Considerations for Copper Sprays in Tree Fruits
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Now that spring is here and trees will be breaking bud soon, it is important to think about upcoming copper sprays. The following article came from Dave Rosenberger, Cornell.

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Copper fungicide/bactericide sprays have proven useful for managing fire blight of apples and pears, peach leaf curl and bacterial spot on peaches and nectarines, and bacterial canker on cherries and apricots. When a fixed copper is applied to apples at green tip to suppress fire blight, the copper in that spray will also provide protection against apple scab equivalent to that provided by mancozeb applied at 3 lb/A. Several lines of evidence suggest that the annual use of copper at green tip may also help to suppress DMI-resistant apple scab. However, more work is needed to verify if and determine why a single copper spray in spring might impact resistance to DMI fungicides.

In studies completed in the 1930’s, researchers found that copper-containing Bordeaux sprays applied with fish oil in spring sometimes suppressed development or release of apple scab ascospores from overwintering leaves. However, they concluded that the impact and consistency of copper was too erratic to be useful for apple scab sanitation and they focused on using urea instead. As a result, copper is no longer presumed to provide reliable suppression of scab ascospores even though copper sprays will protect green tissue from infection when applied before spores are released.

Many different copper products are registered for these uses, and it is difficult to know which product to select for any given application. In this article, we revisit a few key issues related to the effectiveness of copper.

In the past, copper products applied to tree fruits at or near bud-break were almost all "fixed coppers" that had low solubility in water. When fixed copper products are mixed with water in a sprayer, the spray solution is actually a suspension of copper particles, and those particles persist on plant surfaces after the spray dries. Copper ions are gradually released from these copper deposits each time the plant surface becomes wet. The gradual release of copper ions from the copper deposits provides residual protection against plant pathogens. At the same time, the slow release of copper ions from these relatively insoluble copper deposits reduces risks of phytotoxicity to plant tissues.

Fixed coppers include basic copper sulfate (e.g., Cuprofix Ultra Disperss, Basic Copper Sulfate), copper oxide (e.g., Nordox), copper hydroxide (e.g., Kocide, Champ), copper oxychloride sulfate (e.g., COCS), and copper ions linked to fatty acids or other organic molecules (e.g., Cueva). Note that basic copper sulfate behaves differently than the non-basic form of copper sulfate, also known as copper sulfate pentahydrate or bluestone. The addition of hydroxyl ions changes copper sulfate into a relatively non-soluble fixed copper. With traditional Bordeaux mix, which is a mixture of copper sulfate plus lime, the chemical change occurs in the spray tank as the hydroxyl ions from the lime complex with the copper sulfate to form a fixed copper.

Efficacy of fixed coppers is dependent on both the amount of elemental copper applied and on how finely the copper has been ground. The impact of particle size becomes obvious when one realizes that a spherical particle with a diameter of 2.8 microns, common in older copper formulations, contains 64 times more volume than a sphere with a diameter of 0.7 microns. Therefore, copper products with a median 0.7-micron particle size theoretically have 64 times more copper particles distributed across and adhering to treated plant surfaces than would occur following application of a copper product with a 2.8-micron
particle size if rates of both products were adjusted so as to generate the same rate of metallic copper per acre. Furthermore, research as shown that the larger copper particles are more subject to removal by wind or rainfall acting on the leaf surfaces after sprays have dried. Thus, one can achieve both better coverage and better residual activity with a finely ground copper compared to a coarsely ground copper. That fact has allowed manufacturers to gradually reduced the labeled rates for actual amounts of copper applied per acre in new products.

Reducing the total amount of copper applied in each spray is desirable so long as efficacy is maintained because copper can accumulate in soils. High levels of copper in soil have negative impacts on both plant growth and on earthworms and other non-target organisms. However, even with the best formulations, there will be an end-point where the amount of elemental copper applied in bud-break sprays will no longer provide enough residual activity to suppress fire blight and bacterial canker. That low-rate end-point has not been defined for tree fruit applications, but it undoubtedly varies both with the product used and with the post-application weather in any given year. Copper applied to suppress fire blight may have little impact on disease development if all of the copper residues are removed by heavy rainfall before trees reach the tight cluster or pink stage of bud development.

Over the last several years, a number of new copper formulations have appeared on the market with labels that allow for only very low rates of elemental copper in each application. Some of these products (MasterCop, MagnaBon, Phyton 27AG) contain copper sulfate pentahydrate rather than a fixed copper, and they therefore are more soluble in water. Manufacturers are claiming “systemic activity” for some of these products, and the higher solubility of these products may in fact allow more uptake into plant tissue. However, efficacy of these “low-rate” copper products in bud-break sprays is questionable because we lack convincing evidence that the low rates of copper that can be applied with these products will provide the residual activity that we believe is needed to suppress bacterial diseases in deciduous tree fruits. These low-rate copper products may work very well where repeated applications are made at regular intervals as occurs with citrus and some vegetable crops, but more research is needed before they can be recommended for sprays at bud-break on apples and stone fruits.

Most copper labels list a broad range of rates for bud-break sprays. In general, the upper end of labeled rates are suggested for applications that are made at silver tip or green tip on pome fruits, especially when those bud stages occur early and one can therefore expect a long, drawn-out timeframe for bud development. The lower ends of labeled rates are suggested for applications at green tip (or even at half-inch green, in an emergency) if one expects trees to advance rapidly from bud break to bloom. Using excessive rates of copper, especially finely ground coppers that have good residual properties, could result in fruit russetting on some apple cultivars if copper ions are splash-dispersed to developing fruit tissue after flowers reach pink or bloom.

As noted earlier, Bordeaux mixture is made by mixing copper sulfate and spray lime. With the fixed copper products, there is no published evidence that adding spray lime for tree fruit applications will either reduce phytotoxicity or extend the residual activity of the copper. However, some sweet cherry growers have reported that they achieve better control of bacterial canker when they add spray lime to copper sprays even if they are using a fixed copper that theoretically does not need any additional lime. Lab evaluations of seven different fixed copper formulations revealed that, when mixed at rates commonly used for dilute applications, the copper solutions in the spray tank will have a pH near 8 whereas adding spray lime at 2 lb/100 gal raises the pH to 11.0-11.5. (The old traditional Bordeaux mix formulation of 8-8-100 that was recommended for bud-break sprays also as a pH near 11, whereas a Bordeaux mix with 8 lb of copper sulfate and only two lb of spray lime has a pH near 8.) Thus, it may be that the high pH of both the old 8-8-100 Bordeaux mix and of the fixed copper-plus-lime solutions used by some cherry growers can reduce populations of the bacterial canker pathogen in ways that exceed the capabilities of a fixed copper applied alone.