Final Report to OFRF

Developing integrated irrigation management strategies to improve water and nutrient use efficiency of organic processing tomato in California

Project period: 5/1/2016 – 8/1/2018

Project participants

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Summary of work

This project aimed to develop integrated irrigation practices that capitalize on soil health to improve efficiency of irrigation water and decrease pest pressure and potential N losses of California organic processing tomato production. The current drought has dramatically decreased irrigation water allocated to organic tomato growers and there is an urgent need to test new irrigation strategies that reduce water inputs while maintaining product quality, nutrient supply and high productivity levels. In collaboration with Scott Park, an organic grower located in the Sacramento Valley, we measured how soil health building management strategies can help decrease irrigation water inputs and improve tomato quality in organic system. We found that in fields under long-term organic management, eliminating the final irrigation before harvest saved 0.2-0.5 ac/feet of irrigation water and increased water use efficiency (T harvested fruit/acre feet) by approximately 20% without significantly affecting yield. We observed no impact on diseases and canning quality and there was a trend toward higher nutritional quality (higher phenols). Our findings indicate that terminating irrigation slightly earlier in the growing season is a viable strategy to help organic tomato growers dynamically cope with irrigation water shortages without hampering the quality of their harvested product.

Research activities and results

2016: We hypothesized that soil health building management practices (e.g. diverse crop

rotation, cover cropping, compost, conservation tillage controlled traffic) implemented by Scott Park will improve water use efficiency (WUE) (T harvested fruit/acre feet) and maintain plant water and nutrient status under deficit irrigation without reductions in fruit quality. We established a trial in an un-replicated organic processing tomato field where we imposed two different water management scenarios (1) regular practice with irrigation cutoff 30 days before harvest and (2) deficit schedule that advanced irrigation cutoff to 45 days before harvest. We measured the impacts of water savings on WUE, yield and fruit quality and monitored shifts in water acquisition dynamics and pest pressure. The deficit irrigation implemented saved 0.5 ac/feet of irrigation water and increased WUE by 19% with no significant effect on yield and plant development. We observed no reduction in nutritional value and a trend toward higher phenols. Mineralization dynamics of organic inputs was different between the two irrigation schedules in shallow soil with a sharp decrease after irrigation stops in deficit conditions. Preliminary results from that year suggested that smart irrigation strategies can be optimized for shifts in soil properties and water uptake dynamics with adoption of soil-health building management strategies on organic farms in Northern California. Results are summarized in a poster (Appendix A) presented at presented at the ASA/CSA/CSSA Annual meeting in Phoenix in November 2016 by our undergraduate student Anna Azimi.

2017: We repeated the experiment a second more detailed field season in another field which has been organically managed by Scott Park for the last 23 years. We hypothesized that no yield penalty under deficit irrigation was due to high soil water infiltration, retention, and moisture availability and/or access by roots, as opposed to plant physiological changes in WUE in response to water stress. We established a replicated trial in which we imposed the same water management scenarios as the previous season, (1) regular practice and (2) deficit schedule. We measured the impacts of water savings on WUE, yield, and fruit quality, quantified soil health indicators related to soil hydrology, and monitored potential shifts in root depth and plant water status. The deficit irrigation implemented saved 0.2 ac/feet of irrigated water and increased WUE by approximately 20% with no significant effect on yield and plant development, including roots. We again observed no reduction in canning or nutritional value of fruit and a trend toward higher phenols. We did not detect any impact of deficit irrigation on plant growth, development, and water stress indicators, suggesting that soil health and moisture availability/access, not plant physiological changes, prevent deficit irrigation from reducing yield. Despite not being part of this grant, we established a mirroring trial on a nearby conventional field located on a similar soil type but with lower soil health levels (although we are still in the process of quantifying it). We found a higher, yet non-significant yield loss from deficit irrigation in the conventional field (8.6% vs. 3.6% yield loss in conventional and organic field respectively) which lead to a higher water productivity of the organic systems. Results from the second field season are summarized in a poster (Appendix B) presented at the ASA/CSA/CSSA Annual meeting in Tampa in October 2017 by our PhD student Leah Renwick.

Results across both seasons suggest that terminating irrigation slightly earlier in the growing season is a viable strategy to help organic tomato growers dynamically cope with irrigation water shortages without hampering the quality of their harvested product. These

results may be relevant to other organic farms considering soil health building management and smart irrigation strategies.

Outreach and conference presentations

Once our soil health assessment is complete, results will be used to help develop applied recommendations for smart irrigation strategies optimized for shifts in soil properties and water uptake dynamics with adoption of soil-health building management strategies on organic farms in Northern California. Results from the first field season were presented by Anna Azimi, an undergraduate working on the project, at the ASA/CSA/CSSA Annual meeting in Phoenix in November 2016 as part of the undergraduate competition of the soil health section. Results from the second field season are summarized in a poster (Appendix B) presented at the ASA/CSA/CSSA Annual meeting in Tampa in October 2017 by PhD student Renwick. PI Gaudin also presented results as part of 3 talks in 2017/2018:

- *Building resilience: From theory to management*, Diversified Farming Roundtable, UC Berkeley.
- *Leveraging research to develop climate-smart agricultural systems*, California Senate Policy Brief.
- *From soil properties to services to growers*, California Soil Health Summit, Sacramento.

The project was also featured in an OFRF video published on Youtube which has been viewed 2,534 times. We will continue our effort to communicate results to a wide audience of conventional and organic, producers, advisors, researchers and the general public though a variety of outreach and education activities. Results will be 1) published in scientific journal, shared with 2) growers as part of Russell Ranch field day, 2) at extension meetings that Margaret Lloyd and Scott Park speak to, 3) to students of PI Gaudin's undergraduate and graduate classes at UC Davis and 4) in talks by PI Gaudin and PhD student Renwick.

We sincerely thank OFRF for this opportunity to do on-farm collaborative research. There is growing interest to capitalize on soil health to decrease irrigation water inputs and results from this grant have served as a springboard to write and successfully obtain a larger grant from CDFA Specialty crop block grant in 2016 titled "Decision Support Tools for Processing Tomato Growers to Optimize Fruit Quality and Yields under limited water availability" ($117,130, 10/01/2016 to 03/31/2019, Grant #10.170). Scott Park has also expressed interest to look at leaching levels in his field under both treatments. With the remaining 10% of the grant, we will be conducting this study this fall.