Lessons Learned from the Record-Breaking Drought Experienced in Western NY 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 in 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 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/or August. A mature tall spindle orchard in the early season requires about

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, 2012, 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 10's. Orchards located in the West side of Rochester escaped the bitter cold, or were less affected, than orchards in Wayne. The southern-most sites in Wayne had the lowest temperatures.

1,000 gallons/acre/day and about 4,000-5,000 gallons/acre/day in mid-summer. A newly planted tall spindle orchard requires much less water (never exceeding 500 gallons/acre/day) due to smaller trees with 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 moveable sprinkler pipes, big gun sprinklers, or simply water trees individually with a tank and a hose. We saw even growers tapped into town water supplies using a fire hydrant, installed improvised and moveable 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 and quickly to more severe drought events.

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

Nitrogen (N) availability was reduced: Low soil moisture conditions decreases 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 (NH_4^+) or nitrate (NO_3^-) nitrogen. In dry soils, the risk of NO_3^- loss through leaching or denitrification is reduced, partially compensating for the low mineralization of organic nitrogen in dry years. When significant rain fall 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 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 in 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 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-mid May (if you recall new plantings suffered higher water stress levels in 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 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-born fungi. They aid in improving plant 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 future dry years occur again. 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 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 will results in higher levels of calcium in Honeycrisp fruit next year. Potassium should not be reduced by more than 50%, because it is a critical nutrient for fruit development and sugar accumulation.

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