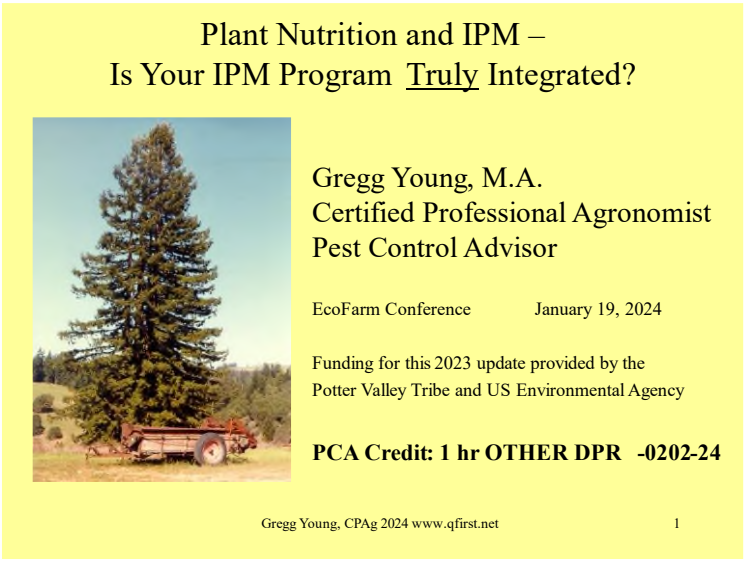
Dictation - EcoFarm Show Friday, January 19, 2024



1) Thank you for inviting me to present at this conference; and I especially want to thank the Potter Valley Tribe for supporting this work within their Pomo Sovereign Food Program, also with funding from the US Environmental Protection Agency.

This is one of my favorite topics - the relationships of plant nutrition and Integrated Pest Management – today we're asking the question **is your IPM program truly integrated?**

2) These are the areas where I've worked - up in the North Coast of California since 1973 as a PCA with soil testing, including for the California Certified Organic Farmers - Mendocino/ Lake Chapter for 15 years. Integrated pest management services in 4 counties from 1979 to 1993. Involvement in compost production (1979-93); all of the above since 1995, mostly in Contra Costa County

3) In 2015 I started working in Southern California and Ventura County working with Mediterranean crops and stone fruit, citrus crops, avocados and others. Currently I just work with a few farms and wineries.

4) This is your typical disease triangle showing that it takes three components for diseases to infect. Thius also applies to insects

5) In today's talk we will stress the conditions that make for a susceptible host

6) Often in integrated pest management we spend our efforts monitoring the pest and disease and the environmental conditions. This shows yellow sticky tape (upper right), a spore monitoring device (aapple & pear scab), and a pheromone trap (moth pests)

7) Here's why today's topic is important: **ALL of the biomass that makes up a mature tree or vine comes from the soil water and air.** A vineyard begins as a small vine and grows into a large trunk and canes, producing crops year after year. Anyone who says that there's no relationship between the the soils and fertilization just really doesn't understand this essential concept

8) With modern agriculture we squeeze as much as we can out of the agroecosystem. Large crops are removed annually – removing nutrients with each crop

9) The roots of healthy trees and irrigation will actually be intertwined, reaching out and competing with each other. This occurs naturally in forests, and even more so with cultivated crops

10) Crops need a biologically active, aerated root zone; anything that restricts that, such as plow pans, tractor tracks and shallow depth to bedrock will restrict the root growth and productivity

11) With drip irrigation the roots are confined to a smaller area - the wetted zone ends up an upside-down cone. Notice that on the left that the root zone tends to be the opposite; you have more root activity in the upper levels, and most of the biological activity is up in the top foot of soil. So, under drip irrigation you have the roots having to form in the lower layers – with less bio-activity

12) Orchard irrigation emitters cover 1/3 to 1/2 the orchard floor - they're very efficient with water, but again you have a restricted root zone during the growing season

13) Early pioneers called for attention to soil fertility in managing pests and diseases: J I Rodale said healthy soil = healthy food = healthy people; William Albrecht, one of the pioneers in soil science development said: food is fabricated fertility

14) As early as 1972 they were noticing relationships between mite populations and nitrogen fertilization

15) As early as 1975 they showed the interactions between calcium and nitrogen-stimulated growth

16) In 1980 they began to talk about the relationships of not just yield and quality, but nutrients and disease resistance or susceptibility in vineyards

17) By 1996 they were beginning to talk about the fact that trees and vines tend to be fertilized with more nitrogen than they could take up and that the **use of excessive nitrogen is not the exception but the common practice**

18) So now some areas in California, such as the Salinas & San Joaquin Valleys nitrogen management plans are now required to meet Regional Water Quality Control Board discharge requirements – due to the excess use of nitrogen and its potential impact on groundwater

19) Here is some basic soil science that will help: this classification system was developed by William Albrecht; showing some of the basic processes that result in formation of soils. On the right we see a **Desert Soil**: very low rainfall; more evaporation than precipitation; low organic matter accumulation; increasing pH & carbonate accumulation; ;ow animal/protein production. These soils were called 'Under Construction' and need water, leaching of excess salts, and sometimes micronutrients. With the addition of abundant water these can be very productive

On the left you see a **Forest Soil**: high rainfall; more precipitation than evaporation; leaching of minerals, increasing acidity; bicarbonate production; supports moderate amounts of animals; high OM in shrubs & trees; produces carbohydrates: wood & fruit. These soils need limestone, often major nutrients, and are called 'Under Destruction' (plants are pulling nutrients from lower layers, dropping leaves on the surface to mulch & slow leaching)

In the middle you see what he called '**Well Developed**' soils. These are prairie/grassland soils; a medium amount of rainfall; balanced precipitation & evaporation; high organic matter accumulation (mostly in the roots); nearly optimum balance of minerals in the topsoil; medium pH range (just enough acidity to dissolve nutrients). These areas produced the most protein; our forages, grains, legumes. This is the corn belt, the soybean belt, where the buffalo roamed. The highest animal production occurs in this type of soil - what it needs is just to maintain the fertility and the organic matter.

20) Soil organic matter is about 5% nitrogen; if you have SOM in your soil from 1 to 4% you can have 1700 to 6800 lbs per acre foot of nitrogen in that soil. Generally, only two percent is considered available for crops - that's 34 to 136 lbs. With thousands of pounds possible achieving the above average or best conditions for nitrogen availability should be the standard practice. Since most crops only remove 100 to 300 lbs of nitrogen per acre then reductions in applications of nitrogen are certainly possible

21) Again, there is quite a bit of potential for improvement in nitrogen use - if a 1% organic matter has 1700 lbs/ac ft of nitrogen and 4% has 6800 lbs of nitrogen, how do we release more than 2%? You need abundant phosphorus, potassium, calcium, magnesium, sulfur, and micronutrients. You need optimum cation balance; optimum soil aeration especially optimum soil biological biological activity.

22) Here's the nitrogen cycle that you would have in any biology class **- the nitrogen cycle requires air**: organic matter breakdown needs oxygen; protein synthesis needs carbon dioxide; nitrification needs oxygen and carbon dioxide. It all works best in a moist, well-aerated soil environment

23) Most nutrients can be taken out and stored by trees for later use, however potassium is not stored in the plant and is a necessary component of cell sap. Fruit becomes a potassium sink when ripening, requiring an abundant supply. Calcium is needed in constant supply for root growth. If trees must search for Ca while blooming or developing fruit, supplies can be short

24) Potassium is one of the most important nutrients for reducing susceptibility to diseases – there are over 140 diseases that are aggravated by poor levels of potassium, caused by fungi bacteria, viruses, and nematodes

25) Calcium has several vital roles in plant tissues: it increases the membrane stability and increases the cell wall strength. Tissues high in calcium have stronger cell walls, are firmer, and resist infection more readily

26) Calcium disorders usually occur if the plant is undergoing rapid vegetative growth. In conditions such as high temperatures and high soil nutrient levels (especially nitrogen) more calcium is required. Commonly found plant pathogens will attack and colonize such compromised tissues

27) A diagnosis error may occur because of the presence of known pathogens which are really only acting as secondary decay organisms. According to this source, in most instances application of calcium to the soils containing “abundant levels” of this element has little effect

28) Quote me on this **there is no standard definition of abundant soil calcium levels, so most fertilizer technicians, researchers and consultants do not know whether the soils they work with have optimum calcium levels - especially for best pest and disease resistance**. To be truly integrated pest and disease management must consider soils and fertilization at the beginning, and should be backed up by data meaning soil and tissue tests

29) This shows fertilizer sales as percent of total NPK in California in 2018. The trends are similar today - 68% of the fertilizers sold are nitrogen, 23% are potassium, and 9% are phosphorus

30) United States agriculture increasingly relies on fertilizer for crop production - here's the trend from 1960 to 2020 - it has tripled during that period

31) World use of nitrogen per hectare increased sevenfold from 1961 to 2020

32) So, what do crops actually need? This is crop nutrient removal for deciduous trees and vines. This can be tricky to determine - I figured this would actually be very easy, you just look up the tables and there they are. You have to make sure they're accounting for the nutrients contained in the fruit, seeds, skins and the woody parts. So here is nutrient removal in pounds per acre per year of the common tree fruits - basically potassium is greater than nitrogen which is greater than calcium; and the other nutrients follow

33) Citrus, which keeps its leaves on all year, requires a lot more calcium - it is mostly contained in the roots and the leaves, so calcium is greater than or equal to nitrogen removal (which is also high due to year-round roots); and both are pretty close to potassium. Phosphorus and magnesium follow. Deciduous nuts and other protein crops tend to require more nitrogen, so nitrogen is greater than or equal to potassium which is greater than calcium.

Sometimes calcium is called a micronutrient which is not true it is a major nutrient.

34) It is important to know that protein crops such as nuts tend to need more nitrogen than carbohydrates (fruits). Citrus and crops that have year-round leaves have more nitrogen and calcium tied up in the leaves and roots - so seasonal tie ups of calcium can occur even if crop removal is less. “There is an agreement that

calcium, nitrogen, potassium are the dominant constituents of the citrus tree biomass; phosphorus magnesium sulfur represents smaller portion”

35) So, under a typical irrigation system in the summer nutrients come from either stored reserves or immediate uptake. This shows oranges - nutrients have to come out of a smaller area than the if the whole orchard were irrigated

(36) This is also true for deciduous tree fruits - they're having to ripen fruit and remove most of that potassium from the the smaller root zone under the irrigation system

37) With vineyards under a drip system, you have a smaller tonnage, but it is all concentrated in that small area under the dripper - you really have to pay attention to the nutrient balance and the total amounts of nutrients that are there if you want to grow good, healthy vines

38) This should have been front page news - research from 1995 showing that excess nitrogen increases susceptibility of nectarines to diseases and pests.

39) This shows photomicrographs of the cuticle of the nectarine - showing that low nitrogen is two to three times as thick as the high nitrogen cuticle - which makes it more susceptible to infection by brown rot, insects, and post-harvest diseases

40) This research showed that two of the main pests in peaches and nectarines: peach twig borer and oriental fruit moth were increased by the higher nitrogen orchards (with more succulent leaves)

41) Most crops show more succulent growth and thinner skins with high nitrogen, which is what pests & diseases love. In citrus they found more vegetative growth as opposed to flowering; the thickness of grapes was found to be thinner with excess shoot growth and reduced fruit firmness. In apples and other fruit firmness was worse, also cell wall thickness and thinner cuticles in apricots and other fruit trees.

42) The following principles should be applied to all crops - 1) excess nitrogen aggravates many problems 2) there's a high likelihood that excess nitrogen is being applied and 3) nutrient budgets should address the other nutrients

43) Here are some of the common pests and diseases affected by excess nitrogen in my research –

TREE FRUITS - **Pests:** 2 spot mites, European red mite, nematodes, mealybugs, leafhoppers, psyllids, oriental fruit moth, peach twig borer. **Diseases** scab, fire blight, powdery mildew, storage rots, bacterial canker, Botrytis, brown rot, shot hole, bacterial rot, do these sound familiar?

NUTS - **Pests:** aphids, navel orange worm, mites. **Diseases:** rust, scab, bacterial canker, brown rot, hull rot, shot hole, kernel necrosis.

GRAPES – **Pests:** 2 spot mite, mealybug, Pacific mite, vine mealybug, Phylloxera, grape berry moth, leaf hoppers. **Diseases**: bunch rots, Botrytis **(14 studies showing excess nitrogen aggravates Botrytis!)**, powdery mildew, cane and leaf spot, Phomopsis, downy mildew (4 studies), grape trunk disease, waterberry, crown gall

CITRUS – **Pests:** Asian citrus psyllid, aphids, black scale, citrus black fly, leaf miner, psyllid, citrus root weevil, white fly, glassy winged sharpshooter, mealybugs, citrus red mites, nematodes, purple scale, thrips, white wax scale, Gascardia, woolly white fly. **Diseases:** citrus canker, fusarium blight, brown spot, dieback, dry root rot, Xanthoma copper deficiency, Key Lime anthracnose, lemon gummosis, Mal secco, Plenodomas, and scab

44) So, we have all these problems related to nutrient availability in the industry – creating the need for sprays, dips, pesticides, and other treatments.

45) So how did we get here? Here are wine grape production costs for the San Joaquin Valley (California) in the 1980s. In those days pesticides were $149 per acre per year; fertilizer was $16 per acre per year (nitrogen only). Can you get sustained yields at 10 tons per acre per year of healthy plants?

46) It is a little more realistic now – here are the 2019 per acre costs to produce produce winegrapes in the San Joaquin Valley: pesticides $310 acre per year and fertilizers $345 per acre per year - so they're adding potassium with the nitrogen; recommending 60 lbs nitrogen to 144 lbs of potassium because now they know grapes remove more potassium. Again, will that produce sustained yields of 10 tons per acre per year?

47) Here are the costs of producing processing peaches from 2011. These are old figures but they recommend putting on 80 lbs of nitrogen with nothing else, spending 2% on fertilizers; 27% on pesticides. (Generally, more N than that is applied today). We need to put in realistic figures on what a nutrient budget would cost to maintain healthy trees

48) Almost every year problems arise; many aggravated from reliance on soluble nitrogen, making the cells thinner and the tissue softer. Crops need potassium, calcium, phosphorus, and other nutrients - and there are many studies demonstrating this.

49) I started researching studies and references on nutrient pest disease relations in 1988.I started with just taking articles and putting them in a folder; then in 1988 I published a paper with 15 insects pests, disease, and nematodes that are all influenced by soil problems and nutritional imbalances

50) After working on my master's degree in the 1990s and learning how to conduct research, use databases and searching with Google Scholar I have cumulated over 520 studies and references on the relationships between nutrition and pest, disease and physiological disorders in the literature **just on tree fruits and vines**. 64% of these references show high nitrogen aggravates the condition; 28% show low calcium aggravates the condition; 12% show relationships with potassium.

51) Slide showing totals since 1988

52) In recent years I started adding citrus and tree nuts to my database - now there are over 800 studies and articles on citrus, nuts, tree fruits, and vineyards of links between nutrients and pests, diseases, and physiological problems

53) Deciduous fruit – (apples, pears, stone fruit, and a few others): there are 81 references showing high nitrogen makes pests worse, and 116 references showing diseases are worse

54) In citrus I stopped at 100 there are 87 showing high nitrogen makes pests & diseases worse; with 12% of them showing calcium makes it better and 11% show potassium is involved. 8% show that ratios of nutrients are involved

55) In nuts out of 50 references, 60% showing high nitrogen makes pests & diseases worse; 24% show Ca better; 22% K involved; 14% say ratios of nutrients are involved

56) Micronutrients, of course, are also involved. One consideration is that trees with leaves on all year require more nitrogen - there are some studies that show high nitrogen **aids** in pest and disease resistance - at least nine I found. It should be noted that the chemical salt forms of fertilizers can knock down pests; in the case of nematodes, they actually will kill off nematodes and then, for various other reasons related to impact of these concentrated salts on soil biological activity, the nematodes can come back in higher numbers

57) I think we have demonstrated that point - are there any questions?

58) Now let's look at some case studies – here is fire blight, the bacterial disease of apples and pears, found pretty much throughout the world. It infects the blossoms and young fruit. They require the presence of

bacteria in the blossom, environmental conditions (they like it warm and humid) and a **susceptible host.** Most sources caution that excess nitrogen aggravates this disease.

59) Here you see an example of excess vigor on April 30th of 2000: when the fruit is very small you have a 5 inch apple leaf just after bloom (not counting the petiole), excess nitrogen in the leaf analysis (16 references show fireblight is worse with high N); deficient calcium and potassium in the soil (6 references show this is worse). The leaf content was approximately 10% above the optimum; and the soil cation ratios show potential for poor uptake of calcium and potassium

60) So, in 2000 and several years since that the weather and cultural conditions were just right for disease development. Apple growers throughout the Central Valley of Calif. suffered severe economic losses - the standard practice of over fertilization with nitrogen to achieve large apples results in a susceptible host

61) This is pretty typical shoot growth in Northern California - this pear orchard shows 24 to 48 inches of shoot growth when they recommend 12 to 24 inch shoots - and I would say that 24 inches is even too much vigor

62) Back to this apple orchard in 2000, which has 24-inch shoots in early June - and they ended up much taller, a perfect condition for fire blight outbreaks under the right weather conditions

63) There are other examples of this: bunch rot in grapes, brown rot in cherries and stone fruit, *Botrytis* rot in strawberries

64) Another case study - brown rot in stone fruit. *Monilinia* brown rot infects the blossoms and twigs and the fruit of stone fruit - 12 references show high nitrogen makes it worse; 10 references show high calcium makes it better.

65) For organic brown rot management you need a combination of mineral and biological fungicides. We've gotten very good, consistent results in peaches, nectarines, plums, and cherries by minimizing nitrogen, and providing abundant calcium and potassium - even in very wet years. We have had good, mixed and sometimes poor results in the early blooming apricots

66) I have observed that it is saturated soils rather than light rain events that aggravate brown rot blossom blight in early blooming varieties. Here is a saturated orchard, February 2023, in Northern California

67) This is an orchard about 3 miles away from the one we just showed that uses compost, mineral balancing, cover crops – the same time of day; it just doesn't have the the standing water and the anaerobic conditions that occur when the soil is saturated

68) Also, every crop has dieback and similar diseases, root rots, branch dieback, decline, nematodes. They have discovered all sorts of different organisms that cause dieback (11 different fungal species isolated from grapevine cankers) - what we find is when they're supplied with proper nutrition, incidence is much lower

69) Again, there are 104 references linking excess nitrogen to pest problems and 256 to the diseases in grapes, nuts, and tree fruits. Here you see aphids building up just around the veins - they're sucking the nutrients as quickly as they can come up into the plant

70) Quantifying crop fertilizer needs is the best way to develop nutrient budgets to address this. Actual crop nutrient removal is a good way to quantify **minimum** fertilizer needs. It is not that easy to find the research on this - they need to consider all the nutrients removed by the crop: edible parts, seeds, skin, stems, plus the woody parts and the roots of trees and vines. Using crop removal with soil analysis results will help you figure out likely limiting factors. To me **the minimal fertilization program should replace the nutrients removed annually by the crop** - this should also consider the temporary seasonal removal by the leaves and roots

71) Newer biological materials can offer 80 to 90% control, sometimes more - but often it is not good enough. Do we need a more integrated approach? **(Yes)**

72) Good news - biological materials are the fastest growing sector in the pesticide industry! This shows a chart - up to 61% of pome fruit growers are now using biological materials. This is up from the 1970s and 80s when almost no farmers used these tools

73) So biological and 'soft' materials do have their limitations - but my question is: will the healthier, less vigorous host allow better control with soft materials? I say **yes**

74) So what do we do to minimize pesticide use and assure optimum quality, flavor, and health - and I should add good yields?

75) This is the program I've been working with since the late 1970s. I put this summary of it together in 1988; here is the program:

- Balance the soil exchangeable cations to 65-75% calcium; 10 to 15% magnesium; 2 to 5% potassium; 0-5% sodium. Maintain the cation balance with appropriate mineral amendments – (this can be adjusted for your area and your crop but can be very important)
- Maintain phosphorus, potassium, sulfur and micronutrients at generous levels
- Build and maintain organic matter through cover cropping, addition of composted organic matter and/or microbial soil inoculants, and promotion of healthy biological activity in the soil
- Supply nitrogen in adequate amounts for crop needs - only avoiding excess soluble nitrogen, applying N sparingly in split applications or via composted organic matter for activation of the nitrogen cycle and slow release
- Foliar feeding of nutrients known to be deficient - applying during stressful times (bloom, maturity adverse weather and pest and disease pressure) (Young, 1988)

76) Why not use the soil cation ratios that most major soil labs show on the soil analysis report form? (many no longer do this)

77) Cation balancing is controversial - there's not enough applied research; here are some facts: the major soil cations calcium, magnesium, potassium, sodium, hydrogen all interact - when one is high others are low or out of balance. The ratios affect the soil poor space, the drainage, and the tilth - especially low calcium with high sodium or magnesium, which results in poor drainage and soil aeration - which adversely affects the nitrogen phosphorus, sulfur cycles and the potassium availability.

These all affect pest & disease resistance

These ratios can be fine-tuned and modified; for instance in wine grapes and tree fruits we like potassium up there near the 5% level because they remove so much potassium

78) Here are some articles illustrating some of this- they found that when you have a chemical imbalance between calcium and **sodium plus magnesium** then you have poor soil structure and drainage. (In the past they calculated Ca + Mg together vs Na ratio – they should be analyzed separately)

79) Calcium is…essential for good soil structure; balancing both the soil and irrigation water using additional calcium can correct nearly all water penetration problems

80) This can result in less irrigation needed and better soil aeration in the root zone

81) For optimum soil structure there should be approximately 16 times more calcium than sodium and 8 times more calcium than magnesium in the soil (this is based on ppm exchangeable Ca; as percent of CEC ratio of Ca:Mg should be about 6:1) GY

82) Cation ratios are valuable for fine tuning fertility programs; solving problem soils (poor structure, tilth, and drainage); developing programs with lower nitrogen inputs; producing higher quality, flavor, nutritional value - not just yields; and improving organic matter management

83) Soils with low clay content retain less K^+ in the exchangeable form, while soils with higher clay content retain K+ to a greater extent

Application of winery wastewater with high K+ and Na+ concentration resulted in accumulation of available K+

The actual amounts and the ratios between the four dominant basic cations, Ca^{2+}, Mg^{2+}, K^+ and Na^+, adsorbed on the soil exchange complex, are important with regard to soil chemical and physical conditions, as well as plant nutrition.

84) "Adequate K^+ is… important for grapevine performance and K+ deficiencies will cause low yields... excessive K^+ levels can cause poor wine quality in terms of low acidity and poor colouring of red wines"

High levels of exchangeable K^+, similar to Na^+, can increase dispersion resulting in reduced soil hydraulic conductivity and water infiltration rate

Dispersion leads to degradation of soil structure, which causes problems such as soil crusting (surface sealing) and slaking that can lead to low water infiltration rates, low hydraulic conductivity, poor aeration, poor root development and functioning

85) If you are fertilizing/watering with a typical low N, high K blend (or winery wastewater) you will be overloading the soil colloid with K. This creates conditions where vines have to exert energy to get needed calcium. **Vines will have reduced ability to resist *Botrytis*, stem necrosis, freeze damage, storage rot, cane dieback, nematodes**

86) Several researchers have tried to validate the cation balancing theory with both greenhouse and field experiments but could not conclude that an ideal cation saturation ratio existed and found that **CROP YIELDS** were similar across a wide range of ratios.

Some even argue that soil balancing improves nutritional quality of the harvested crop. However, **contemporary research to objectively demonstrate such perceived benefits of practicing soil balancing is missing**

87) Here are some of the ways to apply amendments - spreading limestone in an orchard; using a solution injector for gypsum or potash to the irrigation system; and just spot treating trees

88) Building and maintaining organic matter: you can fertilize with compost; use compost tea generators and inject CT or soil inoculants into the irrigation systems; you can also spot treat trees and vines

89) To achieve nitrogen **for crop needs only** - develop well formulated nitrogen budgets, taking into account the enhanced ability of a soil balanced in minerals with best aeration and high in biological activity. These are some of the results I have seen: it is common to put on 100 up to 200 lbs of nitrogen on nuts, and a little less than that in other tree fruits - we've been able to get by very well with 1/2 to 1/4 of that commonly applied amounts

90) Now lately I'm seeing an alarming trend - **people are farming conventionally with organic compliant materials**: overapplying compost with the mistaken belief that only small percentage of nitrogen will be

available for crop use; instead of using mineral sources, attempting to supply high amounts of minerals through compost (calcium, potassium), instead of using the mineral amendments.

And - **fumigating to knock down soil pathogens** (which are result of conventional practices), then planting trees and harvesting after the legal period has passed for non-compatible materials for organic farming (in lieu of biological and mineral augmentation)

91) Compost is controversial – there was research in 2009 on the nutrient value of compost that says net nitrogen mineralization of common types of compost to be less than 10% of the nitrogen in the first growing season (more recent research suggests 30%); very high nitrogen manure based compost is greater than 3%. I do not see this in the field; the crop response just doesn't add up. It is more like 75 to 80% of the nitrogen is released in the first year

92) Foliar feeding - the application of essential plant nutrients to the above ground parts of plants. There are many reasons for foliar feeding: it is a highly efficient and timely method of applying nutrients that could be limiting factors; it can compensate for soil or environmentally induced deficiencies; it can be used to augment resistance to pests and diseases when applied at stressful times

93) Research (2006) that says “calcium sprays are exploited as a main tool in integrated peach production leading to environmentally more friendly growing techniques promptly, by increasing tissue firmness and resistance to brown rot. Even in calcareous soils pre-harvest calcium sprays have proved beneficial”

94) Similar research (2015) suggests that foliar sprays of calcium be used in an integrated approach to post harvest disease management in stone fruit, strawberries, citrus, cherry, melons, and pomegranates

95) What about silicon? Now there are several products registered as nutrients and/or pesticides that help control pests and diseases with silicon.

96) Rudolf Steiner who wrote this in 1924, 100 years ago: “It is only through the balance of these two formative forces - as embodied in these two substances silicon and limestone - that plant life can flourish in the form in which we know it today”. There is the biodynamic preparation 508, prepared from a silicon-rich horse tail plant, used as a foliar spray to suppress fungal diseases. (I tend to prefer the stronger salts of silicon)

97) There are studies showing that added silicon to the growing media reduces the presence of powdery mildew in a variety of plants. This nutrient also protects against bacterial and viral infections in certain plants. Not only does silicon protect against disease, it also reduces the population of insects and mites feeding on plants.

98) Potassium silicate has potential as an alternative to sulfur for powdery mildew control

99) Recent studies show that insects feeding on silicon treated plants produce fewer offspring, suggesting that silicon is altering some aspect of the plant material. Combining silicon with other biocontrol agents may lead to better protection and control over infestations.

100) So, I've called my little movement **Quality First** - a movement to promote the best fertilization for quality, flavor, and reduced pest disease problems . There are companies out there that do sap testing and have products that improve flavor in wine grapes for instance. This shows increased flavor components from an advanced fertility program.

101) For a more comprehensive analysis of this approach see A Training Manual for Soils and Fertilization in the North Coast of California at www.qfirst.net

This includes a review of the work of Albrecht and early soil scientists; lessons for interpretation of soil results; and balancing soil cations, using composts & cover crops, using foliar feeding to raise pest/disease resistance, and **why you can cut nitrogen usage 25-75%**

102) I like this quote “While it is not necessary for everyone to know the details of potash mining or the chemical reactions involved in phosphate fertilizer production, they should be able to understand that **you can't get something for nothing. Plants always require the basic components of growth from the soil in order to thrive”** (not just to live)… “the inescapable link between well-nourished plants and healthy food should be evident to everyone”

103) I have posted the references and more information with the tables and references and a narrated slide show on the website: www.qfirst.net

104) The end

Questions?

gregg-young@comcast.net