly been broken down.

Soil fungi are adept at creating humus from a lignin source. Soil that has been built from the top down through fungal action undergoes humic stabilization—such soil has staying power and maximized nutrient recycling. Fruit trees belong in such soil. Ongoing soil health results from soil structure being managed by soil organisms. Fungal hyphae physically bind soil particles together, creating stable aggregates that help increase water infiltration and the soil's water-holding capacity. This accumulation of acid-rich organic matter as humus results from the decomposition of ramial chipped wood.

Decomposing fungi can be classified into two subgroups. The *white rots* use enzymatic chemistry on lignin-rich hardwood to produce humic substances. The *brown rots* transform softwood cellulose to produce polyphenols and allelopathic compounds specifically relied upon by evergreen species to suppress deciduous species.

Practical Applications of Ramial Chipped Wood

- A mixed chipping containing no more than 20 percent softwood will favor white rots and thus can be spread freshly chipped.
- Steer away from solely softwood wood chips for orchard purpose. That said, aging a homogenous pile for a year overturns the allelopathic impact of brown rots. Mix with mature compost to create rich woody mulch for berry plantings.
- Diversity is always good. Dump ramial wood chips thickly in piles on different sides of bearing trees over the years. Young trees can be ring mulched.
- Leaves in full green make for higher nitrogen content. “Summer chips” heat up beyond the desired fungal influence. This is fine for the initial phase of composting but not something to apply directly as orchard mulch.

Diversity Cannot Be Overplayed

Perennial Genus	Common name	Family	Ecosystem Niche
<i>Achillea millefolium</i>	Yarrow	Aster	beneficials, medicine
<i>Allium tuberosum</i>	Garlic Chives	Onion	beneficials, odor confusion
<i>Alnus rubra</i>	Red Alder	Birch	N-fixer, chop'n'drop
<i>Antennaria spp.</i>	Pussy Toes	Aster	beneficial accumulator
<i>Anthriscus sylvestris</i>	Woodland Chervil	Parsley	beneficial accumulator
<i>Arctium spp.</i>	Burdock	Aster	taproot, bumbles, medicine
<i>Ceanothus americana</i>	New Jersey Tea	Buckthorn	spiders, myco accumulator
<i>Chrysogonum virginianum</i>	Green and Gold	Aster	shade tolerant
<i>Coreopsis spp.</i>	Coreopsis, Tickseed	Aster	beneficial accumulator
<i>Cornus stolonifera</i>	Red Osier Dogwood	Dogwood	beneficials, chop'n'drop
<i>Cryptaena canadensis</i>	Honewort	Parsley	beneficial accumulator
<i>Echinacea purpurea</i>	Purple Coneflower	Aster	bumblefest, bird immunity
<i>Eupatorium perfoliatum</i>	Boneset	Aster	beneficials, medicine
<i>Euphorbia esula</i>	Leafy Spurge	Spurge	vole deterrent
<i>Foeniculum vulgare</i>	Fennel	Parsley	beneficial accumulator
<i>Gaillardia spp.</i>	Blanket Flower	Aster	beneficial accumulator
<i>Helianthus spp.</i>	Perennial Sunflowers	Aster	wasps, bumblefest
<i>Helianthus tuberosum</i>	Jerusalem Artichoke	Aster	late bloom, people food
<i>Inula helenium</i>	Elecampane	Aster	bumblefest, medicine
<i>Levisticum officinale</i>	Lovage	Parsley	beneficials, taproot
<i>Lupinus spp.</i>	Lupine	Pea	N-fixer, bumblefest
<i>Melissa officinalis</i>	Lemon Balm	Mint	beneficials, winter haven
<i>Monarda spp.</i>	Bee Balm	Mint	bumblefest, tea herb
<i>Myrrhis odorata</i>	Sweet Cicely	Parsley	beneficials, taproot
<i>Pulmonaria officinalis</i>	Lungwort	Borage	bumble queen casbah
<i>Pycnanthemum spp.</i>	Mountain Mint	Mint	beneficial accumulator
<i>Rheum rhabarbarum</i>	Rhubarb	Knotweed	beneficial accumulator, pies
<i>Sambucus canadensis</i>	Elderberry	Honeysuckle	wasps, medicine
<i>Senecio spp.</i>	Ragwort, Groundsel	Aster	beneficial accumulator
<i>Solidago spp.</i>	Goldenrods	Aster	wasps, spiders
<i>Spirea alba</i>	Meadowsweet	Rose	beneficial accumulator
<i>Symphytum x uplandicum</i>	Russian Comfrey Bocking 14 cultivar	Borage	taproot, bumblefest, calcium, winter haven
<i>Tanacetum parthenium</i>	Feverfew	Aster	beneficial accumulator
<i>Thymus spp.</i>	Thyme	Mint	wasps, myco accumulator
<i>Tussilago farfara</i>	Coltsfoot	Aster	spring pollinators
<i>Viburnum trilobum</i>	Highbush Cranberry	Honeysuckle	beneficials, spiders

Orchard Fertility

Based on Rational Ratios for Health!

BASIC SOIL VALUES

Seems like a whole lot of shaking going on here with this soil testing business, eh? Each orchard soil has parameters established around organic matter content, cation exchange capacity, and the geological reality of the place you be.

Some simple basic values can be articulated for those not quite ready for the full monty of soil considerations. Keep in mind that these generalized guidelines aren't necessarily as optimal as it gets for a particular situation. The purpose here is simply to give your trees "ground to stand on" with a reasonable chance of success.

- Get that pH in the 6.3-6.7 range.
- Do this in the context of cation balance based on the CEC number for your soil.
- Organic matter fuels the biology. Get OM to 3% at a bare minimum.
- Phosphate and potash readings on a CEC test of at least 200# of each

This checklist defines clear goals for the soil build-up phase in preparing your home orchard. **Organic methods are not going to work as well if the basics of mineral nutrition in your soil are not up to snuff.**

Here's the *ace up the sleeve* offered by vibrant soil biology: Mineralization is a two-way street. Those soluble nutrients produced by the microbes but not taken up immediately by the roots go right back into the next generation of microbes. There's rhythm here—a responsive beat—a tidal sensibility even. Plant roots in turn exude carbon that keeps microbe diversity and the immobilization/mineralization balance humming right along. It's this nature of the life portion of the soil that introduces and enforces the whole concept of balanced nutrition as opposed to the overstocked flooding of the reductionist chemical approach.

Soil Testing

Our role in starting an orchard is simply to check that pantry basics are essentially in balance. A soil test emphasizing biological parameters is the tool by which to gauge this. Certain soil amendments will likely be called for to achieve a proper starting gate for the biology.

Organic Matter

A diverse understory of plants is the principal means of replenishing organic matter from one growing season to the next. Orchard compost and/or a variety of haphazard mulches contribute here as well. The soluble lignins in ramial wood chips fuel the biology to produce the best type of organic matter of all: Stable humus provides for long-term nutrient storage that will be expressed as cation exchange capacity (CEC) on soil tests. Carbon sequestered in microbial fragments through "humus banking" by mycorrhizal fungi improves micronutrient assimilation across the board.

Cation Balance

Magnesium serves to pull soil particles closer together whereas calcium will spread the particles further apart. See where we're going with this? Slightly more magnesium is called for in a porous soil whereas clay requires higher levels of calcium to improve drainage and aeration. The percentage of base saturation for each of these elements provided on a soil test is how we compare the relative levels of each. The Ca:Mg ratio for a sandy soil can be targeted at 5:1 (noting the structural need for magnesium may skew this even lower). This same ratio for the *soil of your dreams*—that fine textured loam—should be close to 7:1. The heaviest clay soils benefit from even more calcium, so now a slightly higher Ca:Mg ratio becomes appropriate. The calcium pushes soil particles apart—that's good for clay. The magnesium pulls soil particles together—that's bad for clay but ever so good for sandy soils that lose water too quickly—which is when a higher proportion of magnesium is desirable. You determine which ratio range to use based on where the CEC number falls for your soil.

Potassium enters in here as well, tagging along on the heels of calcium at no greater than a 14:1 ratio. The percent base saturation numbers that represent “cation balance” for loam soil with respect to Ca:Mg:K are on the order of 70:12:4-5. These numbers shift for sandy soil to more like 65:16-18:3-4 and for heavy clay soil to more like 76:10:4-5.

Phosphorous – P

Phosphate (chemically notated as P_2O_5) requires time to get functioning organically. Ecological ag people have suggested that a phosphate-to-potash ratio of 2:1 is necessary to sustain crop refractometer readings above 12 brix (this being the measure of soluble solids in plant tissue indicative of overall health). Yet often the reverse is true in most biologically-managed soils, as potassium levels are constantly renewed by decomposing organic matter. Indigenous soil properties vary widely across the North American continent as well. Getting the P:K ratio to toe the line nearer to 1:1 can be challenging enough.

Potassium – K

Potassium is needed to renew what has gone into the fruit and to increase tolerance to winter cold and spring frosts. This mineral also strongly influences fruit color and fruit size. A huge heaping of organic matter, whether through generous composting and/or aggressive mulching, may nudge potassium levels too high relative to Ca and Mg, especially in dryland soils. Orchardists with shallow soils are the ones most likely to run short on the K score. *Potash* (being potassium oxide, K_2O) is often used to refer to various mined salts that contain the element potassium in water-soluble form.

Micronutrients

The essential soil nutrients that plants need in very small amounts are iron (Fe), manganese (Mn), boron (B), molybdenum (Mo), copper (Cu), zinc (Zn) and chlorine (Cl). These micronutrients are sometimes referred to as *trace minerals*. Soil tests may reveal a strong need to supplement one or two of these throughout certain regions—that can be done—but for the long haul I prefer using broad-source “soil condiments” in my orchard and garden compost on an ongoing basis.

*The soil food web in all its diversity and complexity trumps
reductionist soil chemistry many times over!*

Holistic Spray Plan for Community Orchards

Every orchard site faces its own array of challenges. Biodiversity of place sets the stage. Specific disease cycles need to be understood to determine if spray applications should be continued beyond the primary infection window. Rots in particular require additional action in the fruit sizing window. Commercial growers concerned with aesthetic diseases and nutrient density will likely continue spray applications into summer. Weave in the organic tool box for insect pressures as necessary – knowing pure neem oil helps considerably here.

Growth Stage	Holistic Spray	Mix includes (per acre)		Comments	
Bud swell	Fatty Acid Knockdown (if needed)	4 gal. liquid fish 1–2 gal. neem oil Follow this up within next 24 hours: 4 gal. activated microbes	Winter's End	Copper or lime sulfur are conventional organic means of addressing overwintering pathogens in buds and bark crevices	
Quarter-inch green	Spring Holistic 1	Core Holistic Recipe w/doubled rates of liquid fish and effective microbes	Primary Infection Window	Thoroughly wet fungal duff zone and trunk/branch structure	
Tight cluster to pink	Spring Holistic 2	Core Holistic Recipe w/trace minerals		Add Bt to this spray mix if surface feeding caterpillars in evidence	
Spring Feeder Root Boost				Organic blends with nitrogen boost for young trees, weak trees, and biennial bearers	
Bloom	Competitive Colonization Boost (CCB)	NO FISH, NO NEEM 1 quart karanja oil 4 gal. activated microbes 12 oz. seaweed extract 1 pint molasses		Blossom thinning options	Blossom Protect, Blight Ban, or F-1 add even more microbes for fire blight. Use liquid kelp if freeze likely.
Petal fall	Spring Holistic 3	Core Holistic Recipe w/trace minerals		Timing to be averaged across varieties	
Week of petal fall	Fruit set pests (eastern growers)	Surround for curculio Spinosad or quassia extract for sawfly		Base coat of kaolin clay to be applied in 2 to 3 layers	
1 st Cover (5 to 7 days later)	Spring Holistic 4	Core Holistic Recipe w/trace minerals		Micronized sulfur can be considered as well in an exceptionally rainy year	
Week of fruit set	Fruit set pests	Renew Surround for PC 1 st generation moths	Fruit Sizing Window		
2 nd Cover (7 to 10 days later)	Comprehensive Holistic 1	Core Holistic Recipe w/ silica tea w/ calcium tea		Fermented plant extracts provide calcium and silica for the “cuticle defense”	
Next week of fruit set	Fruit set pests	Renew Surround for PC 1 st generation moths			
	Borer trunk spray	Pure neem oil at 1% concentration		Adjust borer timing to the specific species at your site	
3 rd Cover (7 to 10 days later)	Comprehensive Holistic 2	Core Holistic Recipe w/ silica tea w/ calcium tea		A tighter spray frequency reflects more frequent wetting periods.	
4 th Cover (7 to 10 days later)	Comprehensive Holistic 3	Core Holistic Recipe w/ silica tea w/ calcium tea			
				Hand thin crop load within these 30 days	

5 th Cover (10 to 14 days later)	Summer Holistic 1	Core Holistic Recipe w/o liquid fish w/ calcium tea	Fruit Ripening Window	Comfrey and green nettle in a fermented tea provide a farm source of foliar calcium.
	Apple Maggot fly	Sticky ball traps		Keep sticky renewed!
	Borer trunk spray	Pure neem oil at 1% concentration		Adjust borer timing to the specific species at your site
6 th Cover (10 to 14 days later)	Summer Holistic 2	Core Holistic Recipe w/o liquid fish w/ calcium tea		
7 th Cover (10 to 14 days later)	Summer Holistic 3	Core Holistic Recipe w/o liquid fish w/ calcium tea		Including sea minerals with mid-August app helps trees prep for winter dormancy
8 th Cover (10 to 14 days later)	Summer Holistic 4	Core Holistic Recipe w/o liquid fish w/ calcium tea		If deemed necessary on later varieties
Fall Feeder Root Boost			Harvest Time	Organic blends with appropriate cation balance, rock phosphate, and trace minerals
Leaf drop in progress	Fall Holistic	4 gal. liquid fish 1 gal. neem oil 4 gal. activated microbes	Post Harvest	Thoroughly wet fungal duff zone and trunk/branch structure

Community Orchard Rates. It takes anywhere from 100–250 gallons of spray applied with a hydraulic handgun to cover an acre of trees to the point of runoff. The size of one’s trees and canopy phase determines how far a spray tank of a given volume will go. The numbers given here are based on recommended “acreage rates” for each product. Ground applications are often at higher rates than foliar applications, as shown in the chart. Farm economy determines exactitude, as nutrition-purposed ingredients can be applied more openhandedly than toxins, especially when pulsing biological activity. The pivotal requirement in adjusting rates for higher spray volumes is to maintain the neem oil concentration at 0.5% (or slightly less for sensitive pear varieties) accordingly.

Core Holistic Recipe. A half-gallon of pure neem oil stirred with a quarter cup (plus) of soap emulsifier mixed into 100 gallons of water achieves a 0.5% neem concentration, for instance. Seaweed extract at 8 ounces (dry weight), 2 gallons of liquid fish, and 2 gallons of *activated* effective microbes completes the brew.

Enhancements to the Core Recipe.

- Micro-Pak trace minerals applied at Spring 2, 3, 4 (one quart per acre). Sea-Crop (sea minerals) equally improves enzyme cofactor synthesis.
- Karanja oil works synergistically with neem oil (substitute 1/3 by volume)
- Manganese chelate with foliar calcium balances potassium excess.
- Raw cow milk (diluted 1:10 with water) helps with rots in the fruit sizing and fruit ripening windows. Experiment here and report in please.
- Aerated compost tea can be substituted for effective microbes. The ideal may actually be to use both in order to maximize species diversity.