# Growth Stage Based Irrigation Management of Spring Safflower

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## Introduction

- Productivity and stability of agriculture in the Southern High Plains depend on Ogallala aquifer.
- Irrigation well outputs are declining rapidly in the region.
- Extending aquifer life by judicious use of limited water is of prime importance in the region.
- Inclusion of drought resistant crops, such as safflower, in the cropping system will be beneficial to achieve this goal.
- Excessive rainfall or irrigation, especially after flowering, is reported to reduce safflower yield.
- With limited water availability, a better understanding of effect of water stress at particular growth stage on yield formation of diverse safflower cultivars will assist in better use of irrigation water.

## Objective

- To assess drought physiology and yield formation of three spring safflower cultivars under growth stage based irrigation management.

## Materials and Methods

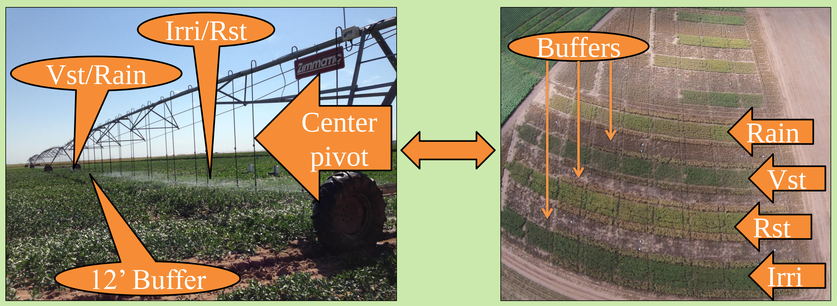


Fig.1. Pictures showing physical layout of the trial along with large buffer areas (aerial shot; right) and irrigation treatments application using a center pivot irrigation system (left).

- **Location :** Agricultural Science Center, Clovis
- **Experimental design : Split Plot**
- **Treatments :**

**1. Main plot : Irrigation treatments (4) and targeted irrigation (inches)**

| Irrigation Treatment | | Establish-ment | Vegetative Stage | Reproductive Stage |
|---|---|---|---|---|
| Irrigated | (Irri) | 1.5 | 5.0 | 5.0 |
| Stress at Vegetative Growth | (Vst) | 1.5 | 0.0 | 5.0 |
| Stress at Reproductive Growth | (Rst) | 1.5 | 5.0 | 0.0 |
| Rainfed | (Rain) | 1.5 | 0.0 | 0.0 |

**2. Sub-plot : Cultivars (3)**
- PI8311, 99OL and Nutrisaff

- **Replications :** 4
- **Planting dates:** April 30, 2013 and June 17, 2014 (Entire trial was replanted after severe hailstorm damage in 2014).

## Results

**Table 1. Effect of irrigation treatments on yield and yield attributing characters of diverse spring safflower cultivars at Clovis, NM in 2013-14.**

| Treatment | Heads plant$^{-1}$ | | Seeds head$^{-1}$ | | 1000 seed wt (g) | | Biomass (kg ha$^{-1}$) | | Seed Yield (kg ha$^{-1}$) | | HI (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Irri | 6.6 a | 15.5 a | 31.0 a | 27.6 a | 31.0 a | 28.8 c | 7327 a | 7583 a | 2367 a | 2817 a | 32.1 b | 35.5 c |
| Rst | 6.0 ab | 13.3 b | 28.3 ab | 22.6 b | 28.3 ab | 28.0 c | 5594 b | 5982 b | 1915 ab | 2268 b | 30.3 c | 36.3 c |
| Vst | 5.6 bc | 9.7 c | 28.3 ab | 26.8 a | 28.3 ab | 31.3 a | 4928 bc | 5335 b | 1767 bc | 2222 b | 34.0 a | 40.8 a |
| Rain | 4.8 c | 8.0 c | 26.1 b | 22.8 b | 26.1 b | 29.9 b | 3420 c | 4379 c | 1308 c | 1766 c | 32.8 ab | 38.3 b |
| Cultivar | | | | | | | | | | | | |
| 99OL | 5.1 b | 10.5 b | 30.6 a | 26.6 a | 30.6 a | 30.0 b | 5477 a | 6224 a | 2118 a | 2425 a | 34.2 b | 37.3 b |
| PI8311 | 5.7 b | 12.4 a | 22.5 b | 22.1 b | 22.5 b | 33.9 a | 5204 a | 5912 a | 1887 b | 2259 ab | 36.5 a | 41.9 a |
| Nutrisaff | 6.4 a | 12.0 a | 32.2 a | 26.1 a | 32.2 a | 24.7 c | 5270 a | 5249 b | 1514 c | 2120 b | 26.2 c | 34.4 c |
| Treat x Cul | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

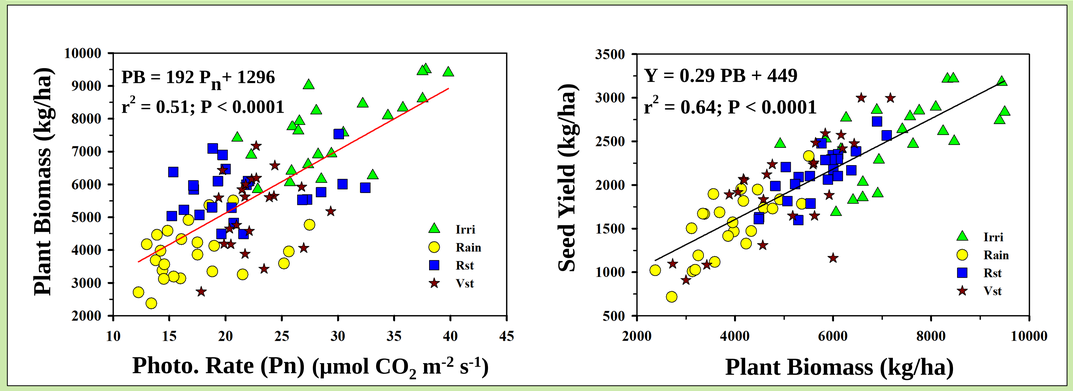


**Fig.2. Relationship of plant biomass with photosynthesis (left) and seed yield (right) obtained during 2013 and 2014 at Clovis, NM.**

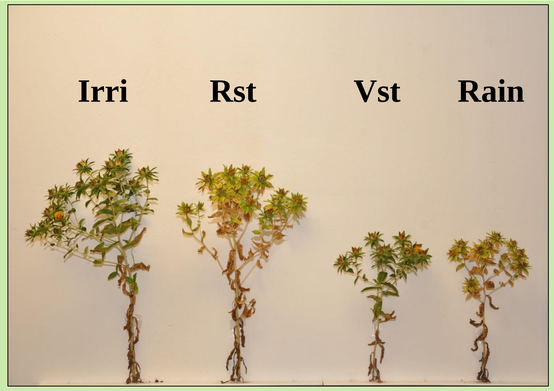


**Fig.3. Irrigation treatment effects on growth of safflower cultivar PI8311 at Clovis, NM (2014).**

## Results

- Compared to irrigated treatment, limiting irrigation reduced biomass and seed yield production by diverse safflower cultivars. However, the least reduction was with skipping irrigation after flower initiation (Table 1).
- Heads per plant, seeds per head were more sensitive to irrigation management compared to 1000 seed weight (Table 1).
- Safflower cultivars differed significantly in seed yield production with cv. 99OL producing the highest yield in both years, while the lowest was with cv. Nutrisaff (Table 1).
- Higher HI in more stressful Vst and Rain treatments compared to Irri and Rst treatments in both years indicates that safflower was more efficient in partitioning biomass in to seed under stressful environments (Table 1).
- Among cultivars, PI8311 had higher HI compared to other cultivars (Table 1).
- Lack of significant interaction between irrigation treatments and safflower cultivars indicates that in spite of differences in yield and yield parameters, all safflower cultivars responded to irrigation treatments similarly (Table 1).
- Visual observations of safflower plants indicated that not only plant architecture (height, branching and biomass) but also maturity was affected by irrigation treatments (Fig. 3).
- Leaf photosynthesis rate was significantly related to plant biomass, which in turn was positively related to seed yield production in safflower (Fig. 2).

## Conclusions

- Farmers can skip irrigation after flowering to safflower in water scarce conditions as it is least detrimental to safflower yield formation.
- In addition to reducing water use by safflower, it will reduce irrigation need during peak water demand.
- Photosynthesis and plant biomass are the driving factors for yield formation in safflower.
- 99OL was the highest yielding cultivar followed by PI8311 and Nutrisaff.
- Lack of interaction in three diverse safflower cultivars indicates that skipping irrigation after flowering works for all safflower cultivars.

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