Onion Irrigation

Evaluating Subsurface Drip Irrigation in Onion Crop Production to Decrease Water and Nitrate Losses

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Objective:

Optimize parameters of Sub-Surface Drip (SSD) irrigation to increase onion productivity and reduce water and fertilizer losses

Introduction:

The Columbia Basin, located along the eastern border of Oregon and Washington has some of the highest onion production in the US, relying primarily on overhead irrigation. Overhead irrigation results in evaporative losses, non-target water and fertilizer placement and increased incidence of disease. The intent of this project is to address the critical need to improve water delivery, and reduce fertilizer (nitrate) leaching. The project evaluated SSD irrigation in onions with differing irrigation parameters to optimize crop yield and increase water use efficiency. Soil moisture throughout the profile was modeled to determine water patterns. It was hypothesized that with proper management, SSD could increase onion yield and quality with reduced water usage and associated negative environmental impacts.

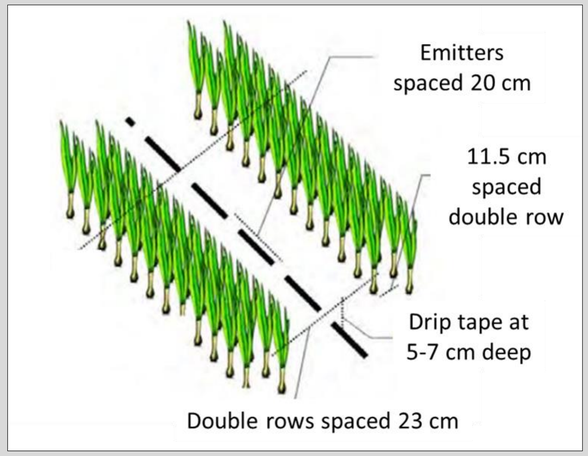

Figure 1. Onion bed planting configuration

Materials and Methods:

- Onions were direct seeded in coarse soil (Atkins sandy loam) in a random complete block design with 4 treatments and 5 replications.
- SSD irrigation was installed at 5-7 cm (Fig. 1) beneath the soil surface.
- Soil moisture data was collected with Watermark granular matrix sensors and used automatically to initiate irrigation.
- Treatments consisted of two irrigation onset soil moisture values of 10 and 20 centibars (cb). At each onset value, low flow (0.64 L/min) and high flow (1.29 L/min) rates of water were tested.
- Nitrate was sampled with soil solution access tube (SSAT) lysimeters installed at four depths up to 1.8 meters.
- Crop data consisted of plant establishment, plant height and vigor, and graded onion counts and yield.
- Data were analyzed using an analysis of variance, if significant differences were detected, means were separated with Fischer's Least Significant Difference test

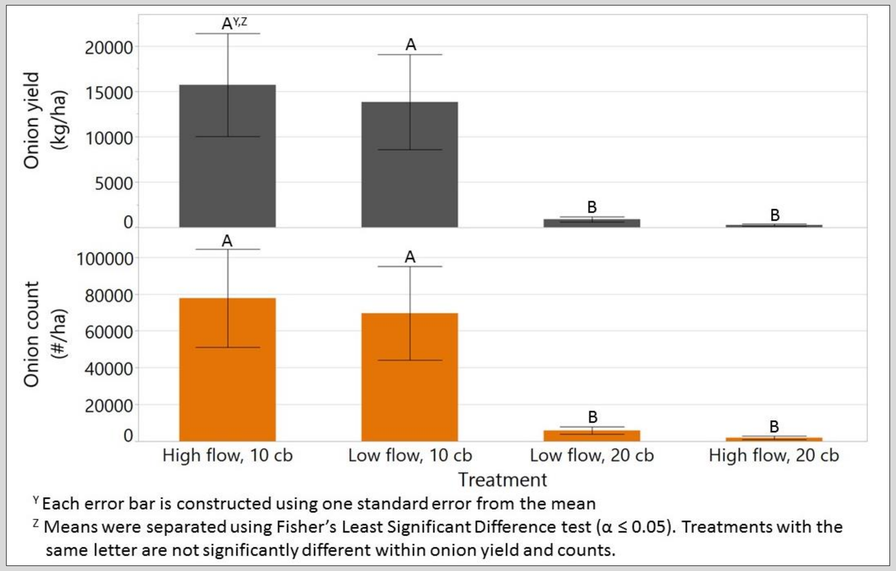

Figure 2. Onion yield and count data at harvest

Results:

Results of onion yield indicated a significant difference between treatment effects (P=0.0053). Onion yield treatment means (α=0.05) were significantly reduced by the 20 cb irrigation onset threshold (Fig. 2). Optimal yield was found at 10 cb onset, with no significant effect of flow rate (Fig. 3). Yield in the high flow 10 cb treatment was numerically optimal to the low flow 10 cb treatment, resulting in 15707 and 13820 kg/ha, respectively. Onion counts exhibited the same numerical and statistical trend (P=0.0037) as yield, with the numerically highest counts found in the high flow 10 cb treatment (77781 onions/ ha).

Soil moisture modeling identified a deeper infiltration of irrigation water past the onion roots and less lateral spread over 24 hours with the low flow treatment (Fig 4). The high flow treatment saturated the soil laterally but did not infiltrate past the root rhizosphere (Fig 5).

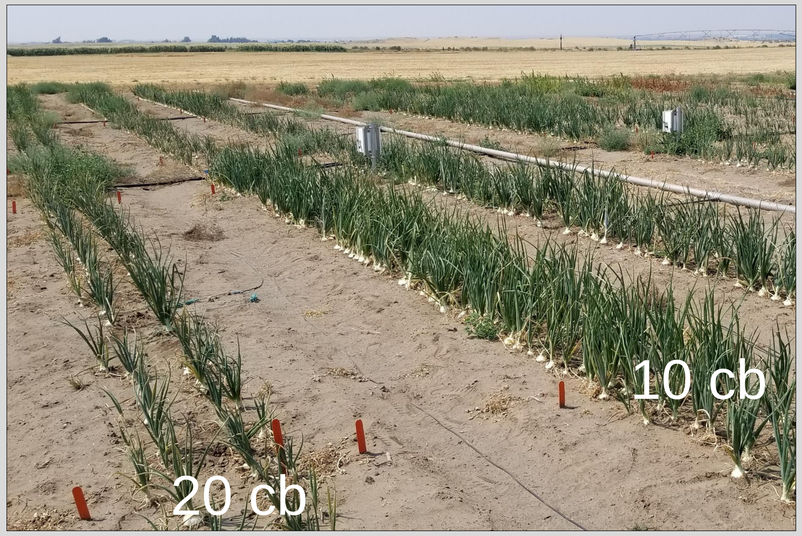

Figure 3. Comparative photo of 10 and 20 cb irrigation treatments. Optimal production was found in the 10 cb soil moisture onset treatment

Conclusions:

Our findings suggest that onion production is optimized when using SSD irrigation with either 0.64 L/min (low flow) or 1.29 L/min (high flow) set to irrigate when soil reaches a point of moisture that exceeds 10 cb. 20 cb treatments are too dry in sandy soil and cannot support onion development.

Soil moisture distribution appears to be more suitable laterally with less deep infiltration with the high flow treatment. This result can be valuable to reduce water losses and subsequent fertilizer leaching. Based on one year of data, this study is recommending that SSD irrigation in sandy soil can optimize onion production with a high flow rate, irrigating at 10 cb. Nitrate data is not presented due to a lack of reliability of instrumentation.

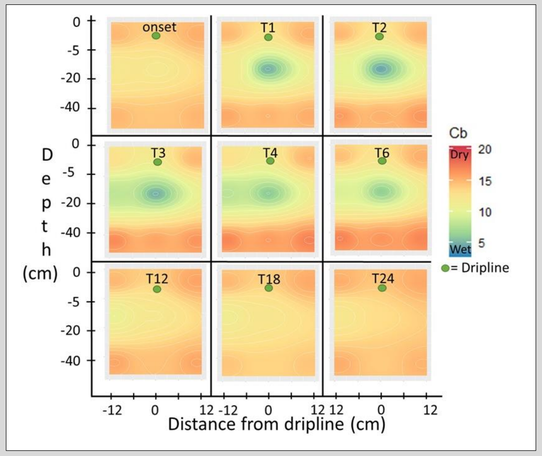

Figure 4. Soil moisture, with low flow over 24 hours

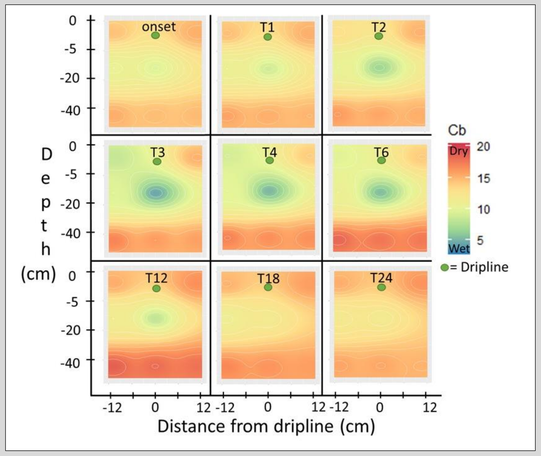

Figure 5. Soil moisture, with high flow over 24 hours

Acknowledgments:

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