

Phosphite use in a declining fungicide market

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Phosphite has been a controversial topic for years. Is it fertilizer, a biostimulant, or a fungicide? Looking carefully, one can conclude that phosphite serves all three functions. In this article, we'll focus on the use of phosphite as a fungicide. As with

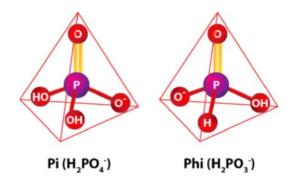
everything we do with chemicals and nutrition, we need to be aware of possible negative effects, and we also need to determine how we are using the phosphite materials and the results we are seeking. Earn 0.5 CEUs in Integrated Pest Management by reading the article and taking the quiz.

Phosphite has been a controversial topic for years. Its use and benefits are argued in hundreds of research papers across the world's scientific communities. Is it fertilizer, a biostimulant, or a fungicide? These questions are discussed in multiple university research results. I believe that if we look carefully, we can conclude phosphite serves all three functions. As with everything we do with chemicals and nutrition, we need to be aware of possible negative effects. We also need to determine how we are using the phosphite materials and the results we are seeking.

Phosphite (PO₃³⁻), a reduced form of phosphate (PO₄³⁻), is widely marketed as either a fungicide or fertilizer or sometimes as a biostimulants. Because crop consultants, growers, and distributors see the product marketed in all three ways, it can cause confusion. Each designated use will most likely be tied to the phenology (growth stage) of each crop treated. Timing is critical to determine which effect we are seeking. Previous articles have addressed phosphite in a plant nutrition role. Additional articles speak of phosphite in terms of a biostimulant.

In this article, we broach the controversial topic of phosphites as a fungicide.

Phosphite's history since the 1970s has given rise to many fungicide brand options for agriculture use. USEPA-registered labels exhibit several active ingredient versions of the phosphonate category, which are all derived from various manufacturing processes. Phosphonate is a general collective term used for the salts and esters of phosphites. This will also include



Phosphite (Phi) has one less oxygen compared with phosphate (Pi). This substitution results in significant differences affecting the behavior of both molecules in plants.

phosphorous acid, phosphoric acid, and phosphonic acid.

Mode of action against pathogens

Phosphite salts can be used as a biodegradable fungicide to protect plants against
Phytophthora dieback. It is usually applied as potassium phosphite, derived
from phosphorus acid neutralized with potassium hydroxide. Calcium, aluminum,
ammonium, and magnesium phosphite may also be used. The phosphonate fungicide
group disrupts the *Phytophthora* fungus through interference of phosphate

metabolism. Polyphosphate and pyrophosphate accumulate in the cells, which divert ATP from critical metabolic pathways. The result is decreased growth of the *Phytophthora* fungus. Oomycetes pathogens, in addition to *Phytophthora*, may be controlled or inhibited directly or indirectly with applications of phosphites.

A known indirect method of fungal control of how phosphite works is by boosting the plant's own natural defenses and thereby allowing susceptible plants to survive within sites that are infested with Phytophthora dieback. It is important to note **that there is** no treatment that will eradicate Phytophthora dieback, including phosphite.



Dieback of pepper plant due to Phytophthora capsici stem rot and blight. Photo courtesy of Nancy Gregory, University of Delaware, Bugwood.org.

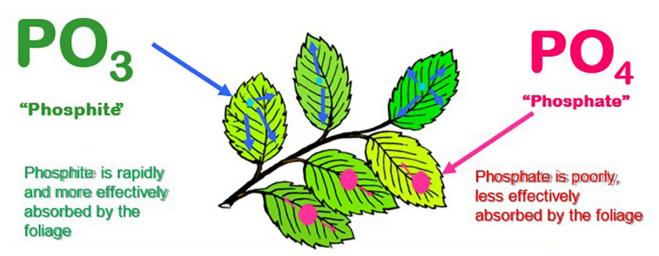
Phosphite can enhance plant health directly through control of selected fungi on cultivated or native plants. In general, phosphite acts as a priming agent of several plant defense responses. The plant's disease defense response is referred to as systemic acquired resistance (SAR). Cell-to-cell signaling triggers a dramatic increase in gene expression. A 2021 study showed phosphite applied to potatoes upregulated 2,856 different genes. Excellent reviews on the use of phosphite to control or reduce the severity of selected plant diseases have been published. Phosphite-based fungicides often are labeled as fertilizers because of signifi cantly less complex and costly regulatory

approval processes required for fertilizers compared with fungicides.

Use of phosphite as a fungicide is primarily targeted to control of oomycete pathogens like those of *Phytophthora*. It has been shown to control many others. In studies, growth of a phosphite-sensitive strain was inhibited regardless of phosphorus supply, whereas resistant strains were inhibited by phosphite only under low phosphate levels. Phosphite is effective in controlling root and crown rot caused by *Phytophthora*, and researchers reported a linear reduction in the severity of downy mildew and a significant improvement in soybean with an increase. Significant phosphite control of phytophthora disease in citrus may be achieved through both soil and foliar applications. Soil-applied phosphite was more effective in controlling citrus root rot. In addition, some nematode control has been documented.

Wide range of control

The concentration of phosphite at the infection site is key. At lower levels of concentration, antifungal metabolism can be triggered, and at higher concentration, phosphite can inhibit fungal growth. Ink disease in walnuts was significantly reduced through some treatment methods. Foliar-applied phosphite has been successful in controlling pecan scab. Phosphite has also shown it can be effective in crown rot on peppers. Fungicides containing phosphite can suppress foliar and soil-borne diseases. With foliar diseases, repeated applications are frequently needed as phosphite should be present at the time an infection occurs. In contrast to non-systemic fungicides (e.g., mancozeb) labeled for oomycetes, phosphite is readily translocated throughout the plant, which is especially advantageous for disease control in potato tubers and other underground plant tissue in potatoes. Phosphite has been foliar-applied during the growing season or sprayed on potatoes post-harvest both with excellent fungal disease control.



Leaf entry of phosphites vs. phosphates: Stabilized phosphites are able to penetrate foliage more effectively than phosphates. Illustration courtesy of Verdesian.

Interestingly, phosphite has been shown effective against summer decline in creeping bentgrass by *Pythium*. Root and shoot growth improvements have been observed in turf management along with good control on dollar spot. Additionally, positive control of *Pythium* in bluegrass was observed. *Pythium* blight suppression due to phosphite treatments on perennial ryegrass and creeping bentgrass and anthracnose basal rot on an annual bluegrass were reported.

As seen below, the benefits of phosphite in the control of numerous diseases have been researched for years (Table 1). The number of research reports is too numerous to go into in a short review. We encourage CCAs and PCAs to research this effective tool on their own and find the fit in the crops they manage. We need all the tools at our disposal, and phosphites are proven by research to be effective. The phosphonate chemistry is designated as a Group 33 fungicide. Consider using this active ingredient with your fungicide program to help prevent or delay disease resistance.

Table 1. Summary of reported phosphite control of fungal diseases in crops.

Plant disease	Causal agent
Apple mouldy core	Alternaria alternate
Avacado dieback	Phytophthora cinnamomi
Banksia dieback	Phytophthora cinnamomi
Bentgrass summer decline	Pythium spp.
Cabbage clubroot	Plasmodiophora brassicae
Chestnut ink disease	Phytophthora cambivora
Cucumber damping-off	Pythium ultimum
Grape downy mildew	Plasmopara viticola
Lupin dieback	Phytophthora cinnamomi
Maize downy mildew	Peronosclerospora sorghi
Orange brown rot	Phytophthora citrophthora
Papaya fruit rot	Phytophthora palmivora
Pecan scab	Fusicladium effusum
Pepper crown and root rot	Phytophthora capsici
Potato late blight	Phytophthora infestans
Potato pink rot	Phytophthora erythroseptica
Potato bacterial soft rot	Erwinia carotovora
Soybean downey mildew	Peronospora manshurica
Strawberry leather rot	Phytophthora cactorum
Tangelo brown spot	Alternaria alternata
Tobacco black shank	Phytophthora nicotiana

Phosphite performance will vary from suppression to control of certain fungal pathogens. Keep this in mind if you use them without a tank mix partner. Since all phosphites are not created equal, we advise caution to use them correctly. Without special stabilization through the manufacturing process, they do not mix well with metal micronutrients or metal-containing fungicides and pesticides. There is currently technology that allows you to mix phosphites safely and effectively. To learn more about a special patented technology that can stabilize your phosphite and allow safe tank-mixing and complete efficacy of applied products, visit this site or call Verdesian Life Science at 559-203-0976.

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Self-study CEU quiz

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- 1. The fungicidal properties of the phosphonate chemistry class
 - a. allow it to be used alone in a fungicide program.

b. make it inerrective against comycete patnogens.		
c. allow it to be used with a tank mix partner.		
d. prevent it from being translocated throughout the plant.		
e. Both a and c.		
f. Both b and d.		
2. Phosphites control or suppress fungal pathogens by		
a. direct and indirect methods.		
b. altering soil pH.		
c. acting as an herbicide.		
d. None of the above.		
3. Which class of pathogens do phosphites primarily target?		
a. Revtraviricetes (mosaic virus).		
b. Oomycetes (water molds).		
c. Ustilaginomycetes (smuts).		
d. Helminths.		

4.	Mitigating disease organisms with phosphites can occur by interference of phosphate metabolism and upregulation of multiple genes. a. True.
	b. False.
5.	Phosphite is recognized as a
	a. fertilizer.
	b. biostimulant.
	c. fungicide.
	d. All the above.
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