An Autopsy of the 2016 Growing Season

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Most tree fruit growers in New England will agree that 2016 was one of the most challenging growing season in memory. While the preferred approach would be to forget this year, I would like to reflect on it and try to glean as much information as we can so that if we are again confronted with similar environmental conditions we will have more information that we can use to help make informed management decisions.

A Review of the Weather

The weather in 2016 resulted in a great deal of damage to the tree fruit crops but not all portions of New England experienced the same degree of adversity. Consequently, this summary will include generalizations that hopefully will apply to most situations. The 2015 season was one of the best and most profitable for the majority of growers. Moisture was adequate and yields were generally among the best in the recent past. The weather was conducive to producing an excellent crop of large fruit. While most did not think of it at the time, trees may have entered the fall slightly stressed because of the heavy crop load. The heavy all-around set offered the possibility that we may experience below average return bloom in 2016. The fall was generally warm with no extremes as trees went into dormancy. For the first part of the winter, temperatures were above average and precipitation, especially snow, was almost nonexistent. There were some temperature fluctuations in late December into early January that may have stressed the trees. In the middle of February trees were exposed to temperatures that went down to -16º F to -17º F for two nights in a row. The transition between warm to the very cold was not sudden but it did occur over a relatively short period of time and this may have made the trees more sensitive to the very cold temperatures. There was no question that the peach flower buds were killed at those low temperatures but the extent of injury or stress to other tree fruit was uncertain. Relatively warm temperatures between the Arctic blast of cold in February to early April allowed buds to start to show development and loose some cold hardiness. During the first week in April another freeze occurred that resulted in significant damage to buds of nearly all trees. As flowers started to expand, varying degrees of damage were noted. In many apple flower cluster a varying number of buds were killed, while spur lea f damage manifest itself as leaves appearing to be small, crinkled, chlorotic, and generally unhealthy looking. Near bloom in May the weather turned very cool, without frost, for nearly 2 weeks. These temperatures were accompanied by clear sunny days and cool nights which favored carbohydrate accumulation. Fruit growth was very slow. There were few stresses on the trees during this time and the chemical thinning period. This postbloom period heralded the arrival of one of the worst dry periods that we have experienced in the past few years that lasted through harvest and it continues to persist.

Fruit Size

The apple fruit size in 2016 was one of smallest in recent memory. This was completely predictable for several reasons. If a tree carries a very heavy crop load throughout the season the size of the flower buds initiated for the following year tend to be small. It is well known that there is a positive correlation between the size of flowers bud and the

Apple flower bud damage on April 8, 2016, and the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA.

size of fruit that develop from these buds. Spur leaves play a critical role early in the seasons in determining fruit size. Spur leaf quality was fair to poor which undoubtedly impaired the leaf from photosynthesizing at optimum level. (However, to my knowledge the extend of this impairment was not documented so this is open to speculation.) Equally important at this time was the temperature following bloom. The period of time after bloom is when fruit are actively undergoing cell division. The low temperature during this period led to a reduction in the rate cell division which in turn resulted in fewer number of cell being produced in the apple. The final cell number in a fruit is largely determined during this period after bloom and this more or less determines the potential for a fruit to increase in size. There were just fewer cell being initiated in the fruit at this critical time. As fruit development proceeds, fruit increase in size primarily by cell enlargement of previously initiated cells. However, if cells are not present they can't increase in size. Spur leaves also play a critical role in fruit growth. Storage carbohydrates are exhausted in a tree by petal fall, therefore, fruit growth is then dependent upon photosynthesis in the spur leaves until the bourse shoot leaves can contribute when the bourse shoot reaches about 10 inches in length. Severely frost-damaged spur leaves were smaller and were incapable of providing the same amount of carbohydrate to the fruit as healthy leaves. Admittedly, there is little information in the literature documenting the photosynthetic capability of frost damaged leaves so we are left to make educated guesses about the degree of impairment. The freeze that occurred during the early part of April killed many flowers. Generally the most physiologically advanced flowers are damaged first and to the greatest extent. Consequently, many king flowers were killed. Less developed lateral flowers often survived. Further, in some instance all of the flowers in the spur were killed or severely damaged to the point where they did not set. Some cultivars produce flowers on 1-year-old wood. These flowers are frequently delayed in opening, many survived, set and developed into fruit. Fruit that develop from king flowers are usually larger than those that develop from secondary flowers in the spur cluster and fruit that develops from flowers on 1-year-old wood are generally the smallest. Finally, the drought conditions that developed during the period of fruit expansion also contributed to small fruit size. Any one of the above-mentioned factors or a combination of these are undoubtedly responsible for the unusually small fruit size we experienced this fall.

Initial Set and the Chemical Thinning Period

The pollination period was variable depending on location in New England. In general, it was cool and there was pollinator activity, although in many cases it was limited. It is well documented that emerging spur leaves play a critical role in aiding and assuring initial set. The chemical thinning strategies that we now recommend involve making thinner applications at multiple times, starting as early as bloom. If a bloom spray is not applied then we normally recommend a petal fall spray. The extensive damage to the spur leaves and the uncertainty related to injury to flowers/fruit prompted overall extreme caution in the use

Gala apple flower cluster on May 22, 2016, at the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA.

of thinners. This was a big black box. We adopted a very conservative wait-and-see approach to thinning at this time. The cool sunny weather following bloom resulted in a heavier initial set than we would normally expect from trees with extensive spur leaf damage. We interpret this result as the spur leaves remained sufficiently functional to produce sufficient carbohydrate to allow fairly good initial set. The cool sunny conditions resulted in a carbohydrate excess that favored fruit set.

Preharvest Drop

The last few years we have focused on developing strategies to allow acceptable preharvest drop control until fruit can be harvested in a timely manner. Orchardist have available ReTain, Harvista and NAA . These can be used alone or in combination at various times and rates to achieve acceptable drop control on drop-prone varieties. However, there are two environmental factors that may either diminish or negate drop control efforts. High temperatures, especially those experienced in the 2-3 weeks prior to and during harvest that tend to negate or gravely diminish drop control efforts. Short of using overhead sprinkler irrigation there is little an orchardist can realistically do to counteract heat stress. The second major factor that reduces the effectiveness of drop control compounds is drought. All are acutely aware of the drought conditions that have gripped much of New England and New York. Many of the new plantings that have gone in recently include trickle irrigation. However, the drought has been so severe in recent months that many growers ran out of water for irrigation. We have experienced one of the hottest summers on record and the lack of water was so severe as to warrant declaration of a state of emergency in affected areas of New York and New England. Fruit drop when they are prematurely stressed leading to early ripening. A recent study done in Massachusetts confirms that all fruit that dropped were climacteric and they were producing significant ethylene. The ethylene given off by these early ripening fruit was sufficient to trigger drop. It was my observation this year that the most effective drop control strategy involved using ReTain at or near label limits. There was very little Harvista used in Massachusetts in 2016 so it is difficult to make meaningful observations this year. Because of the very high temperature the use of NAA should have been low except in circumstances where fruit was to be sold soon after harvest.

Flower Bud Formation- The Crystal Ball

Flower bud formation for the major tree fruit crop is or has occurred during this current drought. In advance of the 2017 growing season it may be worthwhile to at least discuss some of the possible ramifications that may result.

Apple- The trigger that generally leads to flower bud formation in apple occurs relatively early, within 5 to 6 weeks after bloom. However, the first manifestation of the bud developing into a flowers bud is generally not seen until August. During most of the critical period this summer trees experienced severe drought. It is known that drought can limit the extent of flower bud formation. This raises two questions, first, how

robust will return bloom be even with the very reduced crop load experience in many orchards? What effect will this drought have on the vigor of the flower buds that are initiated? The size of the buds entering into the winter may provide a clue to this question. Larger flower buds are generally considered stronger and more robust. How resilient will these buds be if exposed to cold temperature stress even remotely close to the temperatures these trees experienced this past winter?

Peach- Peaches differ from many other tree fruit in that they produce their flowers on one-year-old wood. Therefore, all flower buds initiated for a crop in 2017 were initiated under drought conditions. Essentially there were no peaches produced in New England in 2016. During the spring there were discussion revolving around how to handle peach trees without a crop. A prominent scenario was to cut the nitrogen in half in response to the lack of a crop. However, as the season progresses many peach trees did not look very healthy and in some situations additional nitrogen was required to bolster green color in the leaves and make their foliage appear somewhat normal. This raises the question of how much unseen tissue injury in the wood was sustained due to cold last winter. As we approach the winter months there are questions. Did the peach trees suffer some type of tissue damage from last year that may extend into 2017? What are the characteristics of flower buds initiated under drought conditions? How vigorous and robust will these flower buds as we enter the winter? How much cold will they be able to withstand to survive?

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