

# Effect of Irrigation Technologies and Plant Densities on Soil Water Dynamics and Cotton Growth Parameters

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## Abstract

Weather conditions in the high plains of Kansas and a decline in water resources affect cotton production. This study aimed to assess the effect of different irrigation technologies, rainfed conditions, and plant densities on soil water dynamics and cotton growth. Results indicated that the Mobile Drip Irrigation 2 (MDI2) had the highest growth characteristics such as plant height, leaf area index, and canopy cover, while the rainfed treatment registered the lowest growth performance. Likewise, MDI2 has the highest mean leaf stomatal conductance. Low Elevation Sprays Application (LESA) recorded the highest bolls and open bolls count per plant. The quality analysis of cotton is ongoing.

## Introduction

Cotton (*Gossypium* sp.) is one of the most important crops across the United States and its production is estimated at 3.26 million tons in about 3.52 million hectares in 2020 (USDA, 2021). Recent studies reported a decline in water resources and a change in the environment (Chaudhuri and Ale 2014, Djaman et al. 2020) resulting in a reduction of cotton yield (Lokhande et al. 2014). Further, planting density has been reported to affect cotton production across the world (Xiao-yu et al. 2016). In Kansas State, an increasing interest is given to cotton production by farmers (USDA, 2021). Therefore, it is important to investigate the best irrigation technology and the optimum plant density.

## Materials and Methods

Field experiment was conducted in 2021 at Southwest Research and Extension Center of Kansas State University, Garden City. Two plant densities (55,000, 65,000 plants per ha) were evaluated under four irrigation technologies (LEPA, LESA, MDI1, and MDI2) and rainfed settings. PHY 205 W3FE was the cotton variety tested. The experiment was set up under a split plot design with three replications on May 24, 2021. Growth parameters such as NDVI, leaf stomatal conductance, cotton height, leaf area index, canopy cover and soil moisture data were collected. Also, total biomass, boll weight, lint/seed weight per boll, number of seeds, total bolls per plant and number of open bolls per plant were recorded. Samples were sent to Texas for cotton quality (Micronaire, strength, length) and marketable fiber/seed yield.

### Acronyms

- HD: High Density
- LD: Low Density
- SWC: Soil Water Content
- MDI: Mobile Drip Irrigation (1: 1 Gal/hr; 2: 2 gal/hr)
- LESA: Low Elevation Spray Application
- LEPA: Low Energy Precision Application
- NDVI: Normalized Difference Vegetation Index



Fig.1: Picture of experimental field

## Results

The accumulated Thermal Unit (TU) during 2021 growing season was 1221.73°C, and the reference evapotranspiration varied from 0.67 to 10.29 mm/day. Among the irrigation technologies, Mobile Drip Irrigation 2 (MDI2) had the highest growth characteristics such as plant height, leaf area index, and canopy cover. Rainfed conditions resulted in the lowest growth. A strong relationship was found between the LAI and canopy cover and NDVI and LAI with coefficient of determination of 0.98 and 0.95, respectively. Variation of plant height, bolls per plant, open bolls was statistically significant among the irrigation technologies (p<0.05). MDI2 has the highest plant height while the LESA has the highest number of bolls and open bolls per plant.

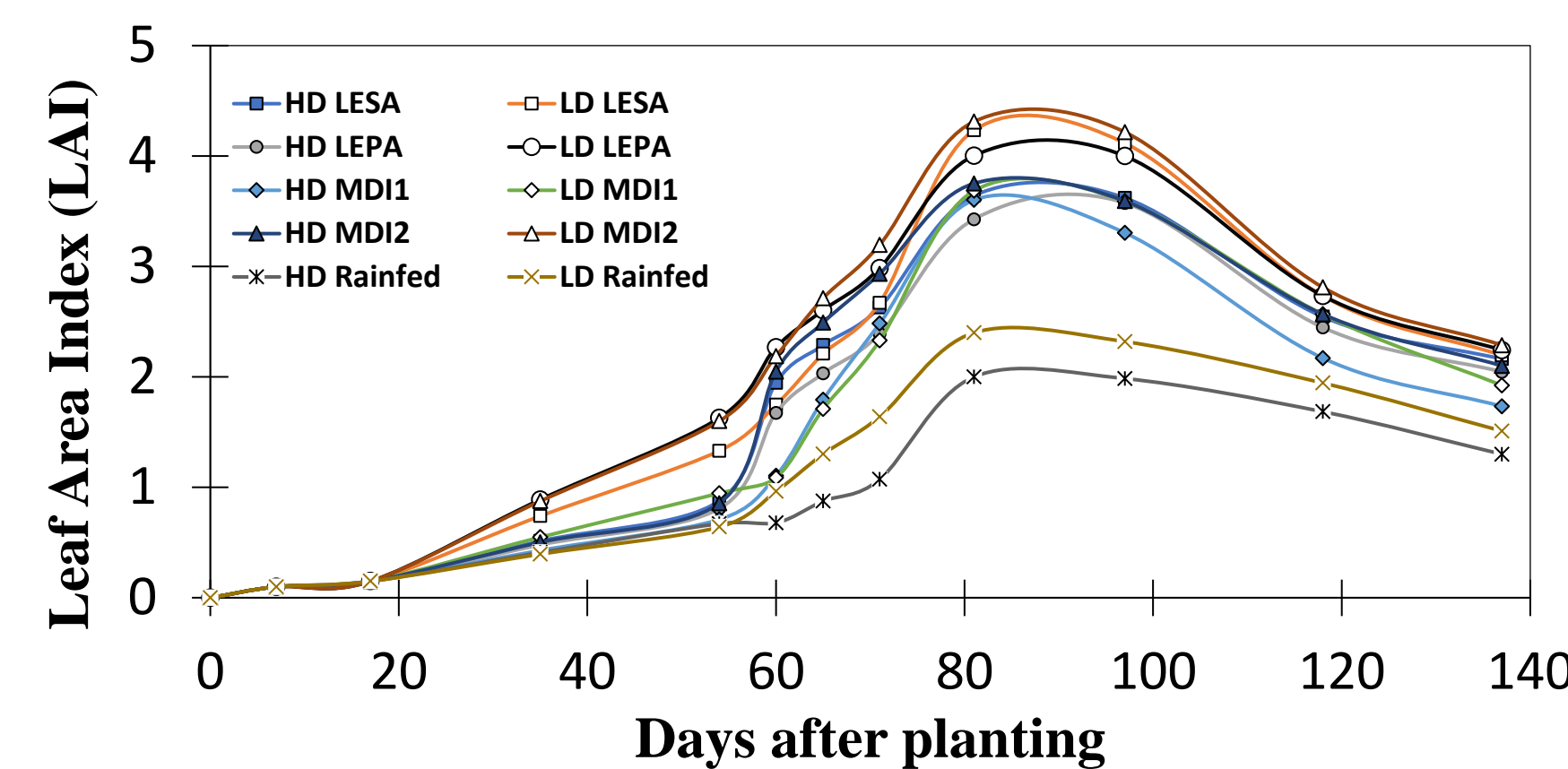


Fig.2: Leaf area index (LAI) under different treatments as function of days after planting

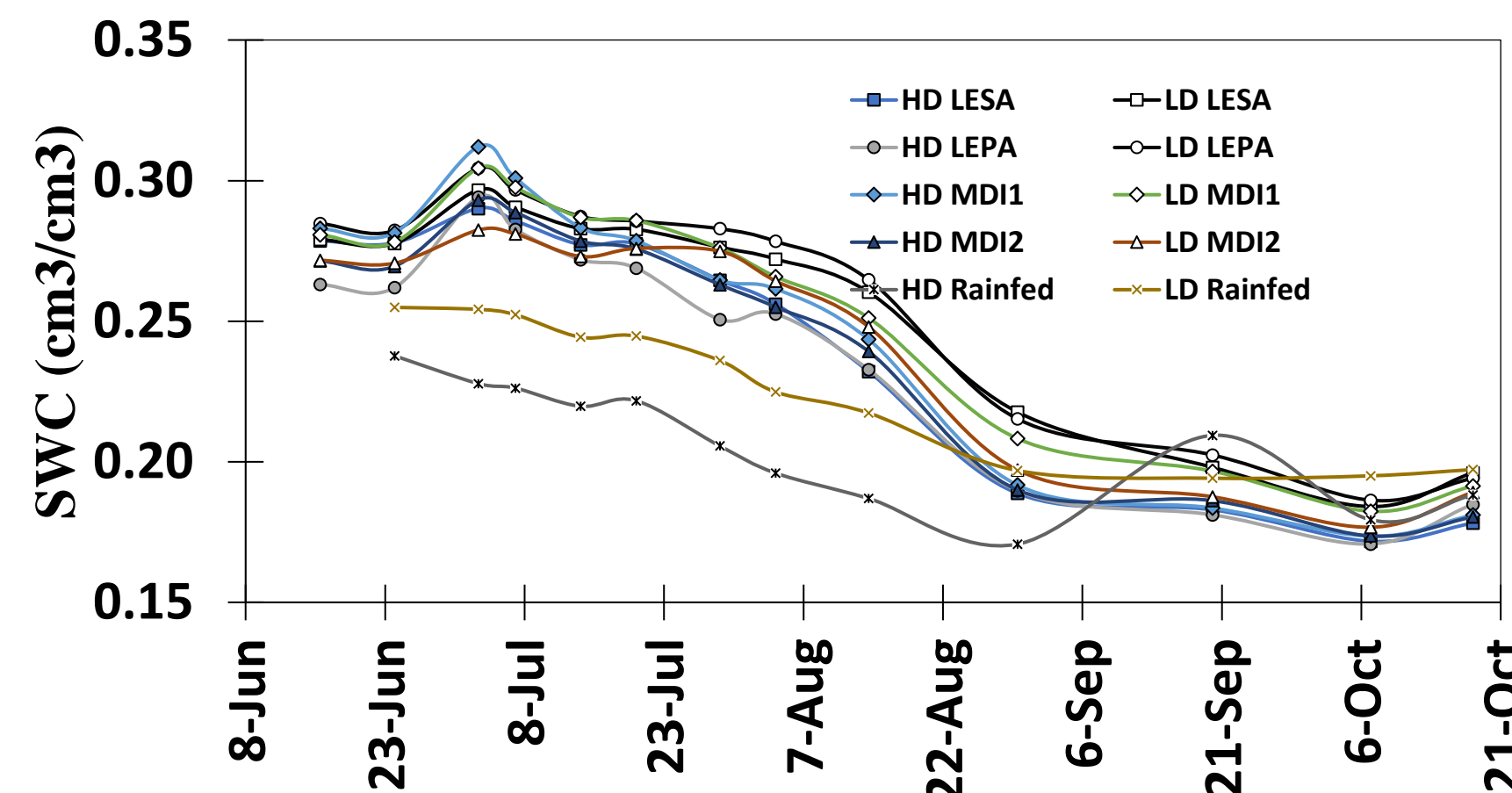


Fig.3: Average SWC in the effective root zone (0-1.35 m)

Table 1: Plant height, bolls, and open bolls per plant as a function of irrigation technology\*

Irrigation technology	Maximum height (cm)	Bolls per plant	Open bolls per plant
MDI2	86.39a	18.55ab	7.56a
LESA	78.27b	27.56a	7.83a
MDI1	79.37b	14.83b	5.16b
LEPA	80.94ab	13.83b	6.61ab

Table 2: Plant height, bolls and open bolls per plant as a function of plant density \*

Plant density	Maximum height (cm)	Bolls per plant	Open bolls per plant
Low density	81.31a	22.19a	7.70a
High density	81.17a	15.19b	5.89b

\*Values followed by the same letter are not significantly different at the 5% level.

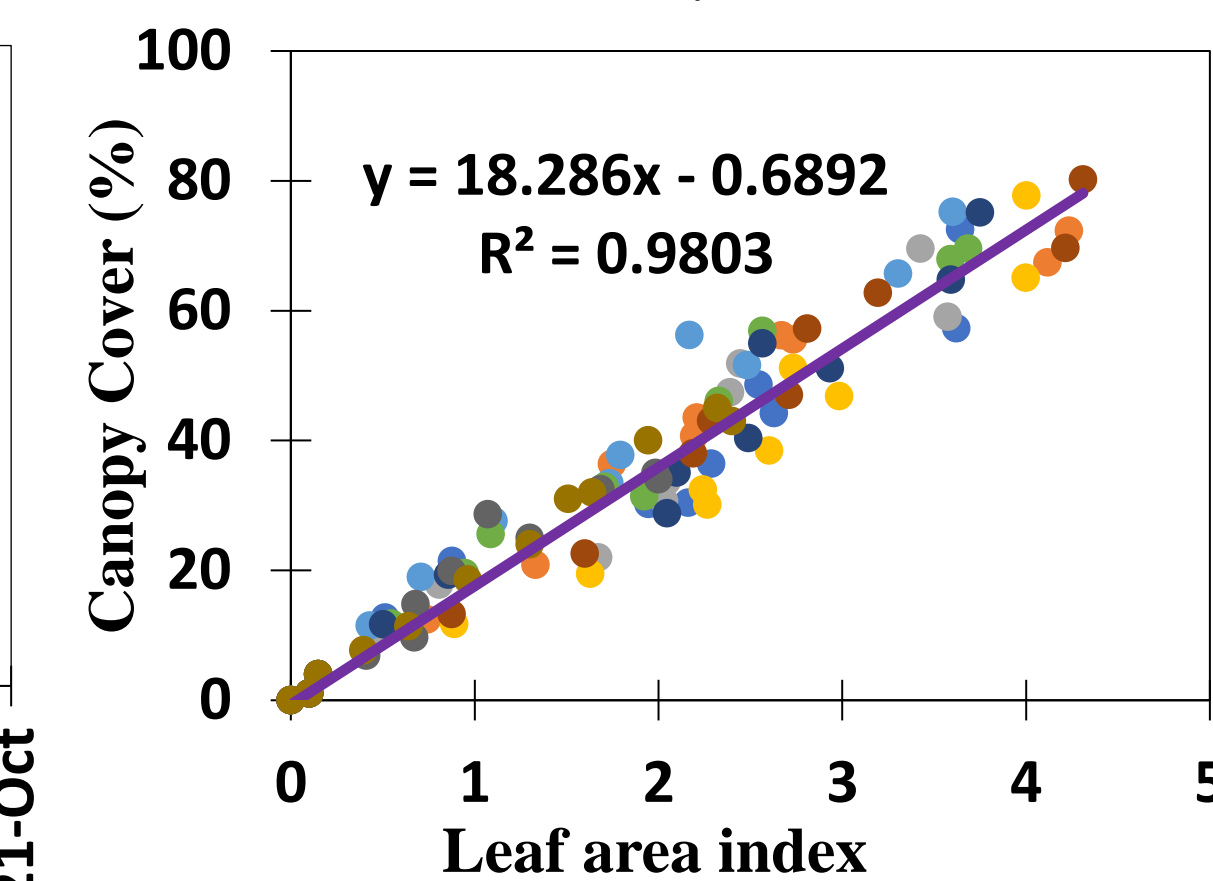


Fig.4: Relationship between LAI and canopy cover

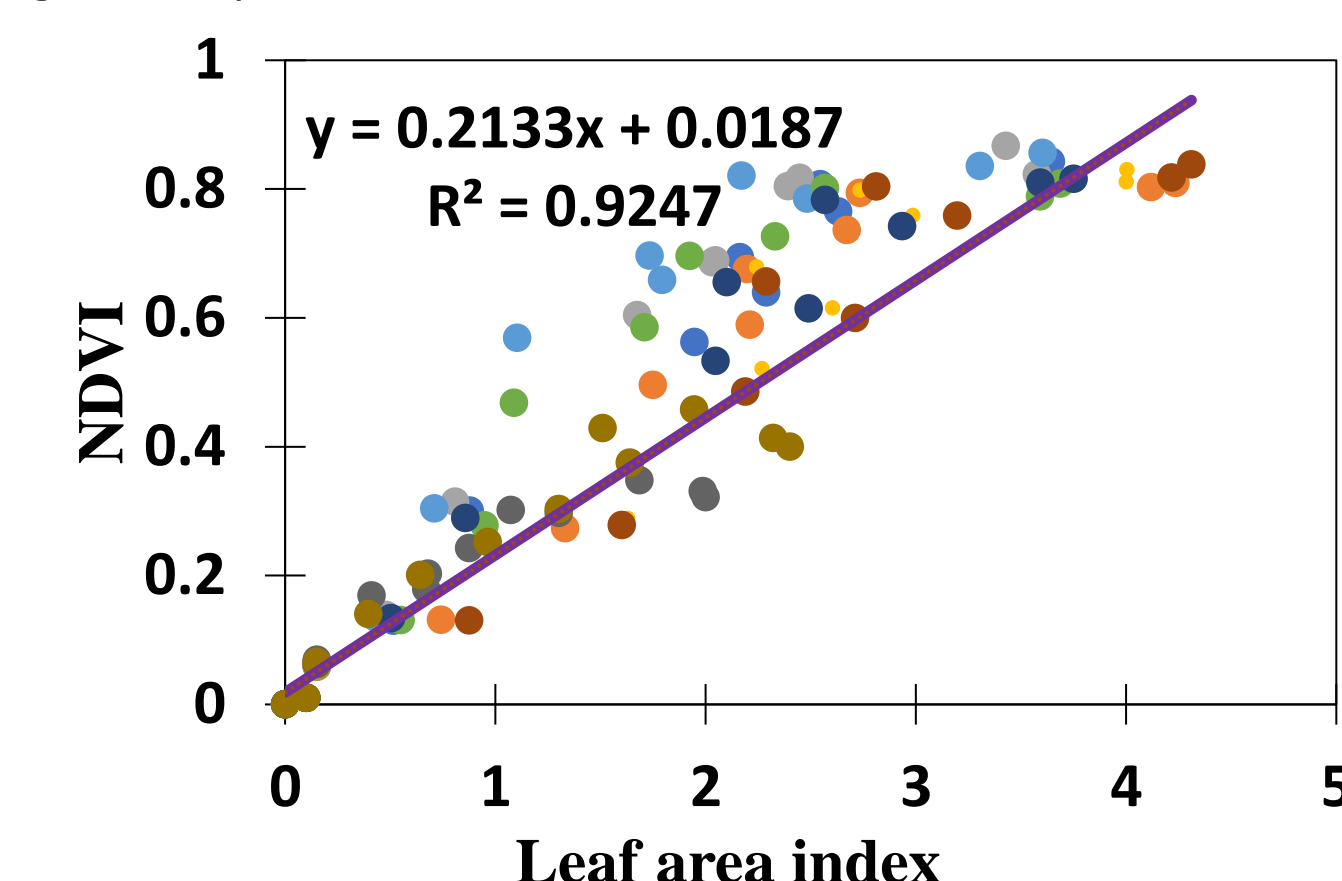


Fig.5: Relationship between NDVI and LAI

## Conclusions

The impact of four irrigation technologies, rainfed conditions, and two plants densities were investigated on cotton performance in Southwest Kansas in 2021 growing season. The results showed that MDI2 resulted in the best crop growth while the rainfed treatment had the lowest. Measurement of fiber quality and marketable lint and seed yield (lab analysis are still ongoing) were important to determine the best irrigation strategies.

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