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Research Report: High Tunnel Tomato Fruit Cluster Pruning

Caterina Roman
University of New Hampshire, Durham, caterina.roman@unh.edu

Rebecca G. Sideman
University of New Hampshire, Durham, Becky.Sideman@unh.edu

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Caterina Roman and Becky Sideman, UNH Cooperative Extension & Dept. of Agriculture, Nutrition & Food Systems

Introduction –

Tomatoes are a high value crop grown worldwide. Indeterminate fruiting varieties, which have a season-long harvest period, are commonly grown in high tunnel structures throughout New England for the fresh market. Indeterminate tomato plants often suffer from a phenomenon called 'June drop' in which the plant's first four to five cluster of fruit set perfectly but the subsequent two to three clusters have poor set and plant productivity drops suddenly. We hypothesized that might be due to the excessive demand for resources by the already-set fruit, and that some strategy to reduce fruit load early in the season could prevent this drop.

While cluster thinning (e.g., reducing the number of fruit allowed to mature per cluster) has been successfully shown to increase fruit size (Hesami et al., 2012; Mitchell et al., 2019; Pathirana et al., 2014), it has generally *not* increased marketable yield. Some previous studies have also shown that plants produce fewer unmarketable fruits when clusters are pruned to 3-4 fruits(Hanna, 2009), however, results from (Mitchell et al. 2019) contradicted this, showing no significant change in unmarketable fruits from cluster pruning. Cluster pruning effects seem to be cultivar-dependent, since different varieties have been shown to respond differently. A study performed by Slatnar et al. (2020) tested cluster pruning on the cherry tomato variety, Sakura F1, and found a yield reduction of 60% when 2/3 of the fruiting clusters were removed whereas an experiment conducted by Mitchell et al. (2019) found that there were no significant yield reductions when 2/3 of the clusters were removed on the large-fruited varieties Cherokee Purple, Jet Star, and Lola.

To the best of our knowledge, the effects of removing individual fruits or entire clusters on fruit set patterns has not been investigated. We hypothesized that reducing the fruit load by thinning clusters *OR* removing alternate clusters could reduce the stress placed on plants, and therefore permit more sustained fruit production throughout the season.

Our objective was to: 1) study the impact of thinning tomato fruit clusters on individual fruit weight and total marketable yields on the tomato cultivar Big Beef within high tunnels, 2) evaluate the influence of cluster pruning on the frequency of common tomato deformities, and 3) quantify the effect of cluster pruning on fruit production throughout the season.

What we did –

On 5 May 2021 Big Beef (Johnny's Selected Seeds, Albion ME) tomato seeds were sown in seedling strip trays containing ProMix BX in a heated greenhouse and fertigated with 17-4-17 at 100ppm N. After germination, seedlings were transplanted into 606 trays and received 17-4-17 at 150ppm N until transplanting.

The high tunnel was prepared by broadforking and then applying soybean meal and sulpomag to provide 100 lbs/acre N and 145 lbs/acre K_2O. For this experiment, plants were spaced 18 inches apart in two rows 6 feet apart. Two strands of drip irrigation tape were laid per row. Black plastic landscape fabric was installed between rows to mitigate weed pressure. On 27 May, the tomato seedlings were transplanted into the high tunnel and a tomato clip was used to trellis each plant to a single strand of tomato trellising twine in a single-leader pruning system.

Sucker and cluster pruning was performed once a week throughout the season. Additional tomato clips were added every 1-2 weeks to trellis the plants. Bottom leaves were removed below the first fruit cluster and subsequently below the lowest remaining fruit cluster. Fruit cluster pruning treatments consisted of the following: **control (no fruit pruned), 6 (six fruit per cluster), 3 (three fruit per cluster), 6A (every other cluster removed and six fruit per remaining cluster) and 3A (every other cluster removed and three fruit per remaining cluster).** The five treatments were applied in a randomized complete block design with 12 blocks, with a single plant representing an experimental unit.

Fruit removal for cluster thinning occurred after the flowers had set, when fruit was approximately marble-sized. All ripe fruit were harvested weekly from July to November. Each fruit was weighed, graded for size using U.SD.A guidelines, and observed for deformities that would render fruits unmarketable (e.g. cracking, uneven ripening, yellow shoulder or smaller than U.S. grade small). Plant height and stem diameter were measured three times during the season (3 Aug, 20 Aug and 3 Sep). Plant tissue samples were collected on 24 Aug and 27 Sept from the tip of the youngest full-sized leaf on each plant to create a single composite sample for each treatment. Samples were dried overnight in an air drier and sent to UNH Extension for routine plant tissue analysis.

The insecticide Bt (Dipel DF, Valent Biosciences), was applied once midseason for tomato hornworm. On 1 July, plants were sidedressed with a rate of approximately 120 lbs/acre of N and 200 lbs/acre of K_20 by applying soybean meal and sulpomag at the base of each plant. High tunnel sides were left open unless it was raining or the night temperature was below 55°F. Irrigation was applied based on the amount of soil moisture using the touch method and generally followed a schedule of watering 1 hour every other day, increasing frequency during hot dry periods, and decreasing periods during rainy weather.

Results: Total yield and fruit deformity impact

The total yield varied by pruning treatment (see Figure 1). **6** plants produced the greatest total yields, averaging 8321g per plant over the whole season. Plants receiving treatment **3A** produced yields significantly lower than all other treatments, averaging 4256g per plant.

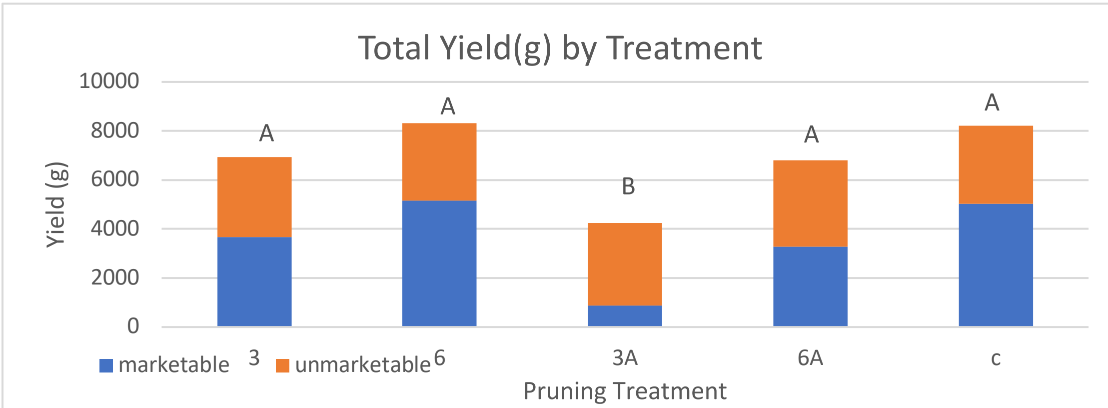

Fig. 1- Average total yield of fruit harvested per plant by cluster treatment. Fruit displaying deformities including cracking, uneven ripening, catfacing, or too small (defined by USDA standards) were labelled as unmarketable. Treatment total yields with the same letter are not significantly different according to Tukey's HSD ($p<0.05$).

The most prevalent deformity in all treatments was fruit cracking, particularly radial cracking originating from the stem scar, followed by uneven ripening of fruit. Treatment **3A** had the highest percentage of unmarketable fruit with an average of 78% being unmarketable whereas **6** had the lowest rate at 37% (Figure 1). These results were unexpected, since we hypothesized that cluster pruning would not affect the total yield and would decrease the rate of cull fruit.

Results: Individual fruit weight

Cluster pruning treatments had a significant effect on fruit size (Figure 2). The pruning treatment **3A**, in which every other cluster was removed and the remaining clusters were pruned down to 3 fruit, had the largest fruit. Treatments **6** and the **control** had the smallest fruit, and treatments **3** and **6A** had intermediate-sized fruit. Regardless of treatment, almost all fruit still fell into the medium, large, or extra-large USDA size categories. The larger fruit present in **3A** plants seemed to correspond with higher rates of fruit cracking which led to greater amounts of the **3A** fruit being deemed unmarketable.

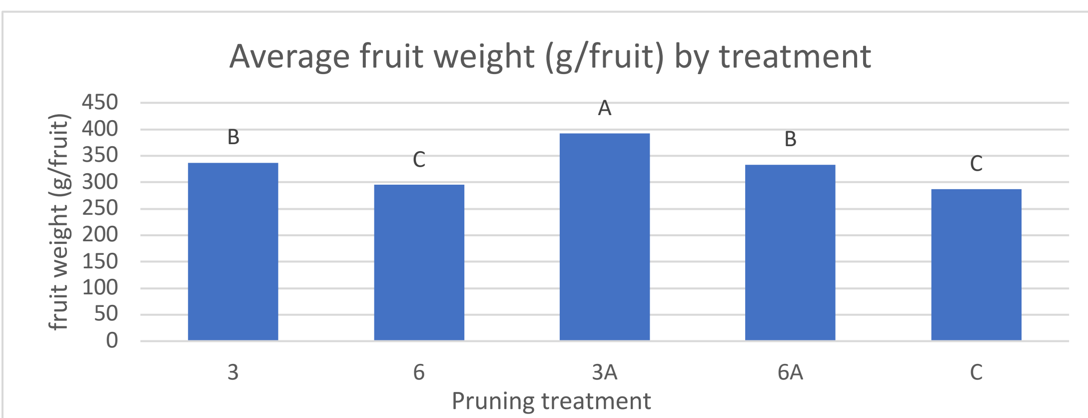

Fig. 2- Fruit size (average individual fruit weight (g) by treatment. Treatments with the same letter are not significantly different according to Tukey's HSD ($p<0.05$).

Results: Pruning effect on production throughout the season

No matter the treatment, clusters rarely set more than 5 fruits (Figure 3). We hypothesized that cluster pruning would maintain productivity throughout the season by altering the ratio of photosynthesizing vegetative growth to carbohydrate sinks (fruit). In **control** (unpruned) plants and in plants pruned to **6** fruit/cluster, yields started very high and dropped steadily throughout the season (Figure 3). In **3A** plants, yields were low and steady throughout the season, and cumulative yields did not reach those of other treatments. Treatments **3** and **6A** showed intermediate performance: they started out with lower yields than control plants but produced higher yields later in the season.

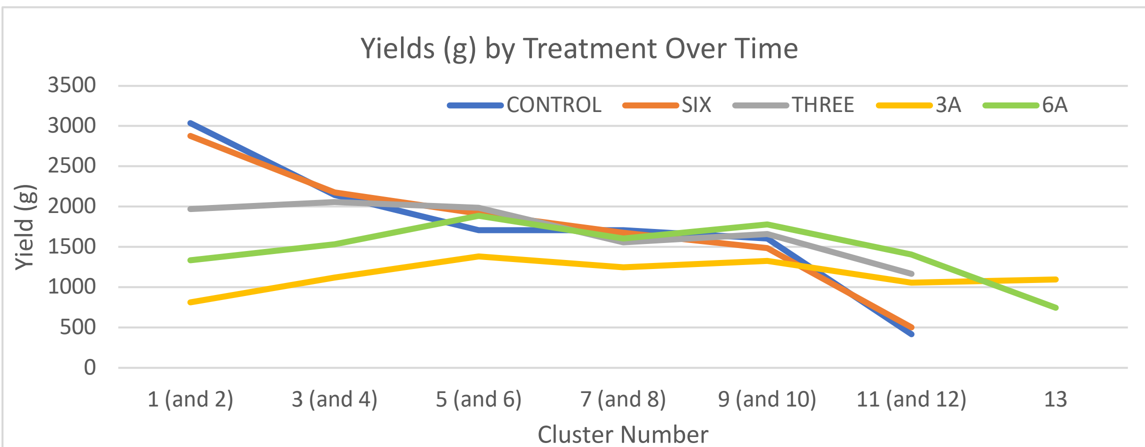

Fig. 3 – Yields over time, presented in total weight harvested per one (3A, 6A) or two (3, 6, and control) clusters.

After the first four clusters, the **control** and **6** plants set *fewer* and *smaller fruits*. On the **control** plants, this was most apparent at the 5th and 6th clusters, with an average of only 2.8 and 2.7 fruits per cluster (Figure 4). In some cases, the cluster only produced 3 flowers; in others, several flowers aborted before fruit set. Many pollinators were present inside the high tunnel, suggesting that flower termination was not due to a lack of pollination.

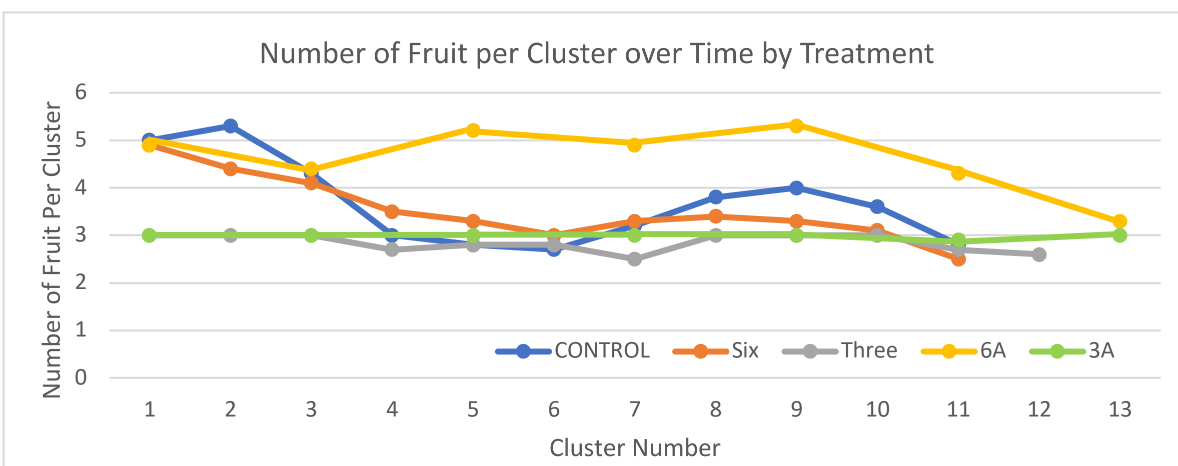

Fig. 4 - Average number of fruit per cluster over time.

Results: Vegetative growth and nutrient utilization

Plant heigh and stem diameter were measured on 3 Aug, 20 Aug and 2 Sept. Plants receiving treatment **3A** had the greatest height and diameter at all three dates. **6A** plants had height similar to **3A** but had a smaller stem diameter at later dates. Plants receiving treatments **C**, **3** and **6** also had a downward trend of stem diameter which would be expected with a heavy fruit set decreasing vegetative growth over time. Plants receiving treatments **3A** and **6A** were visibly greener and the leaves were thicker along with their increased height and stem diameters (Figure 6). These findings suggest that aggressive fruit pruning changes the source/sink relationship of vegetative growth to fruit production. While an adequate amount of vegetative growth is needed to photosynthesize, excess growth may be a waste of plant productivity.

Figure 6. Vegetative differences between treatment 6 (left, blue string) and treatment 3A (right, red string). Plants receiving 3A and 6A treatments were taller, had thicker stems, and were deeper green than C, 3, or 6 treatments.

Leaf tissue samples were collected on 14 Aug and 27 Sept. All pruning treatments showed deficiency in K and, to a lesser extent, P, despite application of moderate amounts of K (345 lbs/acre actual K_2O) and excessive soil P levels. By 27 Sept, all treatments showed deficiencies in Fe and Zn. Leaves from treatments **3A** and **6A** were deficient in N and Mn, however, all other treatments had optimal levels of these nutrients. We hypothesize that the lower N and Mn levels may be caused by the **A** treatments significantly greater vegetative growth that either required more of these nutrients to produce or that the plants had an adequate level but that was distributed over a far greater amount of leaf area, essentially diluting these elements.

Conclusions

The ratio of source (vegetative tissue) to sink (fruit) did not appear to be the only factor in sustaining season-long harvests and controlling overall yields, although it did play a role. Compared with plants that were not cluster-pruned, **3A** and **6A** treatment plants exhibited more consistent fruit production, their overall yield was lower, and the plants had harvesting gaps since all even number clusters were removed. **Control**, **6**, and **6A** plants usually did not produce more than 5 fruits per cluster, due to limited flower production and fruit set. Cluster pruning treatments had a significant effect on fruit size, but we also observed that cracking incidence increased as fruit size increased. Environmental factors including irrigation scheduling and daily temperature fluctuations likely played a role in the rates of cracking as well as yields. Vegetative growth was significantly increased by reducing fruit load; however, this was not correlated with greater yields and required additional labor for increased trellising and sucker removal. Overall, our results thus far do not suggest that removing alternate fruit clusters is beneficial.

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Questions?

With any questions, please contact the author at: becky.sideman@unh.edu or 603-862-3203. You can follow the Sideman Lab's work on Instagram @unh_sidemanlab