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Update on Pest Management and Crop Development

F R U I T J O U R N A L

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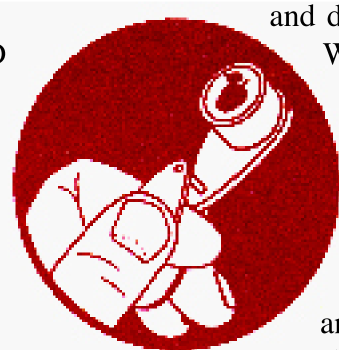
HORTICULTURE

BUT WAIT - THERE'S STILL MORE!

LESSONS LEARNED FROM THE RECORD BREAKING DROUGHT EXPERIENCED IN WESTERN NEW YORK IN 2016: A NUTRITIONAL PERSPECTIVE



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❖❖ In 2016, the western New York fruit production region experienced a summer like no other. We had one of the warmest and driest growing seasons on record in Western NY. In the first four months (April-July), we only had a total average of 6.43" rainfall, with only 1.66" and 1.03" rainfall in June and July, respectively. The minimum and maximum temperatures in the month of August were 53.6˚F and 93.3˚F, respectively. There were 22 days with temperatures above 85˚F in July and August. Comparisons of weather conditions of the 2016 growing season with the most recent warm and dry growing seasons in 2011 and 2012 are summarized in Table 1.

In an average growing season in the northeast, rainfall is usually less than required for optimal tree performance during critical periods of tree establishment and growth. In addition, in 3 out of 10 years, severe water shortages occur during the months of June, July and/

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Table 1. Summary of weather conditions experienced in Western New York during the growing seasons of 2011, 2012, and 2016.

Growing Season	Weather Conditions (June – August)
2011[1]	• Cool/wet spring, followed by a hot/dry summer • **15 days at 85˚F** or above during June and July • Total average rainfall from April-July: **13.75"**
2012[2]	• Hot/dry year with infrequent rains at the end of the season • **19 days at 85˚F** or above during June and July •Total average rainfall from April-July: **9.96"**
2016[3]	•Extensive warm and dry season, with a record-breaking drought across NY State • **22 days at 85˚F** or above during July and August • Total average rainfall from April-July: **6.43"**

[1] Spring was one of the wettest. We had a late and frustrating tree planting season.
[2] In 2012, the abnormally high temperatures of March 12–22 resulted in accelerated bud development in tree fruit crops. We recorded green tip in McIntosh on March 17–19 across the Lake Ontario Fruit region, initiating the beginning of the growing season 3–4 weeks ahead of normal.
[3] On April 5, the WNY region experienced temperatures in the low 10s. Orchards located on the west side of Rochester escaped the bitter cold, or were less affected, than orchards in Wayne Co. The southernmost sites in Wayne Co. had the lowest temperatures.

or August. A mature tall spindle orchard in the early season requires about 1,000 gallons/acre/day and about 4,000–5,000 gallons/acre/day in midsummer. A newly planted tall spindle orchard requires much less water (never exceeding 500 gallons/acre/day) due to the smaller trees having a fraction of the leaf area of mature trees. Therefore, it is essential to have irrigation for tall spindle plantings to ensure tree establishment and maximize fruit size at any given crop load. Water stress at any time of the season reduces fruit growth rate with permanent loss in fruit size, which is difficult to recover later. Also, very dry soil conditions can reduce the availability of nitrogen, phosphorous, potassium, calcium, and boron to tree roots.

So far, we have been fortunate in establishing, training, growing, and nourishing high density apple orchards with less than optimal rainfall during the last eight growing seasons. What was more unusual this year for NY apple growers without irrigation was that several growers had to set up movable sprinkler pipes, big gun sprinklers, or simply water trees individually with a tank and a hose. We even saw growers tapped into town water supplies using a fire hydrant, installing improvised and movable irrigation lines for sets of 4 rows, in an effort to increase fruit size on small-fruited varieties by the middle of August. These temporary setups may have made a difference during the droughty summer, supporting the growth of newly planted trees and in sizing apples for harvest. But these mitigation responses clearly showed how unprepared we were to respond quickly to more severe drought events.

Drought Implications for Availability of Important Nutrients and Fall Recommendations for Optimal Tree Growth

Nitrogen (N) availability was reduced: Low soil moisture conditions decrease soil microbe activity. Microbes play an important role in breaking down organic matter and converting organic nitrogen to inorganic nitrogen, a process called mineralization. In dry soils with low nitrogen mineralization, there could be less plant-available nitrogen in the form of either ammonium (NH4+) or nitrate (NO3-) nitrogen. In dry soils, the risk of NO3- loss through leaching or denitrification is reduced, partially compensating for the low mineralization of organic nitrogen in dry years. When significant rainfall occurs at the end of the season, there is a sudden increase in soil nitrogen. A good orchard soil can generate enough N through the breakdown of organic matter and can release 15 to 20 lbs N/Acre by the end of the growing season.

Phosphorous (P) availability was also reduced: Reduced soil microbial activity in soils with low moisture can reduce organic matter descomposition and the mineralization of organic P to inorganic P. Phosphorous moves from higher concentrations in the soil to lower concentrations in tree roots by diffusion. As

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soils become drier, less diffusion occurs. This is because the water film around the soil particles becomes thinner, making diffusion to the tree roots more difficult.

Potassium (K) and Calcium (Ca) moved less in the soil profile: Decreased movement of K and Ca to the tree roots occurs in dry soil. As soil dries, clay minerals become dry and shrink, trapping K and Ca tightly between mineral layers. Once trapped, K and Ca are unavailable to plant roots for uptake. This K and Ca are released and plant-available again when the soil moisture increases.

Boron (B) shortages occurred particularly on coarse-textured soils: When boron is inadequate, various types of corking disorders may develop in or on the fruit. Shortages of boron are associated with impaired growth of dieback of roots and shoots, premature ripening of fruit, and accentuated preharvest fruit drop.

Bitter pit affected more orchards on the East side than the West side of Rochester and its incidence varied among rootstocks: In general, a higher incidence of bitter pit was observed in Honeycrisp orchards in Wayne County this season. One Honeycrisp site on M.26 with a soil pH of 7.32 showed a 50% incidence of bitter pit. At the VanDeWalle rootstock trial located in Alton, the higher incidence of bitter pit (BP) in Honeycrisp was observed with G.11 (24% BP), followed by G.41 (19% BP), and M.9 (16% BP). The lower incidence was measured with B.9 (10% BP). Thus, it appears that the use of B.9 did largely decrease the incidence of bitter pit on Honeycrisp at the rootstock trial this season (results based on 4 replications by rootstock). We believe rootstock selection will play an important role in bitter pit susceptibility in the following years. Based on data analyzed in the NC-140 rootstock trials, Honeycrisp trees on B.9 seem to have less bitter pit than those on M.9 or M.26.

Management Practices You Should Consider for Long Term Impacts of Extreme Drought

First of all, all new plantings that have gone in recently should include trickle irrigation. Trickle (or drip) irrigation has its largest impact in the first few years (1–5) and so should be installed early in the first year. In a dry season like this year, the application of water should have begun in early to mid-May (if you recall, new plantings suffered higher water stress levels on the west side of Rochester than in Wayne by the end of May). In other more rainy years, the application of water can be delayed until early June. Growers who have used irrigation say that short, but frequent, irrigation helps promote tree growth (shoot and root development). Small amounts of water (and nutrients) applied twice weekly is a good fertigation strategy for the first three years (5 gallons per tree per week in year 1 and 10 gallons per tree per week in year 2).

Another good strategy is to increase the soil organic matter of your orchards. Soil organic matter can be increased from long-term addition of crop residues, organic amendments such as manures and composts, or by including cover crops. Increasing organic matter helps improve soil structure. Improved soil structure helps balance soil drainage in the wet years, and water holding capacity in the dry years, improving conditions for achieving consistent and high yields of high quality fruit over the long term.

A third way to improve soil conditions may be through the use of mycorrhizal fungi to help colonize absorptive roots (located within the top 12 to 15 inches of the soil). Mycorrhizae are created by a union of roots and specific soil-borne fungi. They aid in improving plant

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growth, water and mineral absorption, disease suppression and drought resistance.
Regardless of whether you irrigated or not this summer, the increase of soil organic matter via crop residues, organic amendments, or the use of mycorrhizae will help enhance root growth, improve soil health, and reduce water stress, if another severe drought is experienced in Western NY the following years.

What to do now in the fall?

Now is a good time to take soil samples. By doing so, you can compare the results in a dry year like this with those in more normal years. This can provide valuable information as to what to expect if dry years occur again in the future. Moreover, taking a representative soil sample is important to determine lime and fertilizer requirements and avoid costly over- or under-fertilization. Most soils should be sampled every 2–3 years, more often for sandy soils, or in problem areas. Fall is generally considered to be the most reliable time to pull samples, especially when it comes to pH. Soil pH fluctuates and tends to be lower in the summer when temperatures are higher and soils are dryer. Soil pH determination is more reliable in the fall when soil moisture is a bit higher. Please make sure you maintain an optimal soil pH around the target value of 6 to 6.5.

Finally, we would like to emphasize the following message for Honeycrisp growers who experienced bitter pit issues this year. Until now, we have been recommending to Gala, Empire, and McIntosh growers that, for blocks producing 1,000 or 1,500 bushels per acre, they needed to apply 70 to 100 pounds of potash per acre to replenish what the trees took from the soil. However, for Honeycrisp, we suggest growers lower the potassium rate by 25 to 30 percent this fall, because a lower potassium uptake results in higher levels of calcium in Honeycrisp fruit this coming year. Potassium should not be reduced by 50% or more, because it is a critical nutrient for fruit development and sugar accumulation. ❖❖

POST-MORTEM

AN AUTOPSY OF THE 2016 GROWING SEASON

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[*Note:* Dr. Greene, a very prestigious plant researcher, graciously shared his thoughts and took a hard look at the way our fruit industry was affected in the Northeast this past season. In this article, he highlights the main issues, offers explanations, and concludes by asking important physiological questions. His "autopsy" is a detailed narrative for one of the thorniest fruit growing seasons experienced in Western NY the last years. - Mario Miranda Sazo]

❖❖ Most tree fruit growers in New England will agree that 2016 was one of the most challenging growing seasons 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

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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 -16ºF to -17ºF 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 lose 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 clusters, a varying number of buds were killed **(Fig. 1)**, while spur leaf damage manifested 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.

Figure 1. Apple flower bud damage on April 8, 2016, at the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA.

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 flower buds and the size of fruit that develop from these buds. Spur leaves play a critical role early in the season in determining fruit size. Spur leaf quality was fair to poor, which undoubtedly impaired the leaf from photosynthesizing at an optimum level. (However, to my knowledge, the extent of this impairment was not documented, so this is open to speculation.) Equally important at this time was the

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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 of cell division, which in turn resulted in fewer number of cells 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 cells 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 **(Fig. 2)**. Further, in some instances, 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, and 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

Figure 2. Gala apple flower cluster on May 22, 2016, at the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA.

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

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prompted overall extreme caution in the use 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 remaining sufficiently functional to produce sufficient carbohydrate to allow fairly good initial set. The cool, sunny conditions undoubtedly 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. Orchardists 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, 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 the declaration of a state of emergency in affected areas of New York and New England. Fruits 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 flower 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?

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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. There were essentially no peaches produced in New England in 2016. During the spring, there were discussions 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 progressed, 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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