LEAST LIMITING WATER RANGE IN IRRIGATED SANDY SOILS OF NORTHEAST FLORIDA

Sustainable Water Resources — Complex Challenges, Integrated Solutions — 8th Biennial UF Water Institute Symposium

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BACKGROUND

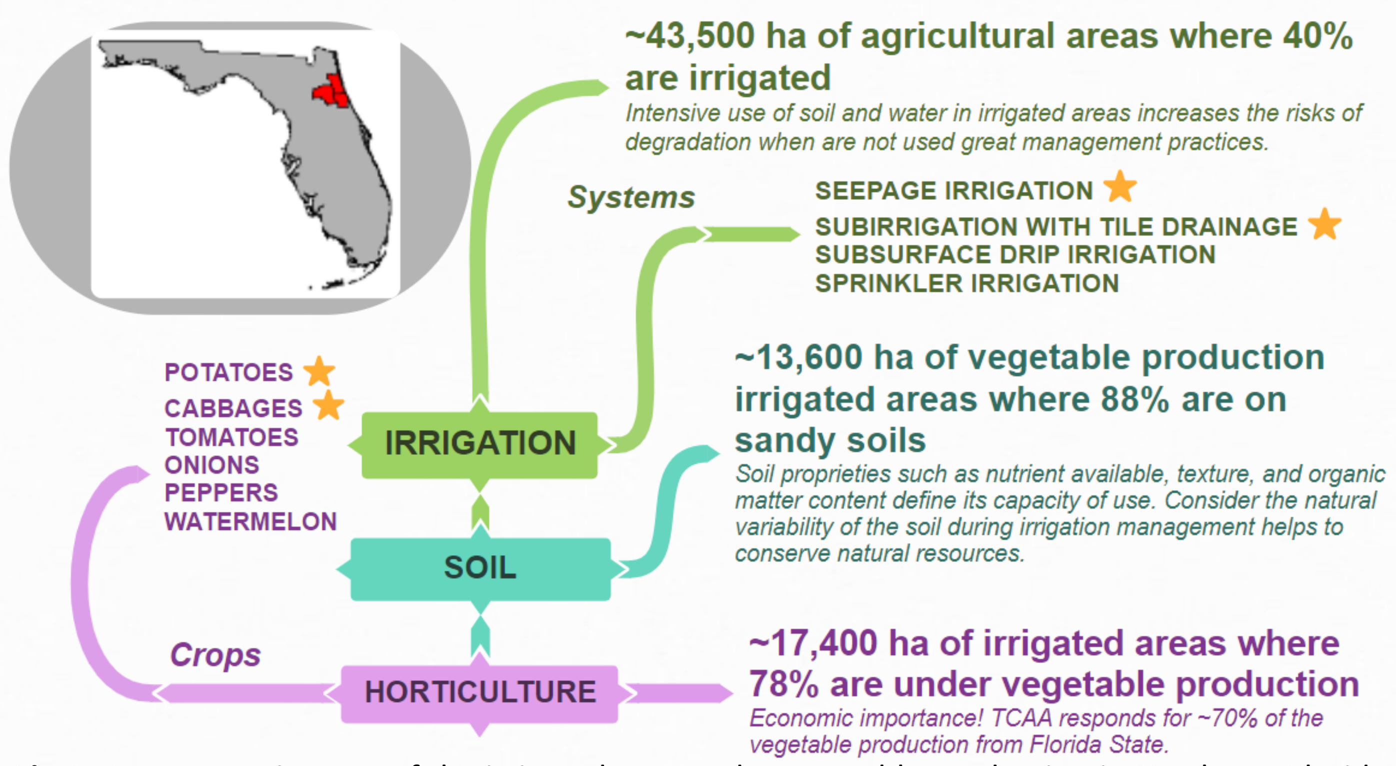

Fig.1. Representativeness of the irrigated area under vegetable production in Northeast Florida. Data source: Soil Survey Staff (2016).

Development of tools to assist growers with irrigation management will reduce water application, nutrient loss and enhance crop production!

- ***The optimum soil water content range for root growth can be estimated using the least limiting water range (LLWR) approach (da Silva et al., 1994);***
- ***LLWR is defined by the limits between soil field capacity (FC), permanent wilting point (WP), air-filled porosity of 0.10 m³.m⁻³ (AF), and penetration resistance of 1.5 MPa (PR).***

❖ **Objective:** Estimate the least limiting water range (LLWR) for irrigated sandy soils under seepage and sub-irrigation with tile drainage (SDT) systems.

MATERIAL AND METHODS

❖ **Selecting and sampling experimental sites:**

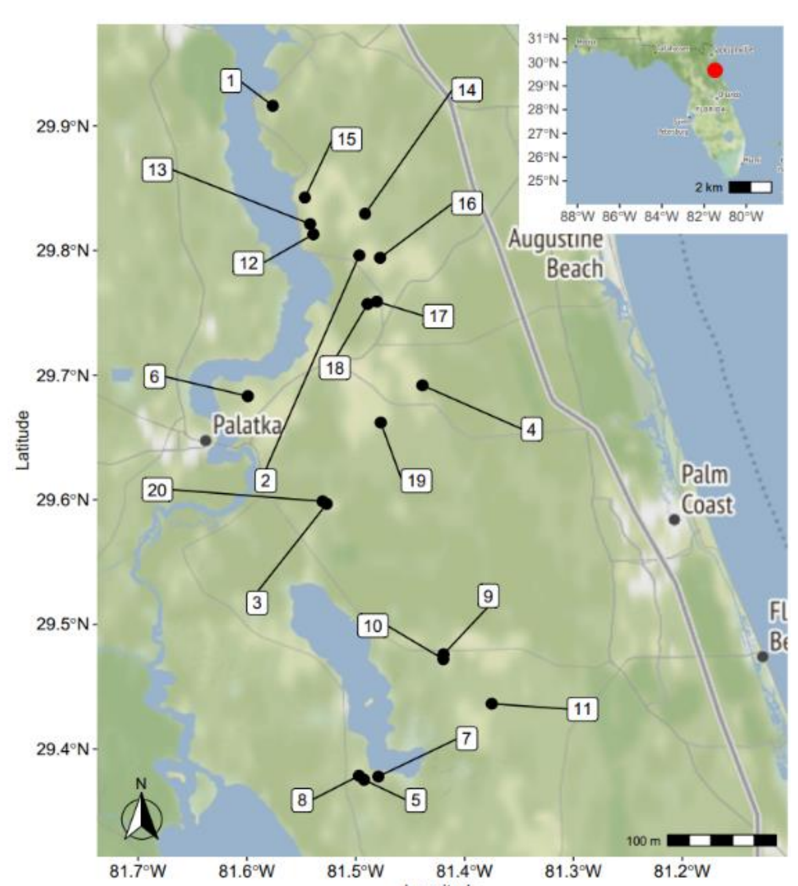

Fig.2. Location of the twenty sites sampled for the soil physics and organic matter characterization of the irrigated vegetable production areas in northeast Florida.

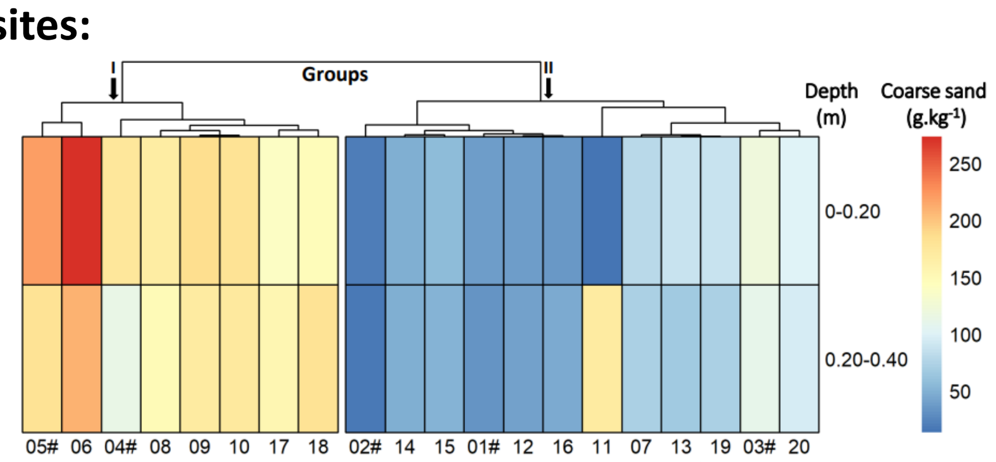

Fig.3. Cluster diagram of the coarse sand (g kg⁻¹) fraction from the 0-0.20 and 0.20-0.40 m soil depth layer at the twenty vegetable production areas. Sites signed with # were selected to represent their respective groups (I and II) for LLWR determination.

Fig.4. Undisturbed soil core sample from the selected sites sampled in the 0-0.20 and 0.20-0.40 m soil depth layers.

- ***From the twenty initially sampled farms (Fig. 2), five farms were selected based on texture variation (Fig. 3), and 66 undisturbed soil core samples were taken from the 0-0.40 m soil depth layer in each farm (Fig. 4) for determination of the soil water retention and penetration resistance curves.***
- ***LLWR was determined for the Farms 2 and 4 with particle-size distribution <250 µm (PSD_{fine}) content of 611 and 866 g.kg⁻¹ in two areas side-by side irrigated using SDT and seepage. Each area was monitored during the 2020 spring potato seasons for soil water content and water table level determination.***

❖ **Soil parameters determination and irrigation monitoring:**

- Water potential (Ψ)
- Water content (θ)
- Penetration resistance (PR)
- Bulk Density (Bd)
- Organic matter content (SOM)
- Particle-size distribution (PSD)
- Water table level (WTL)
- Water content *"in situ"*
- Precipitation

❖ **Data analysis**

- **Soil Water Retention Curve (SWRC)**

$$\theta = a\Psi^{b}$$ *Ross et al. (1991)*

$$ln\theta = \left(a_0 + a_1 * B_d + a_2 * SOM + a_3 * PSD_{fine}\right) + b_0 * ln\Psi$$

$$\theta' = e^{(-3.1663+1.2235*B_d+0.0642*SOM+0.0006*PSD_{fine})} * \Psi^{-0.3550}$$

$p < 0.0001;\ n = 330;\ F = 224.3;\ r^2 = 0.74$

- **Soil Penetration Resistance Curve (SPRC)**

$$PR = a\theta^{b}B_d^{\,c}$$ *Busscher et al. (1990)*

$$ln\,PR = ln\,a + b\,ln\,\theta + c\ln B_d$$

$$PR' = e^{(-4.9575+0.0676*SOM+0.0009*PSD_{fine})} * \theta^{(-0.311)} * B_d^{(8.9189)}$$

$p < 0.0001;\ n = 292;\ F = 531.5;\ r^2 = 0.91$

RESULTS

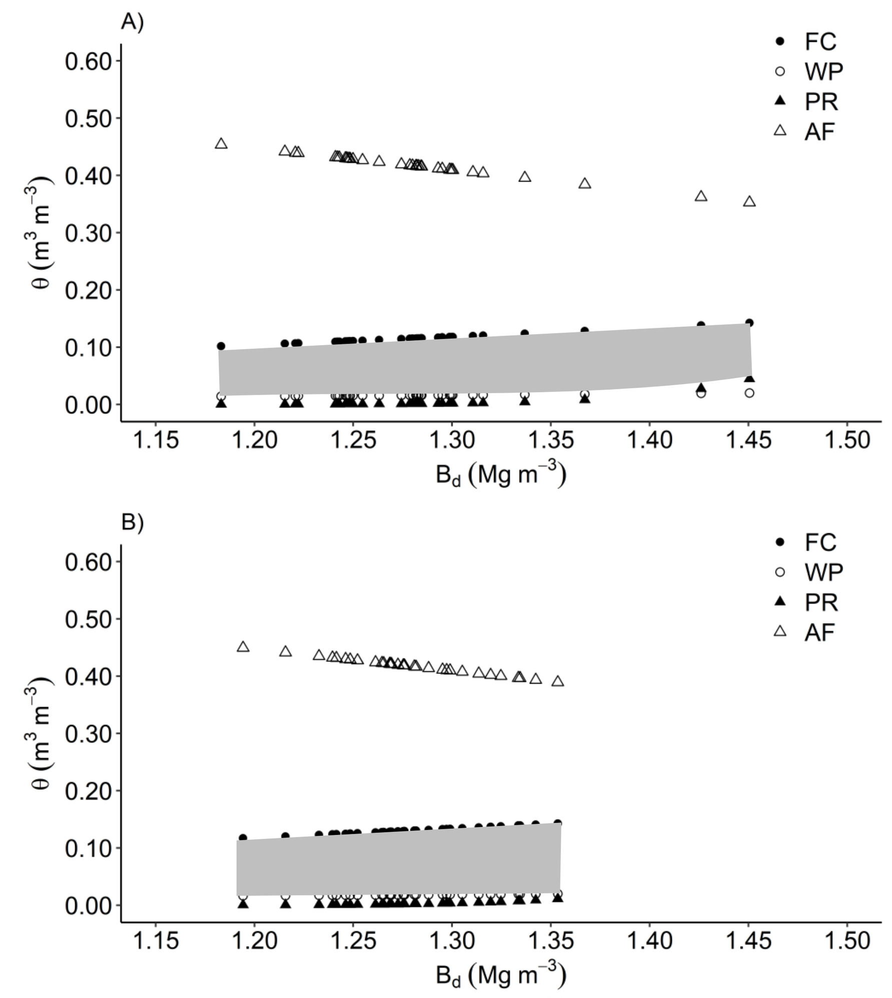

Fig.5. Soil water content variation (θ) with bulk density (Bd) at the field capacity (FC), permanent wilting point (WP), air-filled porosity of 0.10 m³.m⁻³ (AF), and penetration resistance of 1.5 MPa (PR) for the Farms 4 (A) and 2 (B) in the 0-0.20 m soil depth layer with SOM mean of 7.14 g.kg⁻¹. The gray areas correspond to the LLWR.

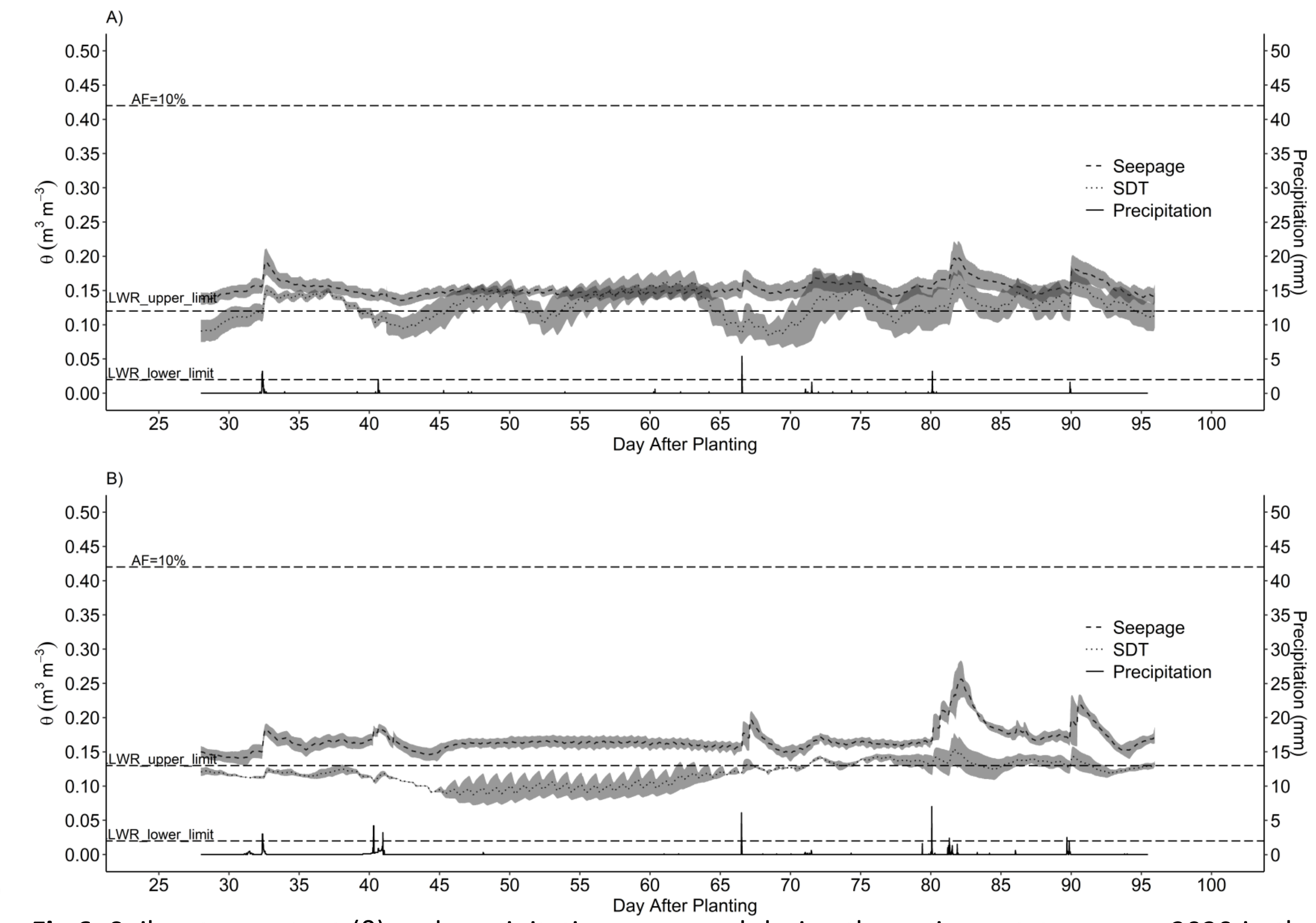

Fig.6. Soil water content (θ) and precipitation measured during the spring potato season 2020 in the Farms 4 (A) and 2 (B) at the 0-0.20 m soil depth layer in areas under seepage and subirrigation with drain tile (SDT). The gray areas correspond to the standard deviation of the mean, and the dash lines represent the LLWR limits for potato roots growth.

- ***The LLWR was 0.02-0.12 and 0.02-0.13 m³.m⁻³ for the Farms 4 and 2, respectively (Fig.5).***
- ***The season-averages of soil water content (θ±standard deviation) for seepage were 0.15±0.16 and 0.17±0.18 m³.m⁻³, and for SDT were 0.13±0.15 and 0.12±0.13 m³.m⁻³ in the Farms 4 and 2, respectively (Fig.6).***
- ***Seepage resulted in θ above the LLWR, while SDT led to improved drainage control of the field, resulting in θ falling within the LLWR for longer periods regardless of the soil texture (Fig.6 and 7).***

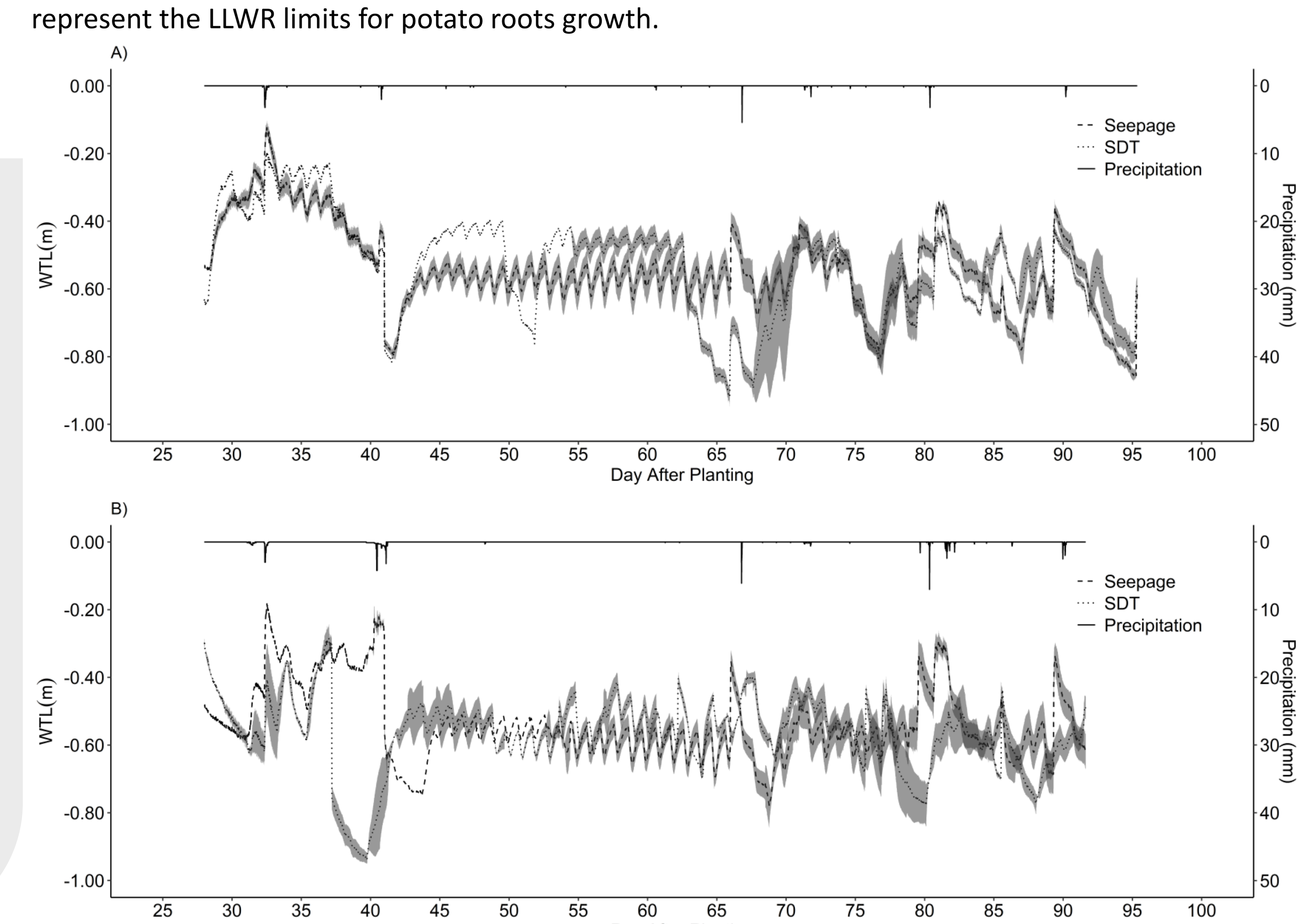

Fig.7. Water table level (WTL) and precipitation measured during the spring potato season 2020 in the Farms 4 (A) and 2 (B) at areas under seepage and subirrigation with drain tile (SDT). The gray areas correspond to the standard deviation of the mean.

IMPLICATIONS FOR WATER MANAGEMENT

❖ The LLWR can be used to enhance soil and water management of subirrigated areas of vegetable production in Florida.

❖ The WTL can be precisely adjusted according to the LLWR approach to provide an optimum soil water content in the root zone for the best crop development, in addition to reducing irrigation needed during crop season.

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