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PRUNING DECISIONS AND EXTREME COLD - Kevin Iungerman

There is no hard and fast rule for when cold is so deep that cell damage to apple tissue is a foregone conclusion. If you followed a recent discussion on Apple Crop concerning when to prune in relation to severe cold events, you may have come away scratching your head. How was it, that in several much milder areas (relative to here) severe injury and even tree loss had been so extensively experienced? In the instance of Nova Scotia, its maritime climate permits an occasional few days below -4°F (-20 °C) in an otherwise rather balmy average regimen that hovers around 23°F (-5 C) in January and February. And the seeming mythic artic experience of Colorado (from the telling of it) where they saw 4 (!!) straight nights below zero in Feb. 1989 (-8, -21, -10, & -14 °F.) as compared to their typical winter lows between 0 and 15°F. If you look at the potential for deep cold in our region (see table below), you will see that the probabilities for our experiencing really cold events are both more extensive and persistent. The odds for all of our area seeing temperatures of -10 F or lower in January for instance is 50: 50. And for several locations the probability is that they will see a January low of -39 once in a hundred years. By my reckoning, some locations may be having their once-in-a-hundred-year cold event two years in a row now! We know cold!

Probability for Seeing Minimal Temperature Cited at Selected Sites in Any Given Year Out of a Hundred Years

City or Town	Elevation	Latitude	99%	95%	90%	50%	10%	5%	1%	Yrs Data
Poughkeepsie			17	10	6	-6	-19	-22	-29	31
Albany (Airport)	275	42' 45"	10	4	1	-10	-22	-25	-31	31
Saratoga Springs	310	43' 02"	1	-4	-7	-16	-26	-29	-34	27
Whitehall	119	43' 33"	4	-2	-5	-17	-29	-32	-39	30
Plattsburgh	190	44' 42"	2	-2	-5	-13	-22	-24	-29	31
Chazy	170	44' 53"	-1	16	-9	-20	-31	-34	-39	31
Geneva	615	42' 53"	14	9	6	-4	-14	-16	-21	31
Ithaca	950	42' 27"	11	6	2	-9	-19	-23	-28	31

Table developed by K. Iungerman, CCE NENYF, Jan. 2004. Information from: Vittum, M.T., Barnard, J., and Gibbs, G. H. "What are the Odds on Maximum and Minimum Temperatures in New York State, Special Report No. 39, April 1981. NYSAES, Geneva.

Most cold injury occurs in situations of rapid fluctuating temperature extremes. Where cold is relatively constant, even though deep, there is less concern. It is known that cold temperatures kill plants by causing the coagulation and disorganization of the cell's matrix of living chemical reactions, its protoplasm. A key factor is whether or not sufficient free water has been exported from cell vacuoles and from within cells themselves to the intercellular spaces surrounding them during acclimation. A second key factor is whether sufficient starch has been converted to sugar in the same process to depress cellular freezing points. Cell injury and destruction come about simply as a result of mechanical injury exerted by residual water phasing into ice. The forming ice mass presses against the protoplasm in the cell and the ice crystals can eventually penetrate the protoplasm and even form within it. Rupture follows. The essential protective matrix which once facilitated the wondrous interplay of so many chemical compounds is no more. Upon thawing, this tragedy is revealed in dead tissue that is brown in color and has water soaked appearance.

Generally speaking, from December through February, all fruit tree tissues are at maximum hardiness. At mid winter the sapwood is considerably more hardy than pith but it is less hardy than bark and cambium. Bark and cambium are most hardy. It requires low temperatures on the order of those cited in so called "test winters" to result in outright injury simply due to cold itself. In NY and our region, extensive injury is usually confined to truly cold winters, such as was seen in the dormant seasons of 1917-18, 1933-34, 1980-81, and 1992-1993. Still, while extensive injury may occur in these years as temperatures reach down to -20, -30 °F and colder, most trees survive. Why? Because we are dealt other factors than cold alone, and these include genetic potential (adapted varieties); different tree cells; tree age; tree fitness; and very certainly, cultural practices. All of these factors individually and collectively serve to buttress a tree's absolute hardiness or to retard it.

Consider the following. After severe cold at mid-winter, flower buds of the apple have been know to survive as isolated areas of live tissue while most supporting tissue is seriously injured. The same observation has been made of sapwood. Sapwood is an essential tissue. All water and nutrients taken up by the tree's roots move up the tree to all of its extensive branch tips via the outer annual rings. Following severe winters, sapwood may appear to be completely killed during examination with the unaided eye, showing the stereotypic brown, water soaked appearance. However, microscopic examination typically reveals many small islands of live tissue. Trees that suffer serious injury to sap wood, but possess healthy bark and cambium, are capable of recovery. They heal by laying down a new annual ring around the injured sapwood. The trees will exhibit a weakened condition until the injured sapwood is adequately surrounded by new wood that can eventually function at full capacity. This healing capacity is the basis for Warren Styles' recommendation for the prebloom zinc-urea applications (see the annual Cornell Guidelines); these foliar sprays help to sustain live islands as surrounding cambium and bark cells knit together new conducting tissue.

During severe winters, the areas of bark and cambial tissue most susceptible to damage are those located in narrow angled crotches, the inside area of upright scaffolds above the same narrow crotches, and also along the undersides of long, large, horizontal branches. These tree parts do not have sufficient nearby canopy which is capable of fully satisfying their need for photosynthates in season and they are also not in a direct line of transport for such assimilated products. In a word, they are relatively starved and thus less resilient to cold stress. These same bark and cambial areas are even more easily damaged by severe cold when they surround large pruning wounds, which of course they most often do. The pruning (i.e. wounding) actually stimulates the tissue and lessens its resilience to cold.

Bob Stebbins and Dick Hayden recounted seeing a young apple orchard in Ohio where rows of 1-2 year old trees had been pruned at various times before and just after a hard freeze. Damage was quite dramatic but it was confined to the trees that had been pruned two weeks or nearer to the time of the freeze. Consequently, both agreed, as Hayden put it, that "when a severe drop in temperature is forecast, put the pruners up and do something else till after the freeze." Doll offered like advice after recounting similar mishaps with peaches in Illinois. Hayden, continuing, cautioned that, if pruning cuts made prior to severe cold included major scaffold branches, then the potential existed for losing substantial parts of the tree. Further, if the temperatures were low enough to cause injury to unpruned trees, he reasoned, then regular pruning after a severe freeze might make injuries worse. Because of this, Purdue usually advises a delayed, and then only a light pruning, following an injurious freeze event.

Different rootstocks and cultivars tolerate cold better than others. In the northern Champlain, McIntosh, Cortland, and Honeycrisp, do better than Macoun which does better than Empire which does better than Jonagold, etc., etc. Apples can be grown beyond their comfort zone in many years but not without building risk that, at some point, must cumulatively come due. Dr. Harold Larsen's suggestion (Larsen is with CSU's Orchard Mesa Station, Grand Junction, CO.) for evaluating cultivar responses to pruning over several seasons, while of some short-term benefit, really affords too brief a span to acquire a sound read. Flagging a dozen or so trees and either pruning them (or leaving them unpruned) at different times and then tracking their bloom, cropping, and vegetative vigor over a couple of seasons would have benefit if it happened to coincided with a run of test winters. Otherwise, at a given farm this might not provide much useful information. On-going data collection at research station is another story.

Many cultural and site selection aspects are especially important to bear in mind. First and foremost, know the Cardinal rule: pruning, cropping, and pest management must be carried on so as to ensure a healthy leaf surface throughout the growing season. Canopy is the foundation for a robust annual hardening process. As an example, defoliation of Montmorency cherries at mid-season by leaf spot frequently results in complete tree kill by winter cold, while sweet cherries, a more tender species, in the same planting, but without foliar damage, may suffer no freeze injury. Similarly, nematode infections, virus diseases, mite or psylla injury, not always recognized, can all significantly impact spur leaves and lead to lessened hardening. In such instances, relatively mild winter temperatures of -18 to -20 °F may kill significant amounts of sapwood in tree spurs.

Trees on poorly drained soil usually produce smaller leaf surfaces in proportion to the amount of wood needing to be hardened than do trees on well-drained land. Site selection should avoid heavy soils, adopt tile drainage, and make good use of slope or, when needed, raised beds. After tree planting, basins should not be allowed to form around trees trunks as this allows for the collection of water and can lead to water or ice damage. Any post-planting fill should be of similar density and porosity as the surrounding soil and preferably the same soil.

Wind is a significant factor contributing to cold injury. Wind velocities of 30 mph or more in combination with cold temperatures of zero or lower can greatly exacerbate injury. Damage is generally worse on north slopes, outside rows, outer (exposed) parts of trees, and on hilltops. Beware though; trees in well protected areas are at risk too, because solar thermal warming can represent a serious threat. If such trees have a southern exposure, they are likely to experience greater injury than trees facing north; this is because southwest injury is likely under certain conditions. As an example, researcher A.J. Mix4 amply demonstrated this potential in NY way back in 1916. At 3:00 p.m. on a very cold, bright, sunny day, Mix found the temperature of the inner bark and outer sapwood on the southwest side of a tree trunk to be 39°F higher than the atmospheric temperature, the same tissues on the northeast side or the shaded side of the same trunk!

So, the dark colored bark of large tree trunks can absorb much heat in a short period when exposed to direct rays of the sun. With the onset of darkness and dropping atmospheric temperatures, the temperatures of the warmer bark on the southwest side of the trunk drops much faster than the colder bark on the opposite side of the trunk. Mix found that he could always kill most of the cells in the bark, cambium and sapwood by immediate exposure to -4°F, a temperature that is approximately 40 to 45 °F above that at which they would otherwise be injured when temperatures fall gradually and tissues are at maximum hardiness. Trees with a white washed mixture of latex and thiram are less susceptible to damage as the mixture attenuates solar absorption and the thiram provides some fungicidal benefit against pathogen entry via minor freeze wounds. Windbreaks located on the west side of orchards do have a beneficial effect. However, the first row of trees should not be too close to the break. A distance of 75 feet is recommended. Otherwise, too heavy a snow accumulation may draw apple branches down and subsequent ice formation may cause them to split at their crotch level.

Several other practices need to be reviewed. Avoid scoring young trees to force earlier bearing. When done in the spring prior to a harsh winter this practice leads to increased injury and tree mortality. Also avoid heavy and especially late summer pruning, as this too weakens trees and aggravates winter injury. And prune regularly. You prune not only to achieve proper bearing angles and light penetration but to limit the wood diameter to canopy ratio; doing so ensures that the tree is capable of nurturing both the wood and the fruit you wish to retain. The goal of regular pruning is to prevent large wood accumulation, which in turn obviates the need for large cuts, and in turn, reduces the risk for winter injury. And watch nitrogen fertilization on bearing trees: be lean and mean.

Crop load needs to be watched too and limited early. No trees with excessive fruit set ever develop the degrees of hardiness as one with a normal, light, or no crop. Thin early and successively. Allowing too much fruit to persist, finally to be hand-thinned in mid-July, both encourages small fruit and predisposes the tree to greater winter injury. Delayed harvest can also hamper the hardening process. Try to harvest promptly at optimum maturity times.

There you have it. Early dormant pruning is always a gamble. All of the warnings cited in the Apple Crop discussion about watching forecasts and avoiding pruning immediately before and immediately following severe cold events are well founded. But so too is my admonition to stay the saw past the solstice, till February if possible. Time and labor do not allow this for most orchards I know, so risk dictates your moving on the least valued trees first. Other practices cited are sound too: prune pears, then apples, and then stone fruits (peaches last) and then grapes.

Finally, the be all message: Many choices along with proper pruning contribute to building strong and cold hardy fruit trees. Injury is not necessarily an act of God alone.

Sources: Field Observations and experience and: 1) Arnson, Phil A. and Edgerton, Louis J. "Cold Injury of Fruit Trees". Information Bulletin 47, Plant Sciences: Plant Pathology 3. NYSAES, Geneva. 2) Chandler, Craig K. and Feree, David C. "The Winter of 1983-84: A Test Winter for Ohio's Fruit Crops". Department of Horticulture, Ohio State University. 3) Granger, Raymond L. "Cultural Practices Which Facilitated Survival of Apple Trees in the Severe Winter of 1980-1981." Research Station, Agriculture Canada, St-Jean-sur-Richelieu, Quebec. 4) Mix, A. J. "Sun Scald of Fruit Trees, a Type of Winter Injury". Bulletin 382. NYSAES, Geneva. 1916. Cited in Hoffman, M.B. "winter Injury" Pomology Department, Cornell University. Apple Crop, Discussion on Winter Pruning, January 9 through 12, 2004.