**Project Title:** Effects of irrigation and management practices on soil health and soil salinity in processing tomatoes

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**Key Takeaways:**

* Greater soil organic matter levels were associated with increased soil nitrate levels and tomato leaf nitrogen content.
* As soil sodium levels increased, tomato nitrogen and potassium uptake decreased.
* Higher levels of mycorrhizal fungal vesicle structures (storage structures) were observed in roots of tomatoes grown in high-sodium soils
* Higher levels of mycorrhizal fungal hyphae were observed in tomatoes with high plant but not high soil potassium (K) levels, suggesting that mycorrhizal fungi benefited tomato K uptake.

**Goal and Objectives:**

***Goal:*** To explore on farm management practices and how these relate to soil health and tomato productivity indicators, including yields. Relationships between soil salinity, mycorrhizal associations, nutrient uptake, and yield will be explored.

***Objectives:***

* Conduct survey of farm management and soil health indicators on processing tomato farms in the San Joaquin Valley.
* Determine relationships between saline soils and mycorrhizal associations, and between mycorrhizal colonization and crop nutrient uptake and yield. Determine relationships between soil health indicators and crop nutrient uptake and yield.

**Progress**

We visited 8 farms in the San Joaquin Valley/Kern County region and collected soil and tissue samples from 38 fields in June and July 2019. Soils were analyzed in the lab for chemical parameters (N, P, K, Ca, Mg, Na, cation exchange capacity, dissolved organic carbon, total dissolved nitrogen, pH), soil organic matter, and biological parameters (microbial biomass carbon and nitrogen, mycorrhizal colonization). Tomato leaf samples were analyzed for total N, P, K, and S content. Half of the soil samples have been processed for aggregate stability, a measure of physical soil structure, and the remaining half is anticipated to be completed by mid-October. All soils are currently being analyzed for PLFA analysis, a microbial fingerprinting technique that will provide total microbial biomass, and lipid biomarkers for certain classes of microbes such as saprophytic fungi, arbuscular mycorrhizal fungi, and gram +/- bacteria. When all processing is complete, each soil sample will have been analyzed for 30 different biophysical parameters. Grower interview data is recorded and management history for each field collected. Biophysical soil parameters will be analyzed alongside management history data to elucidate connections and relationships between management and soil health factors. We will be contacting our grower collaborators at the end of September/beginning of October to request tomato yield data, to add to the productivity factors data. Data analysis will be conducted by examining correlations and constructing bivariate and mixed models to determine which soil factors are related to tomato productivity outcomes.

**Preliminary Findings**

Figure 1.

There was a positive relationship between soil organic matter content and tomato tissue and soil nitrogen concentrations. Every one unit increase in soil organic matter increased soil nitrate by 15 ppm (e.g., increasing soil organic matter by 0.1% increases soil nitrate by 1.5 ppm). Soil organic matter increased tomato leaf nitrogen content by 0.5 percent for every one unit increase in soil organic matter (Figure 1).

Figure 2.

Soil sodium levels were variable and very high in some areas of the San Joaquin Valley. Soil sodium negatively affected tomato nitrogen and potassium uptake at soil sodium levels above 200 ppm. Every 100 ppm increase in soil sodium decreased tomato leaf nitrogen by 0.2 units and decreased tomato leaf potassium by 0.1 units (Figure 2). Arbuscular mycorrhizal fungi vesicle structures observed in tomato roots increased with increasing soil sodium levels, suggesting that colonization of mycorrhizae in tomato roots is an adaptation mechanism to high salt levels. No relationship between mycorrhizal colonization and tomato N and P leaf contents was observed, but there was a relationship between mycorrhizal hyphae in roots and tomato leaf K content (Figure 3).

Figure 3.

**What’s Next for the Project**

This project motivates many questions about what fundamental mechanisms govern relationships between soil biological and chemical factors, and tomato productivity. Data from this year’s survey work will be combined with last year’s data collected on tomato growers’ fields to create a data set with soil biochemical parameters and tomato productivity across over 70 fields in California’s Central Valley. All soil and plant data will be combined with crop management data, including rotational crops, frequency of tomato cropping, compost use, cover crops use, and tillage intensity to evaluate whether trends exist between management, soil health, and tomato productivity factors, taking into account differences among soil types. Furthermore, the amount of data from a large geographical area across the Central Valley will provide a base for the development of regionally appropriate and attainable targets for soil health indicators like soil organic matter.

**This Project as Leverage for Other Dollars**

Experiences and preliminary data obtained from the work in this project were used to develop and submit a $10 million proposal to the USDA’s Sustainable Agricultural Systems grant program, in collaboration with other soil health researchers in the Midwest, to develop regionally based soil health indicators for vegetable crop producers and to use these benchmarks to develop tools for growers to use to track soil health on their farms and its impact on crop productivity. While the first version of the proposal was unsuccessful, the ideas and collaborations developed in the first round of proposal writing will be used to further develop and submit proposals to other large national grant programs to promote 1) collaborative research projects with California tomato growers, 2) regionally appropriate benchmarks for soil health improvement, and 3) discovery of links between soil health indicators, soil functions, and crop productivity, to determine which soil health management practices are worth investing in on California tomato farms.