Phosphites: Improving Tree Health & Defenses Against Ramorum Blight

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There are limited tree health management options currently available for active interventions with ramorum blight (***Phytophthora ramorum***) in oaks (SOD ñ Sudden Oak Death). Pesticides are available which have been successfully used against other species of ***Phytophthora*** spp. in trees. In addition, there are several other interventions which have received much publicity and generated regulatory discussions, including applications of chemicals currently not labeled as pesticides. Some of these materials have been found to effectively disrupt or slow ramorum blight symptom development in trees.

Improve Defense

A number of treatments listed in the literature for slowing, controlling, or preventing ***Phytophthora*** symptom development are not pesticides. Some materials are foliar, trunk injectable, or surface applied fertilizers and fertilizer-like products. These treatments are not labeled for use as a pesticide. As such, their use as a therapeutic treatment in trees through directly interfering with and killing ***Phytophthora*** spp. is illegal. These products can assist the tree system to defend against symptom development and increase physiological effectiveness.

The semantics of any therapy are critical to prevent regulatory actions against one product and in support of another. Generally, interventions which are not labeled pesticides, but have some therapeutic value to the tree, are products which improve the health and defensive capability of the tree.

Phosphites

One type of material cited and tested for improving tree reactions and survival when challenged by different ***Phytophthora*** species is called phosphite. The popular press, trade journals, and company press releases have carried many different ideas for use of phosphites to improve tree health and defensive capabilities.

Many people are familiar with the generic term phosphate, a highly oxidized phosphorus compound (PO_4). Phosphates are found as a key ingredient in many formulations of fertilizers. Phosphates are relatively easy for the tree to recover from the soil and transform into many valuable components. Phosphite is a common fertilizer component, comprising a small concentration within a phosphate fertilizer. Phosphite (PO_3) is a slightly more chemically reduced (higher energy) form of phosphorus. Trees can not use phosphite as a phosphorus source until it is converted into phosphate. There are a number of soil and tree-surface-resident organisms which transform phosphites into phosphates over time.

Phosphorous Acid Defense

Within a tree, and in the presence of water, phosphite generates phosphorous acid (H_3PO_3) and phosphonic acid (called phosphonate inside a tree). Phosphorous acid is damaging to ***Phytophthora*** spp. Most phosphites are readily soluble in water and usually odorless. Phosphites move throughout (systemically) in the tree, tending to accumulate in older branches and roots. Phosphites are cited as stimulating formation of tree roots.

The impact phosphites have on the health and defensive capabilities of a tree are related to changes in cell walls. Phosphites in the cambium area begin to change the pH of the intercellular spaces between living tree cells and stimulate the production of materials deposited into cell wall spaces. These chemicals components in the cell wall generates a stronger and quicker (more effective and efficient) reaction to damage and disruption. Phosphite can help generate a stronger compartmentalization response in tree sapwood tissues and a greater anti-biotic response in other living tissues.

Activating Tree Defenses

In trees challenged with ramorum blight, phosphite seems to generate a more hostile tree environment for ***Phytophthora*** spp. A major component of this response is minimizing available phosphorus in tree tissues and cell walls. As a result, phosphite has reduced ***Phytophthora*** lesion number and size on newly infected trees by 75%. The stronger the tree response, the slower symptoms of ***Phytophthora*** attack develop. Phosphites have been shown to lengthen the lifespan of trees newly infected with ***Phytophthora***.

It is clear phosphite can not ìcureî trees, but can be effective as preventatives or in the early stages of infection. The lasting impact of a phosphite application is governed by how long the cell wall spaces remain modified. Phosphites have been cited as affecting tree systems for two (2) years when applied by foliar spray and five (5) years when injected into the stem. Initiation of tree changes from phosphite applications usually take from 3-6 weeks to become effective. Note a number of phosphites are phytotoxic to living tree tissues, especially foliage, at solutions reaching 2% and above.

Example Phosphite Products

Agri-Fos (a phosphite trade name) minimizes symptoms development of ***Phytophthora*** in trees. It has been used in one effective formulation with an organosilicate sticker/surfactant called Pentra-Bark (also a trade name). This combination of phosphite and bark penetrater allows tree bark to be surface sprayed instead of injected. This treatment can be applied every year in the fall. If the tree has been showing symptoms of ***Phytophthora*** for more than a 6 months to a year, no treatment is recommended. This treatment is most effective when used as a preventative or very early in symptom development.

Fosetyl-Al, also called by the trade name Aliette (aluminum tris-o-ethyl phosphonate) is a phosphite product. This product has been found to affect tree changes which minimizes the rate of symptom development from ***Phytophthora*** when applied either as a foliar spray or trunk injection. The active ingredient released in the tree is phosphorous acid (H_3PO_3). Application rates for Aliette is 2.5 lbs per acre applied in May to July. Treatment prices have been listed as approximately $30.00 per tree for the material plus labor.

Nutri-Phite, a trade name of BIAGRO Western Sales, is a combination of a phosphite and organic acids. It is effective at minimizing symptom development in trees from ***Phytophthora***.

A generic type of phosphite is phosetyl-Al. Phosetyl-Al applications increase phosphite concentrations on and in the tree, peaking after 3-4 weeks with a half-life of 2-4 months. Phosetyl-Al degrades in the tree to ethanol and phosphite. Phosphite is slowly converted to phosphate by bacteria in and on tree tissues. Phosetyl-Al has been found to be transported to old branches and roots within one month of application. After 1.5 years, old branches are the dominant location for the applied phosphite.

Potassium phosphite (KH_2PO_3 or K_2HPO_3) can be used as either a trunk injection or foliar application. This material is inexpensive and effective at minimizing symptom development. Application rates for potassium phosphite are 2.6 qts per 200 gallons of water per acre applied in May to June.

Vigor-Cal Phos (a trade name of AGRO-K) is a calcium hypophosphite with copper phosphite (1/4%). The calcium content helps strengthens tree cell walls. Calcium hypophosphite with copper phosphite is a water soluble, greenish-brown, odorless liquid. It can be sprayed over foliage at rates of up to 2 qts per acre. Calcium hypophosphite with copper phosphite can be mixed with SprayTech Oil at rate of 1pt per acre. Spray only in late afternoon, never in full day sun or temperatures over 80^{o}F. The copper phosphite should not be mixed with any spreaders, stickers, or adjuvants except SprayTech Oil.

Other commercial products and generic materials are available. The proceeding products listed were to show classes and types of materials present in the marketplace.

Compound Health Risks

Tree health risk factors which disrupt and slow oak (***Quercus*** spp.) reactions to ***Phytophthora ramorum*** include: larger diameter trees; understories with infected plants; less than 150 feet downwind from infected areas; less than 200 feet downhill from infected areas; growing in stands of trees already infected; and/or, within 1,000 feet of any infected area. The woody plant family groups including the laurels, bays, huckleberries, and rhododendrons can all support and provide a distribution base in an understory or in a landscape for the pathogen.

One source suggests bark-resident moss allelopathy, with an associated decreased pH of bark lenticel surfaces, as well as the trunk base soil, as facilitating pathogen success. Liming and moss control reversed this process. Other tree and soil acidifying processes, including the lack of fire, air pollution, acid rain, and other pollution problems have been cited as initiating tree susceptibility.

Conclusions

Managing tree health under challenges from ***Phytophthora*** spp., especially ***Phytophthora ramorum*** will continue to be challenging. New ways of improving tree defenses need to be explored. Phosphites deserve a closer examination.