Cascade Consulting and Research, LLC

Why Fall Defoliation Using Zinc Sulfate is a Bad Idea

There are a couple of reasons why growers may want to induce early fall defoliation of fruit trees, particularly apple. For some growers crop load management starts with bud counting in October or November, a task that is much easier to do with no leaves on the tree. Growers may have H-2A labor still available after harvest and want to utilize that labor force to begin pruning, again easier to accomplish absent leaves – especially if pruning to bud counts.

Then there is the (mistaken) perception that defoliation automatically equates to early cold tolerance, and the concern around highly vigorous young trees that grow late into the season being particularly susceptible to hard freezes in November or December.

Years ago, we used a couple of different surfactants in the fall to stimulate premature defoliation. Pace International had a surfactant called De-Peg Plus, and DuPont had Surfactant WK. Both of these were used successfully to defoliate fruit trees in the fall, but as it turned out, neither increased cold tolerance. In fact, they actually reduced cold hardiness.

For the past 25 or 30 years, fall defoliation strategies have relied mostly on deliberately induced phytotoxicity from a chemical cocktail mix of high rates of zinc sulfate, often combined with a chelated copper and sometimes urea. The idea is to burn the leaves off the trees. Results from these mixtures have been inconsistent, and even when they do work they cause more harm than good.

Premature defoliation resulting from induced phytotoxicity is detrimental to the tree by damaging leaves before nutrient remobilization into the buds is complete. Such defoliation does nothing to hasten the onset of dormancy, and in fact makes trees even more susceptible to cold injury.

Burning leaves with zinc sulfate in the fall also stops photosynthesis, reducing carbohydrate reserves in the buds. This not only further reduces cold hardiness, but also reduces the stored energy the tree needs next spring before photosynthesis resumes.

Remobilized nitrogen and carbohydrates are both critical to spring growth and flowering. Shoot and leaf growth in the spring relies on remobilized and reserve nitrogen, while

flowering and early fruit development rely on remobilized carbohydrates. Burning leaves off in the fall disrupts the remobilization processes, reducing the reserves needed for optimum development the following spring.

Several studies have shown that early defoliation of apple and cherry from zinc sulfate applications result in:

- Poor growth in the spring
- Reduced fruit size
- Smaller spur leaves
- Less total leaf area
- Lower N content per unit of leaf area
- Lower spur N
- Lower shoot N
- Lower spur carbohydrates
- Lower shoot carbohydrates
- Lower fruit number per tree
- Lower fruit weight
- Lower yield
- Reduced cold hardiness

In nursery situations where trees will be dug in the fall and leaf removal is critical before storage, these things don't matter as much. Using zinc sulfate to burn leaves off nursery trees may be OK (and less expensive than manual leaf stripping), but it is certainly harmful to orchard trees.

Another (again, mistaken) argument for zinc sulfate use in the fall has been that there is some nutritional value to it. Zinc is probably the most immobile nutrient we work with, and virtually all of the zinc sulfate applied as a defoliant in the fall stays on / in the leaf and is not remobilized, so has no nutritional value. Studies with radioactive isotopes have shown that only about 3% of fall-applied zinc travels even as far as leaf petioles. In contrast, up to 95% of fall applied urea and boron is remobilized into the buds within 2 – 3 days after application.

The chart below is from a 2014 trial examining different defoliation treatments. For this trial, leaves were sampled off the ground under the trees after defoliation was complete. These results further illustrate that the fall-applied zinc remained on / in the leaves and provided no nutrition to the tree at all. The nutrients blew away with the leaves.

Sample ID	S %	Zn ppm	Cu ppm
Untreated Control	0.14	121	12.2
$ZnSO_4$ + Urea + Copper Chelate	0.20	1928	555
ABA	0.11	133	11.0
ABA followed by ACC	0.11	133	10.8

For those blocks where early fall defoliation would provide some operational advantages, there is another alternative. Studies over the past 7 years or so have shown that under certain environmental conditions, abscisic acid (Valent's ProTone® Plant Growth Regulator) can be an effective defoliant. The difference between defoliating with abscisic acid vs. defoliating with zinc sulfate is that abscisic acid doesn't burn the leaves off the tree – rather it just accelerates the natural senescence process. This mode of action allows for complete nutrient remobilization and stimulates early-onset dormancy resulting in earlier cold tolerance. All of the normal fall physiological processes occur, just at an accelerated rate.

Of course, there are a couple of caveats to effective use of abscisic acid for fall defoliation. First, shorter photoperiods have to send signals to the tree that fall is here. That means applications should be delayed until mid-October when average daylength is less than 11 hours.

Second, until recently we observed that a hard frost following application was needed for optimum results. However, work done the past couple of seasons has demonstrated that using a high rate of an organosilicone surfactant (0.1% v/v) with the abscisic acid over-rides the need for a frost. This gives us a lot more flexibility with timing these fall applications.

Accelerated natural senescence from abscisic acid

Deliberately induced phytotoxicity from ZnSO4 + Urea + Cu chelate