Northern NY Agricultural Development Program
2016-2017 Project Report

Precision Crop Load and Irrigation to Optimize Fruit Size and Quality of NNY Apples

See separate postings at www.nnyagdev.org: Horticulture for Project Background and Methods; and Conclusions and Next Steps.

Results:

(1) Precision Thinning: Weather conditions and carbohydrate balance
2017 was another challenging year for NY's apple growers. It was marked by freeze bud damage in the winter, cold and rainy weather during bloom, and hail during thinning and/or before harvest.

Due to the particular climate characteristic of the Northern New York Champlain Valley compared to all other apple growing regions throughout New York, trees showed very little bud damage caused by the sudden drop in temperatures registered in early March. Usually bud development/bud break in the Champlain Valley occurs later because of the very intense and prolonged winter in NNY. By comparison, apple trees in the Capital region were more affected and the king flowers within the cluster were either gone or had short pedicels at bloom.

Weather conditions during bloom were not very satisfactory in the Capital region. The cold and rainy weather during flowering drastically reduced bee activity, and pollination was somehow affected (from the apples we opened in general, regardless of variety, we did not see a full set of seeds). Native bees played an important role in pollination. The crop was slightly lighter than usual, however, trees still needed to be thinned. For this reason, chemical thinning was substantially reduced; growers decided to skip bloom and petal fall thinning.

Trees in the Champlain Valley bloomed later than in the Capital region. This favored growers and bees as temperatures were a bit higher, although still not great for the efficacy of the non-caustic thinners. Unfortunately, some growers from this region were hit by hail either at 10-12 mm fruit size stage or before harvest, causing significant damage.

Cloudy and warm weather registered around bloom/petal fall caused a poor supply-to-demand carbohydrate balance (Figure 1) in the Champlain Valley orchards. During this period, the model for most of the regions was recommending to reduce or keep the thinner rate. During the thinning window (petal fall to 12-14 mm fruit size), the model predicted a carbon balance or surplus, and growers were recommended to keep thinners at normal rates and, in some cases, to increase.

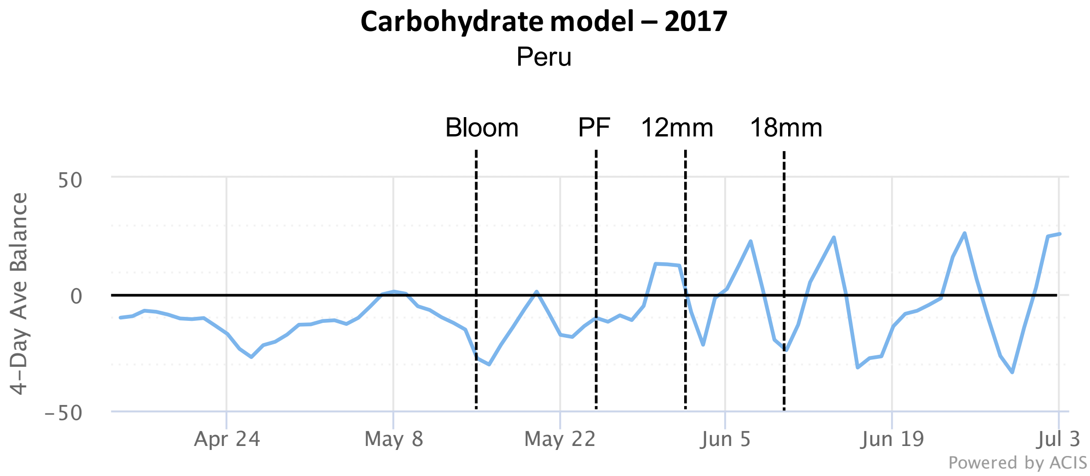

Figure 1. Predicted daily carbohydrate balance during spray applications in Peru, NY, according to weather data and the MaluSim model, 2017. PF= petal fall, NNYADP Precision Apple Management Project, 2017.

Figures 2 and 3 shows how Gala and Honeycrisp trees responded to two thinning sprays – at petal fall and a 10 mm or 15 mm fruit size spray - at Everett Orchards. Grower opted for not applying a bloom spray in these blocks.

As the carbohydrate model was predicting a slightly carbon deficit to balance during the petal fall period, the grower kept regular rates in both blocks. According to the FGR model, a substantial thinning occurred and about half of the fruit dropped, but that was still far from his target of 150 fruit for Honeycrisp and 250 fruit for Gala. Therefore, a second application was recommended for both varieties. As Gala is considered a hard-to-thin variety and as the carbon model was predicting a carbon surplus, the rate was slightly increased in this block, and thinning job was accomplished (215 apples). Whereas, for the most valuable cultivar Honeycrisp, the grower did not increase the rate and thinning was also successfully achieved (169 apples).

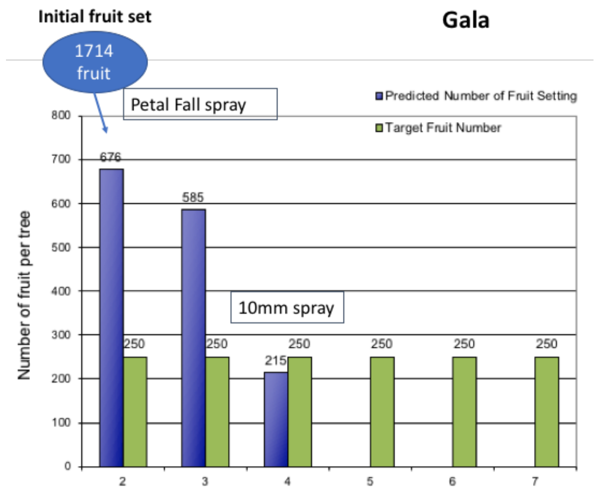

Figure 2. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Gala apple trees after 2 thinning sprays (petal fall and 10 mm fruit size) at Everett Orchards, Plattsburgh, NY, 2017. Blue circle = initial number of fruit per tree. Target was achieved. NNYADP Precision Apple Management Project, 2017.

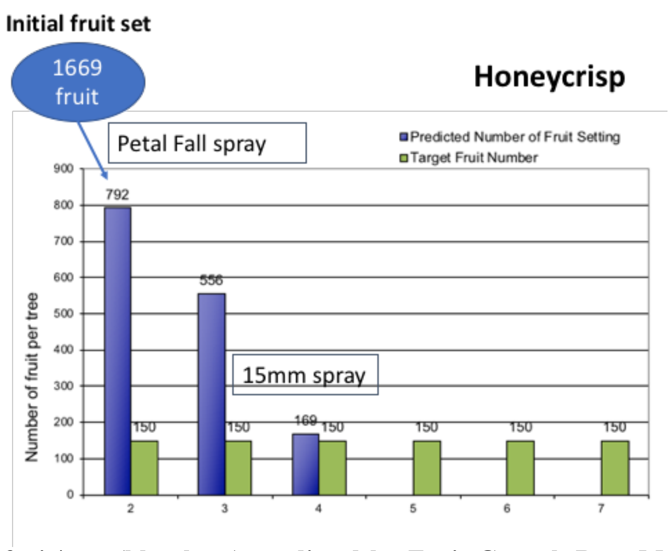

Figure 3. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Honeycrisp apple trees after 2 thinning sprays (petal fall and 15 mm fruit size) at Everett Orchards, Plattsburgh, NY, 2017. Blue circle = initial number of fruit per tree. Target was achieved. NNYADP Precision Apple Management Project, 2017.

The thinning performance of Honeycrisp at Forrence Orchards, Peru, NY, is shown in Figure 4. Grower applied a petal fall spray and a 10 mm spray using a carbaryl-free thinning program. Potential initial fruit set was 1282 fruit per tree; to reach target (90 apples per tree), grower removed 1192 apples. With both sprays, thinning was completed. Unfortunately, a hail event was registered in this block soon after the thinning sprays and the grower ended up with less fruit at harvest.

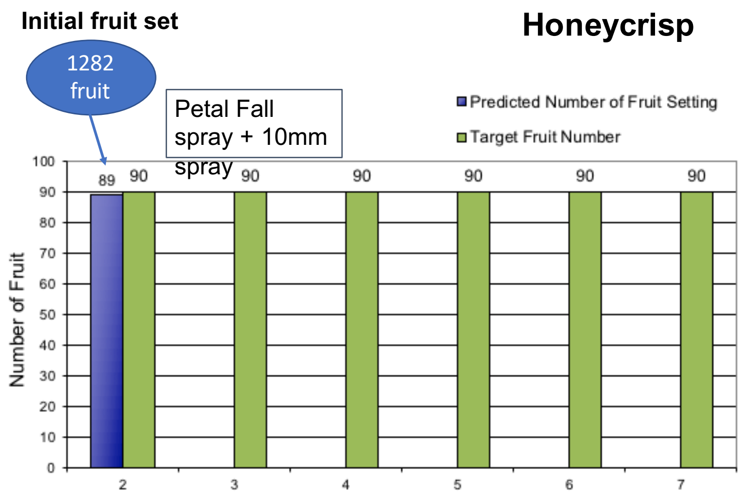

Figure 4. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Honeycrisp apple trees after 2 thinning sprays (petal fall and 10 mm fruit size) at Forrence Orchards, Peru, NY, 2017. Blue circle = initial number of fruit per tree. Target was achieved. Orchard was hit by hail right after the last spray, NNYADP Precision Apple Management Project, 2017.

The petal spray caused significant thinning in the Honeycrisp block at Chazy Orchards, Chazy, NY (Figure 5). However, the 10mm spray was not as effective as at other sites, although very close to the target (125 fruit). Hand thinning was performed in this block to reach target.

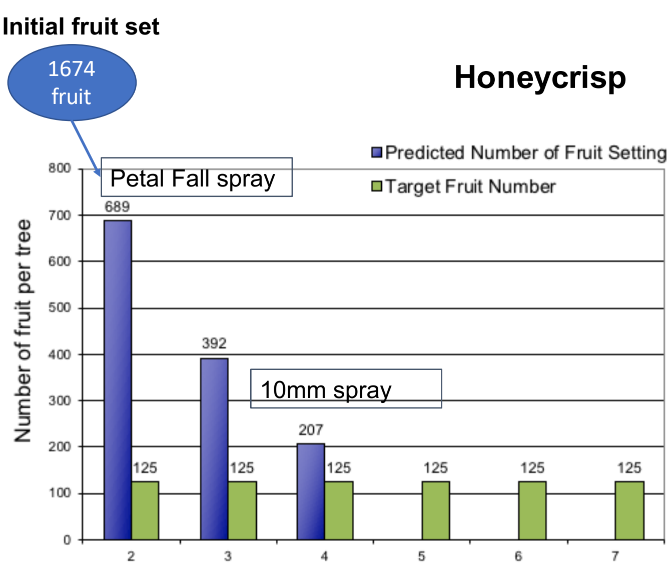

Figure 5. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Honeycrisp apple trees after 2 thinning sprays (petal fall and 10 mm fruit size) at Chazy Orchards, Chazy, NY, 2017. Blue circle = initial number of fruit per tree. The grower did not achieve the target with the chemical thinners and hand thinning was performed. NNYADP Precision Apple Management Project, 2017.

The parallel trial block of Gala in Geneva, NY, received four sprays from bloom through 18 mm fruit size stage. Thinners were kept at regular rates to compare with the carbohydrate model recommendations. Considerable thinning occurred at bloom + petal fall but not enough to reach the target of 130 apples per tree (Figure 6). The significant early thinning may be related to the deficit in carbohydrate as well as due the lack of pollination during bloom due to the cold and rainy weather (Figure 7).

According to the FGR model (Figure 6), the target was reached at the 12mm fruit size, however, we decided to include one more spray at regular rates at the 18 mm fruit size stage. The carbon model (Figure 7) was predicting a carbon surplus and, therefore, rates should have been increased by 30%, but they were not. As expected, very few fruit dropped (~11).

For several blocks located in the Western NY trial, the FGR model overestimated thinning. We attributed that to the poor pollination during bloom. Many un-pollinated flowers/fruit dropped after we marked the clusters, which certainly affected the results predicted by the model.

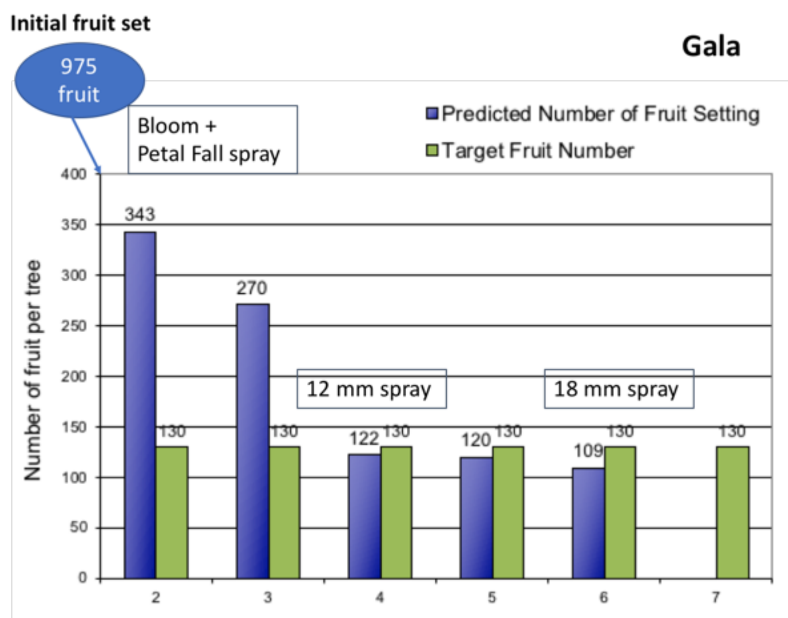

Figure 6. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Gala apple trees after 4 thinning sprays (bloom, petal fall, 12 mm fruit and 18 mm fruit size) at the Experimental Station, Geneva, NY, 2017. Blue circle = initial number of fruit per tree. Thinning was accomplished at the 12 mm fruit size spray; no extra thinning occurred at 18 mm fruit size. NNYADP Precision Apple Management Project, 2017.

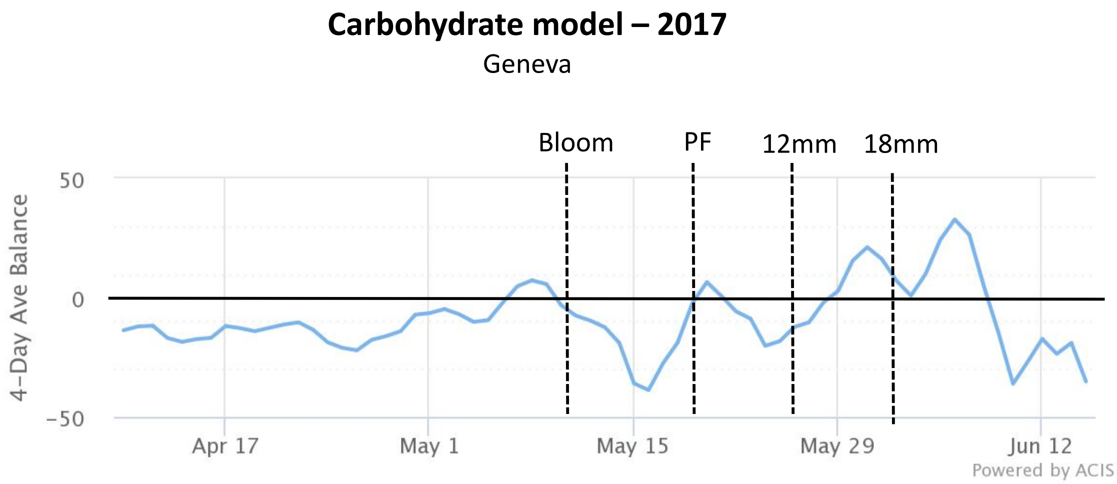

Figure 7. Predicted daily carbohydrate balance during spray applications in Geneva, NY, according to weather data and the MaluSim model, 2017. PF= petal fall. NNYADP Precision Apple Management Project, 2017.

Over the years, our recommendation to growers is that they should be a little more aggressive at pruning. Based on the 2014 data we were suggesting that growers should prune using a bud load factor of 1.5 to 2.0 flower buds for Honeycrisp and Gala, respectively for each final fruit number to make the thinning job easier and reduce the number of sprays.

Also, reducing the number of fruit buds on the tree early through pruning can reduce competition among flowers and fruitlets resulting in increased resources for the remaining fruit and improved fruit size and quality.

However, when Gala data from the last four years is combined irrespective of thinning treatment (hand or chemical), a strong and statistically curvilinear relationship was observed between crop value and bud load, although only 6% of the variation was explained by this model. This resulted in a relatively higher bud load optimum of 2.0-2.5 for Gala than that found in 2014 (Robinson et al., 2014). But, this is not true in dry years as it was in 2016, where a severe pruning should be performed.

(2) Precision Irrigation:

The growth, function, productivity, and water use of trees are closely tied to tree water status. By the use of a pressure chamber, we can measure the suction force that is being exerted by the tree to get the water. The more negative that value is, the more the tension the tree needs to exert, thus, the more stressed it gets.

We consider that tree stress starts with values below about -1.6 MPa. Trees in the NNY Champlain Valley and Orleans County orchards did not reach stress in any of the three years of the study. Overall, lower water potential values were observed for non-irrigated trees.

Accumulating the water balance values from bud break gives cumulative water supply and water demand. Figure 8 shows cumulative values for rainfall and transpiration of the orchards located in the Hudson Valley and Geneva, NY This data provides a good picture about what has happened in NY during the last 3 years.

In 2015 in Geneva, the cumulative graph shows that water supply from rainfall was sufficient to meet water requirement by the tree for the whole season, whereas in the Hudson Valley water requirement exceeded supply from rain from August through October, indicating the need to irrigate the trees during the whole summer (Figure 8). A delay in irrigation within these conditions becomes very difficult to “catch up” later on the season, when the cumulative water deficit becomes large. Heavy irrigation in a short period to catch up can lead to water and nutrient leaching.

In 2016 in Geneva and in the Hudson Valley, the cumulative graph shows that water requirement exceeded supply from rain from June through October, indicating the need to irrigate the trees during the whole summer. In 2017, both in Geneva and the Hudson Valley, the cumulative graph showed that water supply from rainfall was sufficient to meet water requirement by the tree for the whole season, being the highest cumulative rainfall values of the last three years.

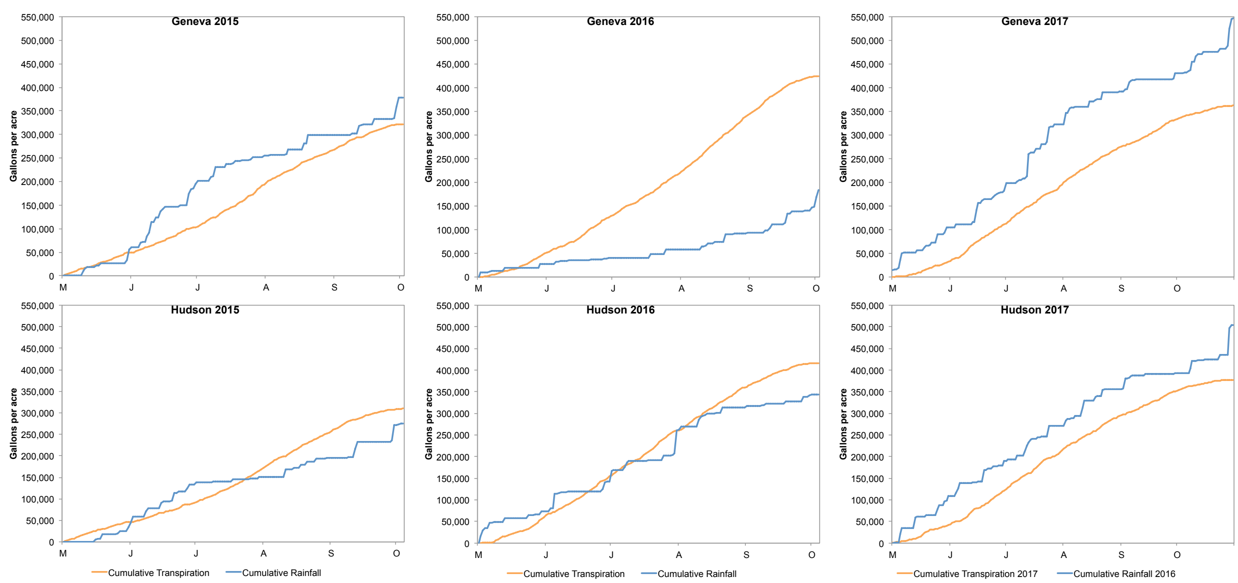

Figure 8. Cumulative tree transpiration and rainfall from May through October in Geneva and Hudson Valley, NY, in 2015-2017.

No tree stress was observed in Geneva in 2015, where no differences were observed between irrigated and non-irrigated trees (Figure 9). On the other hand, even though significant differences were observed in 2016 for Geneva, non-irrigated trees barely reached stress (Figure 9).

Significant water stress was observed during all three-summer measurements in 2015 in Hudson for non-irrigated trees, with values lower than -1.6 MPa (Figure 9). In 2016 here, significant differences were observed between irrigated and non-irrigated trees, but stress was not as important as the previous year (Figure 9). No tree stress was observed for Geneva and Hudson orchards in 2017; yet, non-irrigated trees had significantly lower water potential values.

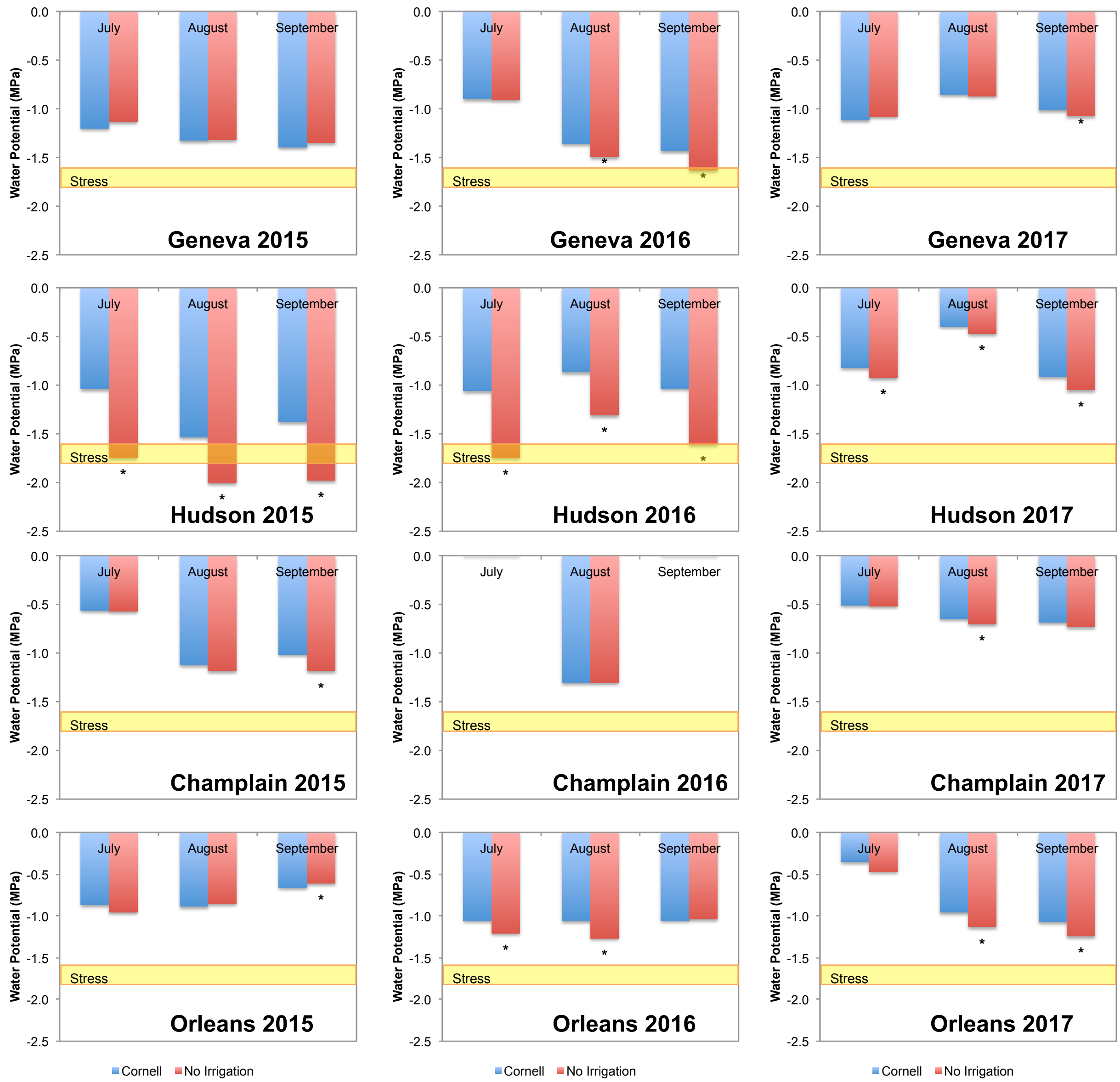

Figure 9. Tree stress during summer in Geneva, Hudson, Champlain, and Orleans orchards in 2015-2017. Asterisks indicate significant differences. NNYADP Precision Apple Management Project, 2017.

Yield, Fruit Size, and Fruit Quality

The Champlain Valley and Orleans orchards' harvest was not recorded in 2015.

In 2016, significantly higher yield was observed in the Champlain Valley orchards, with approximately 2kg/tree more on irrigated trees. No significant differences between treatments were observed in 2017, yet, irrigated trees tended to have ~3kg/tree more in Orleans.

Regarding yield and fruit size, no differences were observed in Geneva for all three years (Figure 10), where not much tree stress was observed (Figure 9). Conversely, yield and fruit size in Hudson were significantly much smaller for those non-irrigated trees (Figure 10). Irrigated trees in 2015-2016 had an average of 1.5 kg more per tree, with bigger apples about 140 g vs 110 g (irrigated – non irrigated respectively) (Figure 10). In 2017, irrigated trees in Hudson tended to have 3 kg more per tree than non-irrigated trees, however significant differences were not observed. On the other hand, fruit size was significantly smaller for non-irrigated trees (180 g. *vs* 160 g).

Overall, fruit quality such as soluble solids and fruit firmness were not significantly different between treatments (Figure 11).

Considering the results from the Hudson orchard on its 5th leaf, we can estimate a loss of 235 bu/ha (1,117 trees/acre) or 414 bu/ha in case we had a high density orchard as in Orleans (1,980 trees/acre). In terms of crop value, lack of irrigation will infer a loss of 3,859 \$/ha – 6,809 \$/ha depending on the tree density. Usually, when the crop is light, there can be some stress with little effect, but when the crop is heavy any stress has a stronger effect. Losses due to water stress could even be worst for full productive orchards and late varieties with a longer growing season such as Fuji.

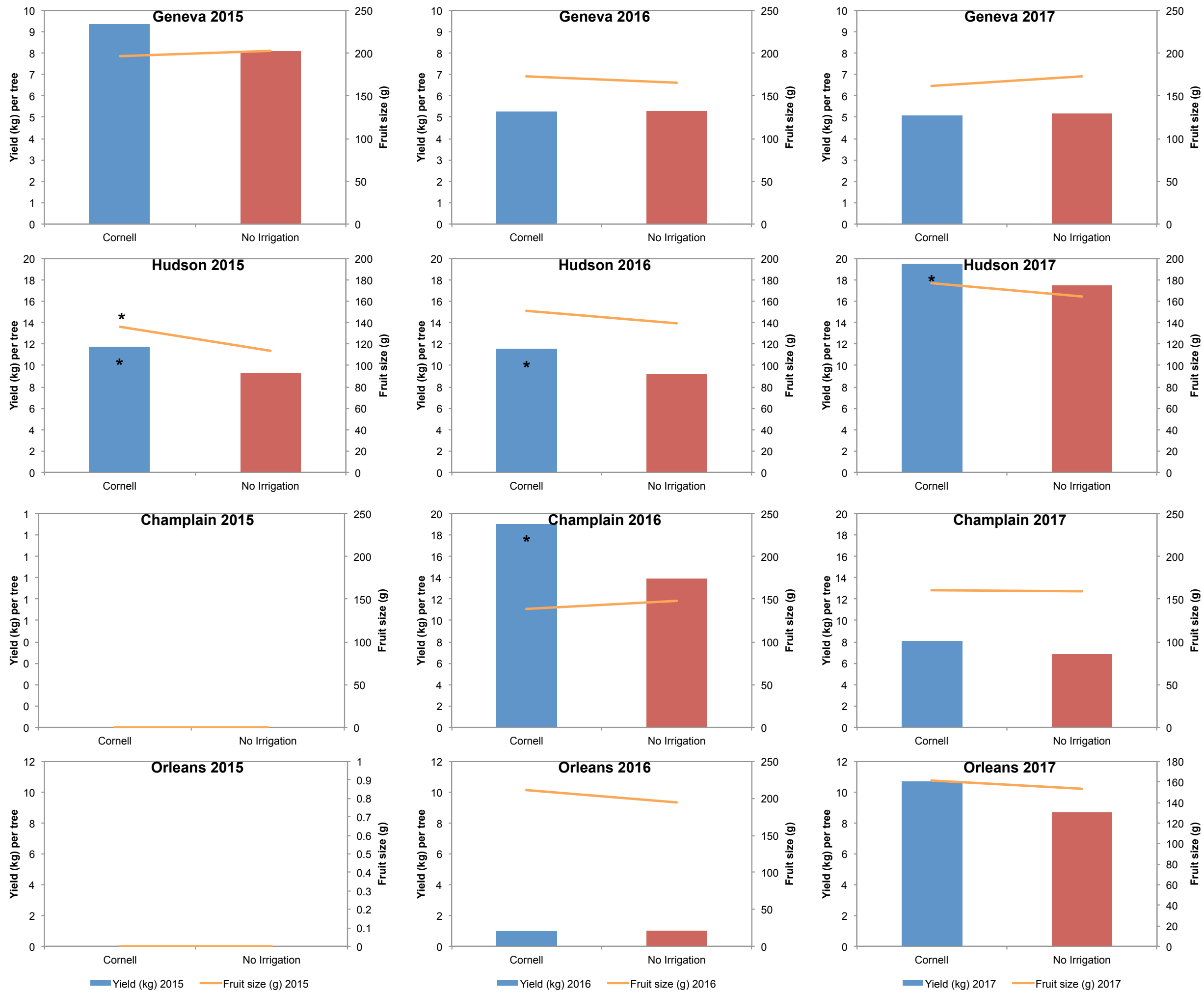

Figure 10. Yield and fruit size in Geneva, Hudson, Champlain, and Orleans orchards in 2015-2017. Asterisks indicate significant differences. No harvest was recorded in 2015 at Champlain and Orleans orchards. NNYADP Precision Apple Management Project, 2017.

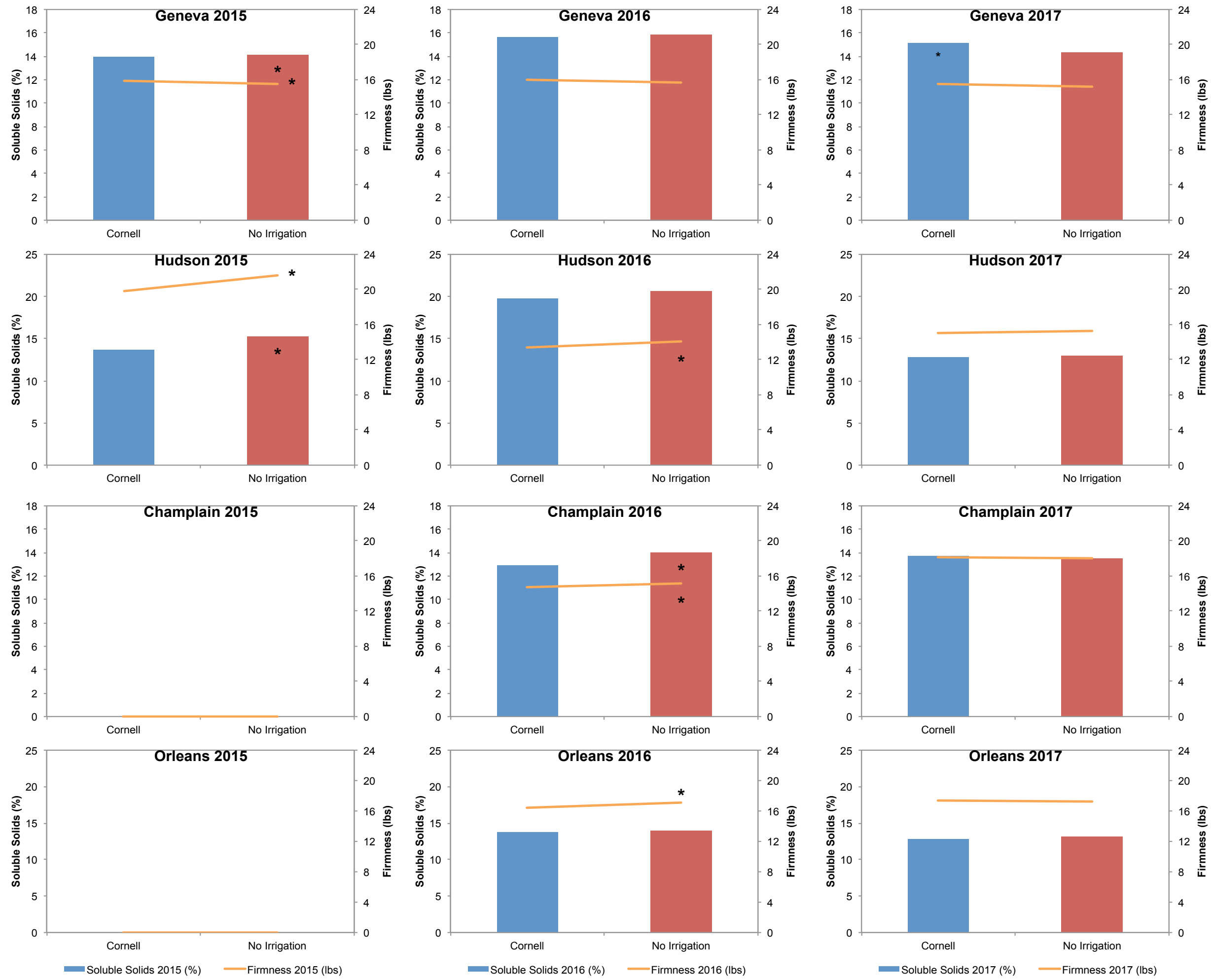

Figure 11. Fruit firmness and soluble solids in Geneva, Hudson, Champlain, and Orleans orchards in 2015-2017. Asterisks indicate significant differences. Harvest data was not recorded in 2015 at Champlain and Orleans orchards.

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