Spring Safflower Water Extraction Patterns Under Different Irrigation Management Strategies

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Introduction

- Irrigation well outputs are declining rapidly in the Southern High Plains and improving water use efficiency is of great importance.
- Typical center pivot system wets top soil profile frequently leading to high evaporation losses.
- Preseason irrigation to store moisture in the deeper profile may reduce evaporation and supply moisture at critical stages, but efficiency is not known.
- Best irrigation strategy for deep rooted, stress tolerant crops like safflower needs to be assessed.
- Water use and yield relationships for alternative crops in the Southern High Plains are needed for management decisions.

Objective

- To assess seasonal patterns of water extraction of two diverse spring safflower cultivars under different irrigation levels with or without pre-irrigation.
- To study effect of pre-irrigation and irrigation levels on the water use efficiency of two diverse spring safflower cultivars.

Materials and Methods

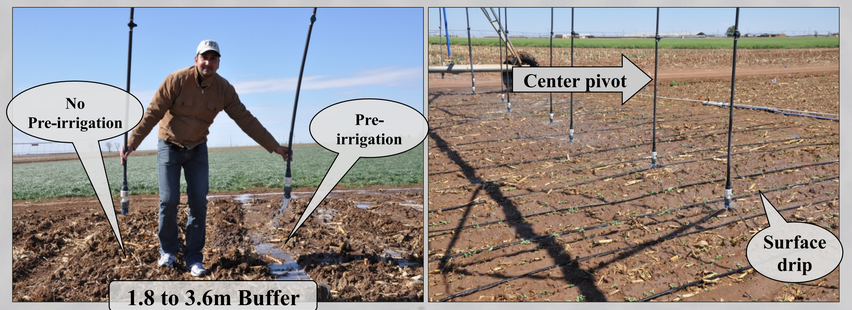

Figure 1. Pictures showing Pre-irrigation (PI) vs. No pre-irrigation (NPI) (left). Drip and center pivot irrigation system (right) at Clovis, NM (2012-13). Center pivot with bubbler pads for PI and surface drip with water meters for irrigation levels were used.

- **Location:** Agricultural Science Center, Clovis, NM
- **Season:** 2012 and 2013
- **Soil Type:** Olton Clay Loam
- **Design:** Split Plot Factorial
- **Treatments:**
  1. **Main plot: Soil Profile**
     i. Pre-irrigation **(PI)** (soil profile depleted by previous crop of corn (2012) or wheat (2013) was rewetted with 160 mm of water)
     ii. No-pre-irrigation **(NPI)** (depleted soil profile)
  2. **Sub plot: cultivars and irrigation levels**
     Cultivars: S333 and PI8311
     Irrigation levels: I_1, I_2, I_3, I_4 and I_5 (rainfed, 75, 150, 225 and 300 mm)

  PS: Rainfed treatments were irrigated only for establishment.
- **Replications:** Four

Results

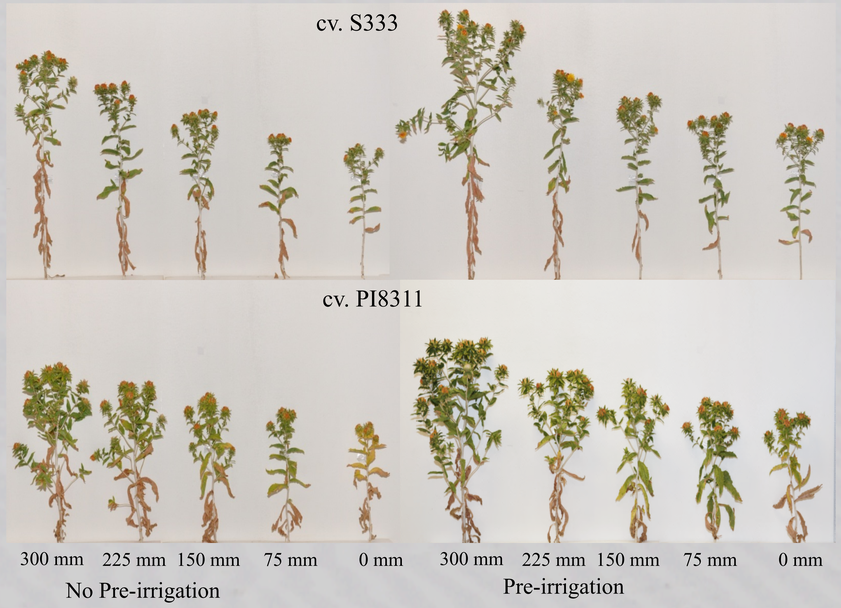

Figure 2. Visual presentation of growth and yield formation responses of two diverse safflower cultivars to pre-irrigation and irrigation levels at Clovis, NM in 2012.

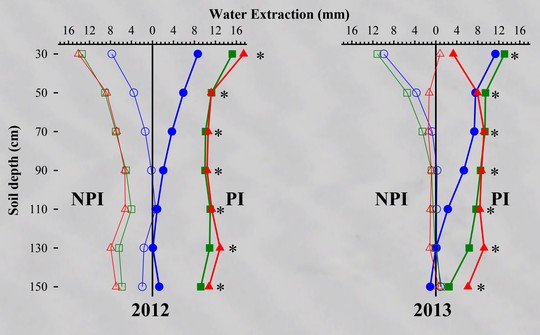

Figure 3. Water extraction patterns of safflower with pre-irrigation (PI) and no pre-irrigation (NPI) treatments in 2012 (left) and 2013 (right). Blue, green and red lines represent water extraction during 1st, 2nd and 3rd observation periods, respectively. Stars indicate higher water extraction in PI over NPI at respective depths.

- PI increased water extraction by safflower over NPI at all depths from 20 to 150 cm in both years and significance was greater at deeper layers (Fig. 2).
- Irrigation levels affected water extraction patterns early in the season and lower irrigation receiving treatments relied heavily on soil moisture (Fig. 3).
- Although two seasons varied in total seasonal water extraction, the highest irrigation receiving treatment was less efficient in exhausting all soil moisture.
- Late season rainfall in 2013 affected water extraction.
- Although PI increased water extraction by a modest amount of 29.7 to 48.5 mm, WUE was significantly higher compared to NPI in both years (Fig. 5).
- Although less than1/3rd of pre-water was extracted by safflower, utilization of that water at critical stages to improve WUE was observed.
- Cultivar differences for water extraction and WUE were relatively small.

- WUE did not differ among irrigation levels in 2012, but in 2013 irrigation levels higher than 150 mm had higher WUE.
- Safflower growth, biomass accumulation and yield formation was responsive to water availabilities (Fig 2).
- Water use efficiency was significantly higher in 2013 with preseason water added to the irrigation amounts, indicating importance of deep moisture for safflower.

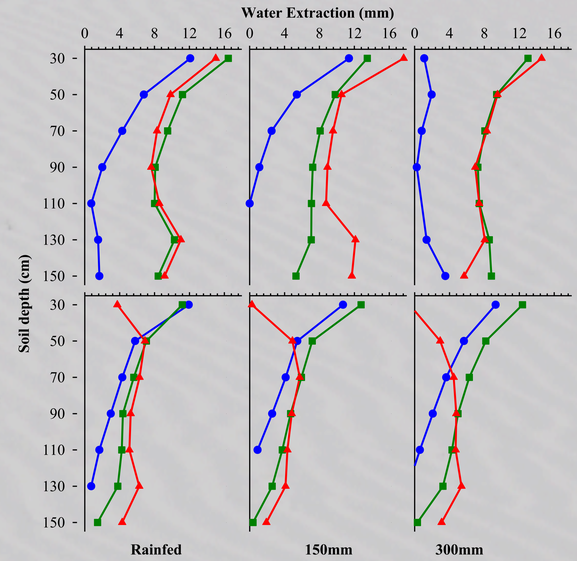

Figure 4. Water extraction patterns of safflower under irrigation levels I1, I3 and I5 in 2012 (Top) and 2013 (Bottom). Blue, green and red lines represent water extraction during 1st, 2nd and 3rd observation periods, respectively. Late season rainfall in 2013 confounded water extraction patterns by rewetting soil profile. Data is mean of two safflower cultivars

Conclusions

- Safflower can utilize its deep root system to extract soil moisture stored beyond 150 cm depth.
- Pre-irrigation is promising to improve WUE of safflower, but efficiency of storage and crop use proportion needs to be improved with stubble and tillage management.
- Safflower adjusts its yield formation to water availability and maintains water use efficiency over wide range.

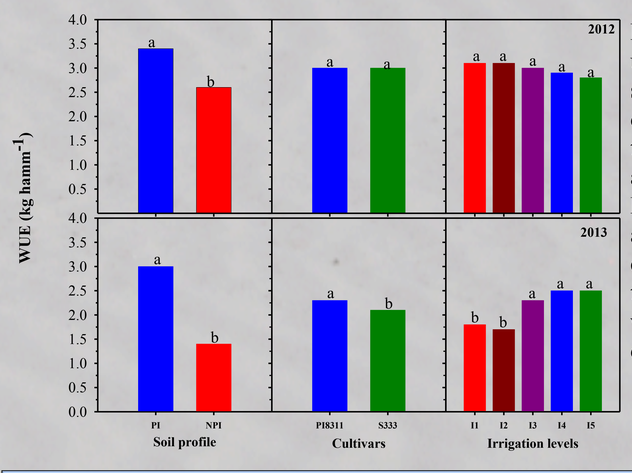

Figure 5. Water use efficiency of safflower under different treatments in 2012 and 2013. Different letters above each column within a treatment group were statistically different.

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