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Phosphates vs. Phosphites

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Phosphates vs. Phosphites

- How are they similar
- How are they not alike
- When and where do you use them
- The controversy
- The Law
- Phosphite (phosphorous acid): Fungicide, fertilizer or bio-stimulator?, Thao and Yamakawa, Soil Science and Plant Nutrition (2009) 55, 228-234
- Last year's WPHA phosphorus presentation can be found at www.holdenresearch.com for further review of what I will be discussing in part today.

My History

- Approached by Biagro Western in 1994 to formulate Nutri-Phite
- Built plant at AG RX in 1995 and started production.
- Shut down for 3 months till January of 1996 over legal dispute with Rhone-Poulenc.
- Conducted my own research on the nutritional effects of PO_3 on avocados and citrus during the same time period.

My History

- The questions and misunderstandings raised by the introduction of phosphite fertilizers has generally taken more of my time as a single subject than all other nutrient or cultural practices for the production of the crops I work with.
- There is significant misunderstanding and ignorance about these products!
- Hopefully I do not add to that misunderstanding today.

University Recommendations for Cool Season Vegetables

Fertilize only when soil testing suggests that plants are likely to respond to fertilization. For soils with pH > 6.2, the most appropriate soil test is the Olsen (bicarbonate) procedure. Soils with Olsen P > 80 ppm contain sufficient available P for optimum vegetable crop production. Continued fertilization of these soils wastes money and increases the potential for P pollution. Soils testing in the range of 40 to 80 ppm may under some circumstances (low soil temperature, for example) respond to P applications, but only a small amount of P would be required. Small, at-planting "starter" applications would be sufficient. For summer-planted fields, no P fertilization should be necessary for soils that test > 40 ppm.

University of California, ANR Publication 8098, Nutrient Management In Cool Season Vegetables

What are the Issues with Phosphorus Availability

- pH
- Temperature
- Cation inhibition
 - Calcium
 - Zinc
 - Etc.

How Soil pH affects P₂O₅

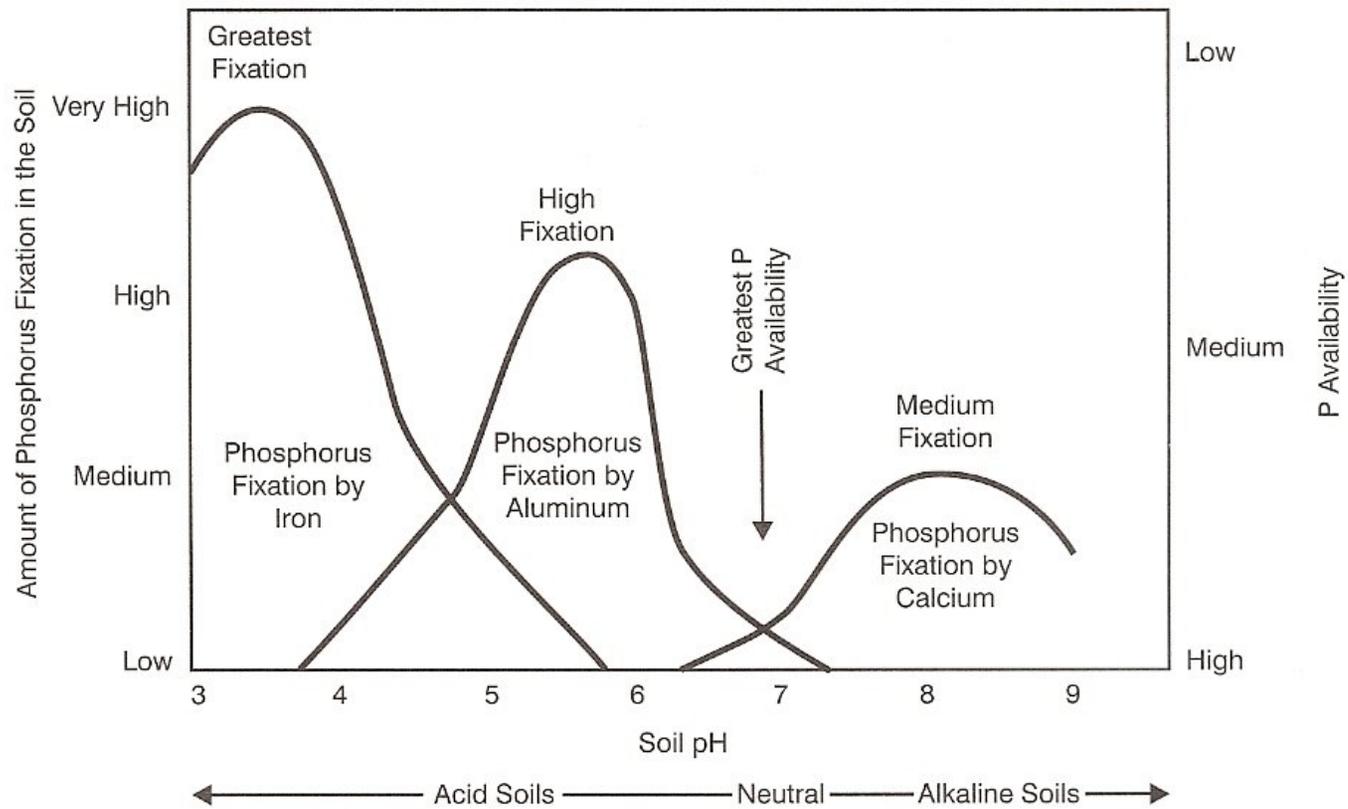


FIGURE 4-4. Phosphorus availability as influenced by soil pH.

Cool Soils

- Cool soils may induce phosphorus deficiency
- With cool soils you have slower root growth and development
- Less opportunity for roots to come in contact with the phosphorus they need at this time
- Limiting phosphorus in cool seasons exacerbates the ability for cool season vegetables to grow.

Cation Inhibition

- Calcium and zinc cations (and others) have an affinity for PO_4 , phosphate anion.
- They form calcium and zinc phosphate precipitates which are now hard to resolubilize for root uptake.
- But this also helps reduce leaching of PO_4 from the soil solution.

Plant Phosphorus Utilization

- Forms nucleic acids (DNA and RNA)
- Used in the making of the chemical energy molecules of ATP and ADP.
- Through this transfer of chemical energy it is utilized in new growth and reproduction.
- Note that dry leaf analysis of P_2O_5 in young leaves is always higher than that found in older leaves.

Symptoms of Phosphorus Deficiency

- Slow growth, stunted plants
- Purplish coloration on foliage of some plants (older leaves first)
- Dark green coloration
- Delayed maturity
- Poor fruit or seed development

Not So Obvious Symptoms of Phosphorus Deficiency

- Poor root development
- Reduced production
 - Sizing reduction
 - Fruit set reduction

Phosphate vs. Phosphite or Phosphoric Acid vs. Phosphorous Acid

- One is the source for a fertilizer, the other is a source for a fertilizer and a fungicide?
- Phosphate fertilizers are generally made from phosphoric acid (H_3PO_4), while phosphites are made from phosphorous (not phosphorus) acid (H_3PO_3)
- PO_4 vs. PO_3 . PO_3 will (?) oxidize eventually to PO_4 or converted by soil micro-organisms.
- Know the difference. There is still quite a bit of confusion regarding these source products

Are Phosphites Fertilizers or Fungicides

- Well technically it depends on what the label says.
- Excellent Journal paper on this issue
- Phosphite (phosphorous acid): Fungicide, fertilizer or bio-stimulator?, Thao and Yamakawa, Soil Science and Plant Nutrition (2009) 55, 228-234
(<http://onlinelibrary.wiley.com/doi/10.1111/j.1747-0765.2009.00365.x/abstract>)
- But even their conclusions are still controversial

What are Phosphites?

- Fertilizer?
- Fungicide?
- Bio-stimulents?
- Or an inducer of Systemic Acquired Resistance (SAR) in plants? In other words in the presence of phosphites certain genes are “turned on or off” that help the plant in the presence of certain diseases.

Fertilizer

- Works by Lovatt, Albreggo, and others
- Research by myself.
 - Citrus. Multiple application at 2 qt/a showed no differences in background P levels in the leaf. But in defence of phosphites rarely have I seen increases in P levels with foliar phosphates on citrus.
 - Avocados. Single foliar applications at 2 qt/a at bloom showed increases of retained fruit on the tree at three months post set of 25-30%

Fertilizer

- According to Thao and Yamakawa, there is no evidence that phosphite can be used directly by plants. Numerous studies sited
- Their conclusion is that what appears to be a fertilizer response in field trials is always a response to background field pathogens such as *Phytophthora* spp.
- Some fertilizer response may be due to conversion from PO_3 to PO_4 by field micro-organisms.

Fertilizer Calculations

- Say we have a soil reading of 15 ppm P_2O_5 and want to raise it to 40 ppm
- We want 25 ppm more of P_2O_5 in the soil
- 25 ppm in 1 acre foot is approximately 100 pounds P_2O_5 in 4 million lbs of soil (approximate weight of 1 acre foot)
- Using 11-52-0, it would take 192 lbs/ac. 10-34-0 would require 294 lbs/ac or about 25 gallons.
- Using a 0-29-26 Phosphite fertilizer would take the equivalent of 344 lb/ac or 27.3 gal (344/12.6 lb/gal)
- That is a lot more than most Phosphite labels suggest per acre per application (usually 2-3 qt/ac)
- This is not practical based on cost and could very well be detrimental based on some of the data reported in the Thao and Yamakawa paper.
- But as a foliar fertilizer the 2-3 qt/ac might be practical.

Fungicide

- As mentioned before Thao and Yamakawa contend that there is no evidence to date that can clearly demonstrate that plants use PO_3 directly as a P nutrient.
- Plenty of evidence of the positive effect against the lettuce pathogen that causes Downy mildew (*Bremia lactucae*) or the avocado pathogens that cause root, crown rot in avocados and brown, foot rot (*Phytophthora* spp.) in citrus

Fungicide

- So is the effect of phosphites truly fungicidal or rather bio-stimulent or Systemic Acquired Response effects (SAR).
- My question is it truly a “cide”? Does it kill the disease or cause the plant to survive in the presence of the disease?
- I would contend it is the later.
- More research needed.

What were Thao's and Yamakawa's Conclusions

- Phosphites can be absorbed by most plants through the roots and leaves, but not used directly as a nutrient source.
- Phosphites do not have any stimulating effects on the growth of healthy plants.
- Phosphites effects on crops is strongly dependent on the P nutrient status of the plants. Phosphites can have a deleterious effect on P deficient plants.

Legal Issues

- If the label says fertilizer it cannot be used as a fungicide.
- In order to use a phosphite material as a fungicide it must be EPA and Cal EPA labeled for that use.
- As a PCA you cannot recommend a fertilizer labeled phosphite as fungicide.

My Perspective

- Phosphites are still mysterious
- My opinion is that they fall in a grey area of effectiveness, probably closer to a SAR as mentioned before.
- Will still find the pathogens after their use, but the disease is often suppressed, but not necessarily controlled. A fungicide by definition
- They do seem to stimulate new growth as would a phosphate application. A fertilizer by definition.



Thank you

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