

Oxygation: Enhanced yield and water use efficiency of aerated SDI cotton on heavy clay .

Lance Pendergast and David J Midmore.
Plant Sciences Group, Central Queensland University
Rockhampton.



Irrigation efficiency

- **Surface irrigation (border, furrow, basin) = 40-60%**
- **Sprinkler irrigation = 60-75%**
- **Drip irrigation = 90%**
- **Subsurface drip irrigation = Close to 100%**

Subsurface drip irrigation (SDI)

Disappointing results from early systems for cotton on heavy clay. Anticipated benefits not fulfilled.

WHY ?

- Emitter delivered water purges soil air.
- Available root-zone O_2 (dissolved oxygen @ 3 -8 mg L⁻¹) rapidly consumed → **Creation of anoxic condition.**
- Cycle of temporal anaerobic conditions at emitter reduces metabolic rate and thus water and nutrient uptake.

Soil oxygen status

- Soil aeration is one of the most critical determinants of plant productivity
- Roots require an adequate supply of oxygen to enable normal respiration (5 ml per hour per gram of dry tissue at 25⁰C).
- Insufficient O₂ availability
 - negative impact on yield and water use efficiency.

“NYANG” Field trials

Objectives

- To examine the potential of SDI mediated rhizosphere aeration to improve cotton performance in heavy clay soils.
- Examine for possible along-lateral emitter rate variation.
- Identify/resolve practical considerations associated with commercial scale SDI aeration.

SDI trial site:

- Heavy black clay (vertisol)
- Air injectors retrofitted to existing system.
- Individually metered irrigation to twelve 0.42 ha bays.

Mazzei™ air injectors on delivery manifolds at head of crop



Results.

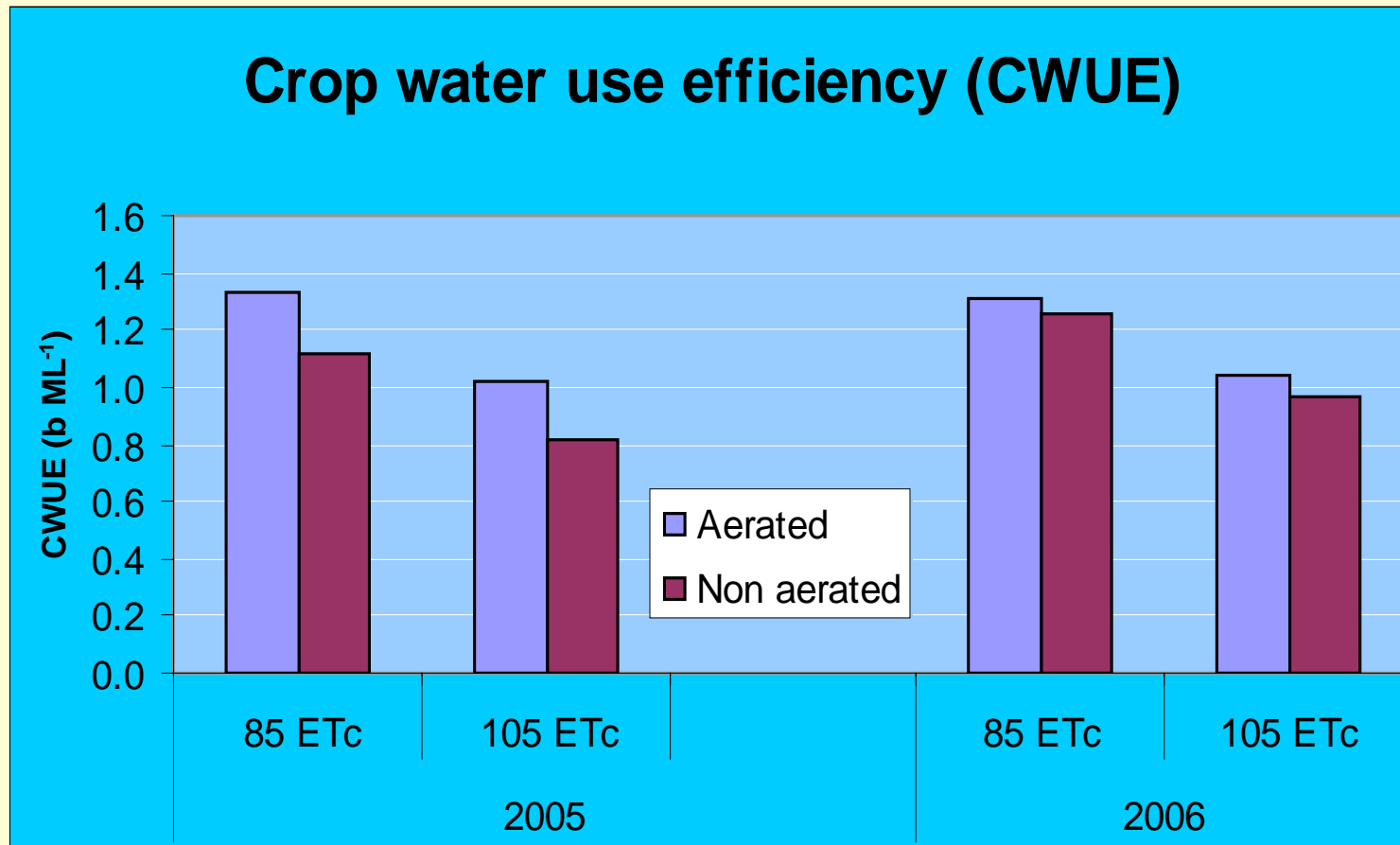


In both years aerated plants produced significantly more cotton than non-aerated plants:

- 21% more bha^{-1} in the wetter '05 season (9.1 bha^{-1} for the aerated compared to the non-aerated at 7.7 bha^{-1}).
- 6% more bha^{-1} in the drier '06 crop (9.3 bha^{-1} for the aerated compared to the non-aerated at 8.8 bha^{-1}).

Results

Aeration also increased crop WUE (compare paired bars with and without aeration).



Results

Aerated plants

- More extensive fibrous root mass than non aerated plants.
- Root length density (RLD) greater at the two sampling points closest to emitters.
- RLD of total plant root greater.

Results

Aeration improved yield along the whole length of the lateral

→ provides strong support for the conclusion that there is a consistent distribution of the Mazzei introduced air throughout the full field length (250 m).


Conclusion

Results support conclusions reached by glasshouse studies

- air injection through SDI increases both yield and WUE.

Oxygation has the potential to make a major contribution to sustainable water use.

The aeration of SDI can successfully alleviate O₂ deficiency in the rhizosphere

- leads to significant gains in both yield and water use efficiency.
 - greatly enhances the economic feasibility of this mode of irrigation.
- 

Acknowledgments

- Tony Ronnfeldt (“NYANG”).
 - Cris Carroll (DNRM&W)
 - CQU for University Post-graduate scholarship award
 - Surya Bhattarai (assistance and advice)
- 