Soil Carbon and Nitrogen Characteristics of Pomegranate Cultivation under different Nitrogen and Irrigation Systems

Rebecca Tirado-Corbalá[1*], James E. Ayars[1], Claude J. Phene[2], R. Scott Johnson[3] and Dong Wang[1]

[1]SJVASC-USDA- ARS- Water Management Research Unit~ Parlier, California, USA

[2]SDI+, P.O. Box 314 Clovis, CA 93613-0314

[3]University of California- Kearney Agricultural Research Center (KARE)~Parlier, California, USA

Introduction

In the past seven years, pomegranate (*Punica granatum, L* var. Wonderful) cultivation has become a popular commercial crop in San Joaquin Valley, California. The rising demand for this crop is primarily due to pomegranate juices' high nutritional value due to bioactive compounds and it antioxidant properties. Additionally, it is thought to be a drought tolerant crop that can thrive on a wide range of soil types. However, the establishment of poorly managed permanent crops in California Valley soils can increase the actual deficit of water and reduce water quality by increasing soil salinity. For that reason, a pomegranate project was initiated by the San Joaquin Valley Agricultural Science Center (SJVASC) in cooperation with the UC KARE Center in Parlier, CA and partially funded by CDFA/FREP trying to determine pomegranate water requirements and nitrogen (N) requirement under different drip irrigation systems [surface (DI) and subsurface (SDI)] and minimize leaching losses of nitrogen and carbon in mature pomegranate.

Objectives

- The overall objective of this project is to optimize water-nitrogen interactions, to improve fertilizer use efficiency of young and maturing pomegranate and to minimize leaching losses of nitrogen.
- The objective of this presentation is to provide quantitative and qualitative information of stored Soil Carbon and Nitrogen, Dissolved Organic Carbon (DOC) under DI and SDI systems on adequate assumed requirements.

Materials and Methods

- Project conducted in a 1.4 ha pomegranate orchard at the UC-Kearney Agricultural Center located near Parlier, CA
- The soil at the field site is a Hanford sandy loam (coarse-loamy, mixed, thermic Typic Xerorthents).
- Climate considered Mediterranean with precipitation occurring from fall to spring as only rainfall.
- The experimental design is a Randomized Complete Block Design.
  - Nitrogen level main treatment
  - Irrigation Method sub –treatment
- The Nitrogen fertility consist of three N levels:
  N1- 50 % of adequate N (AN)
  N2- 100% AN
  N3- 150% AN

* The N fertilizer was applied by continuous injection of urea based sulphuric acid (N-pHURIC, 10% N) to all treatments to maintain the pH of the irrigation water at 6.5 ± 0.5. Ammonium nitrate (AN-20,20% N) was applied to N-2 and N-3 treatments.

- Irrigation system- Drip- In® classic with root guard (0.620 in. diameter, 0.53 gph, 0.045-in. wall thickness, 18-in emitter spacing)

  a) DI and SDI Installed 3.5 feet on each side of the tree row
  b) SDI installed at 20-22- inches depth

- Soil samples from eight soil depths (0-6, 6-12, 12-18, 18-24, 24-30, 30-36, 36-42, 42-48 in) were collected in December 2012, one year after planting 799 Pomegranates trees (Wonderful variety).
- Total N and C contents were determined by dry combustion with a Flash 2000 N & C Soil Analyzer from Thermo Scientific®.
- DOC was determined after saturating the soil with DI water (1:1 soil: water) for 24 hours, shaking for a one hour on a reciprocal shaker, and filtered through a Whatman, no. 42 filter. Carbon recovered in the water extract was determined by using Fusion Total Organic Carbon Analyzer from Teledyne Tekmar.

Results

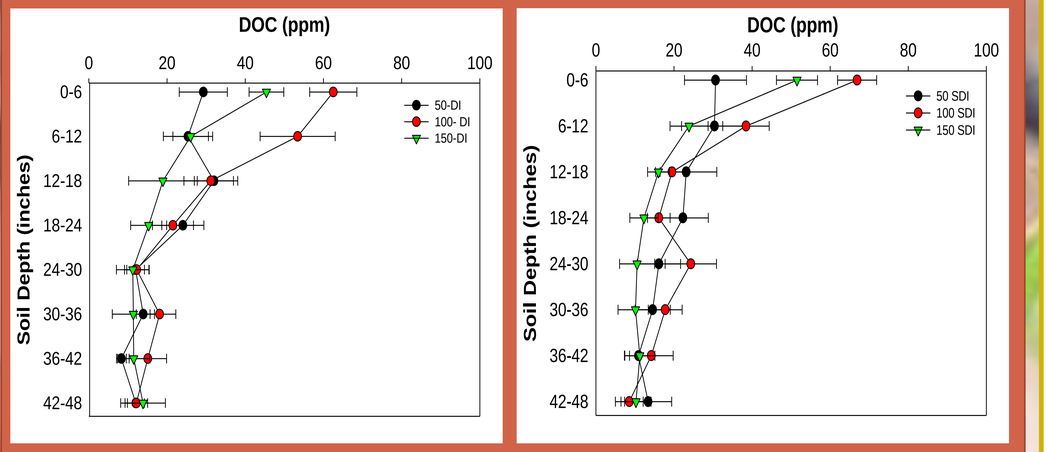

Figure 1. Vertical distribution of soil dissolved organic carbon (DOC) collected from DI and SDI systems and under nitrogen injection treatment plots in December, 2012. Error bars are standard errors of the mean value (n=5).

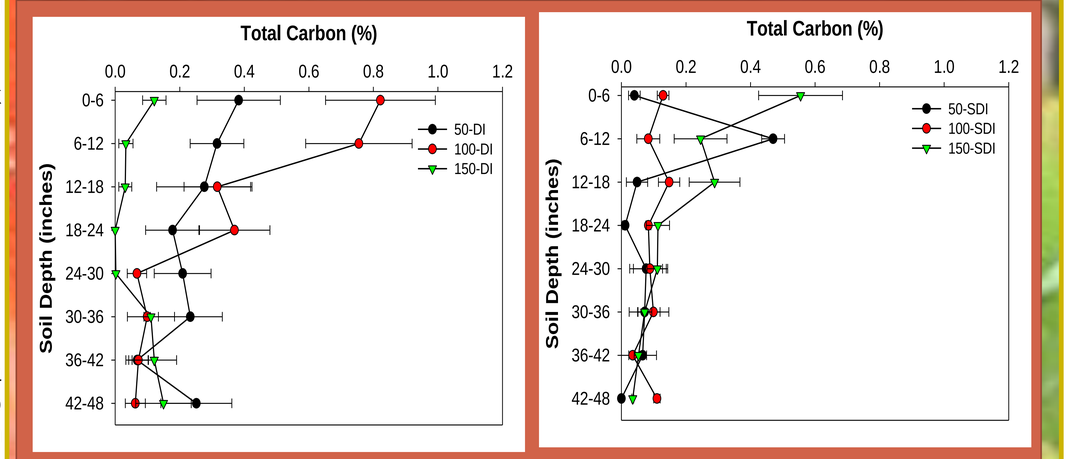

Figure 2. Vertical distribution of soil Total Carbon (%) collected from DI and SDI systems and under nitrogen injection treatment plots in December, 2012. Error bars are standard errors of the mean value (n=5).

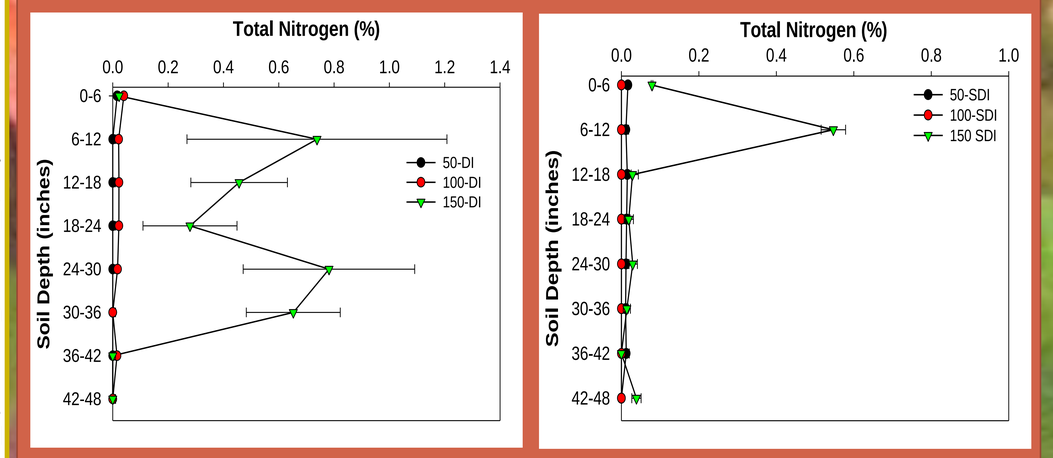

Figure 3. Vertical distribution of soil Total Nitrogen (%) collected from DI and SDI t and under nitrogen injection treatment plots in December, 2012. Error bars are standard errors of the mean value (n=5).

Discussion

Measurements in the following three graphs were obtained from samples collected in December 2012 after receiving the different nitrogen treatments from May12-August 18, 2012.

Dissolved Organic Carbon

Results after one year shows there is statistical difference in $P< 0.05$ in the 1st 12 in on DI (~65 ppm) and 1st 6 in SDI (~ 70 ppm) for N3 (150% N) application. However, DOC decrease with respect of depth on both irrigation system and N fertigation.

Total Carbon

In DI treatment, higher TC % was found in the 1st 12 in (~1 %) on N1 (50% N) and lower TC % on N3 (150% N) on the 1st 30 in. Although, at deeper depth no statistical difference between N treatments. However the TC is higher and more variable over all soil profile compared with SDI irrigation system. In SDI system, higher TC was found under N3 in the 1st 6 in. However, inconsistent response was found in 6-24 in soil depth. At deeper depth, no difference between treatment was found and lower TC (< 0.2 %).

Total Nitrogen

Higher TN% was found under N3 in the 1st 36 in DI irrigation and 1st 12 in. in SDI irrigation system. Really low TN% was found on N1 and N2 DI and SDI combination and at deeper depth (> 18 in) in N3 SDI.

Conclusion

This research is ongoing and additional data will be from 2013 to 2015 to clarify soil TC, TN, and DOC in pomegranate cultivation under high frequency DI and SDI irrigation and N fertigation.

Acknowledgements

The authors wish to thank the CDFA (California Department of Food and Agriculture) for partially funding the project. We also want to thank the following companies for providing: Paramount Farming Co.-trees and cones; Toro Micro-Irrigation- drip lines; Lakos Filtration- sand media; Verdeegal Brothers-fertilizers and DOROT-control valves. We also like to thank the UC KARE Center for providing facilities and personnel support to the project. In addition, we will like to thank Ryan Lancaster, Matthew Gonzalez, Don Tucker, and Julianne Anaya, for helping us with soil collection in the field and soil preparation and analysis help in the SJVASC-USDA- ARS laboratories.