# Just how efficient can we get? The potential and limits of decreased flow rates and/or increased frequencies in drip irrigation

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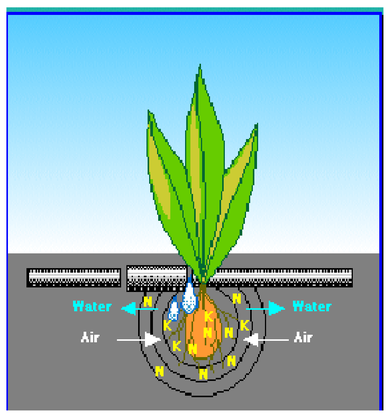
Rawlins and Raats 1975, *Science.*
"Prospects for high-frequency irrigation"
"Effective use of water, land and fertilizer resources as discrete point sources create persistent spatially ordered **non-uniform** water, air and nutrient content in the root zone leading to **increased growth, transpiration, yields, and increased crop water-use efficiency**."

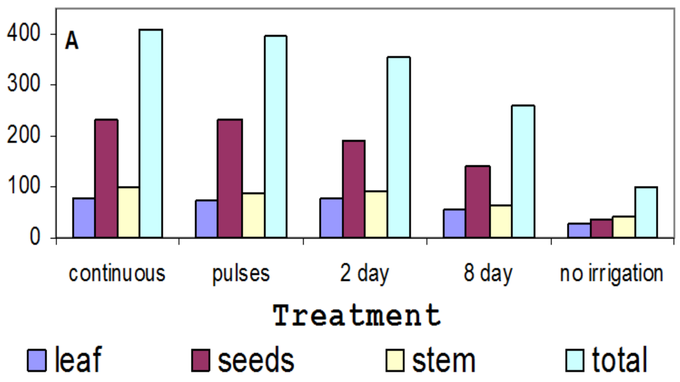
## Background



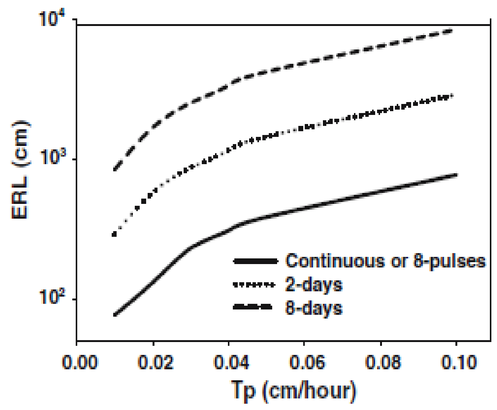

### Micro-irrigation: a paradigm shift in how we provide water to crops

| Other methods | Micro-irrigation |
|---|---|
| ○ Complete soil wetting | ○ Partial soil wetting |
| ○ Replace depleted plant available water in soil | ○ Provide plant water needs |
| ○ Interest to invest in irrigation events as least often as possible | ○ High frequency application |
| ○ Large wetting – drying cycles | ○ Maintain relatively high water content in root zone |
| ○ Fertilization - separate | ○ Fertigation! |

## Water



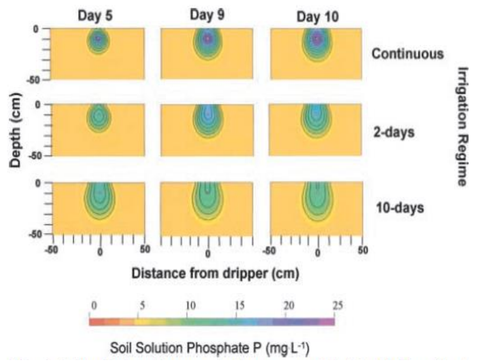

Sunflower biomass as a function of irrigation frequency in a lysimeter experiment. "Continuous" irrigated 4-6 hours per day. "Pulses" irrigated 8 times per day. Segal et al 2006.



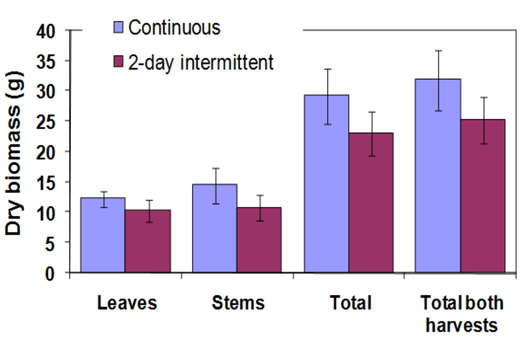

Total effective root length (ERL) needed to deliver potential transpiration (Tp) calculated from a single root uptake model. Segal et al 2006.

When application frequency increases, water is more available, increasing WUE and allowing less investment in roots and more in economic crop production

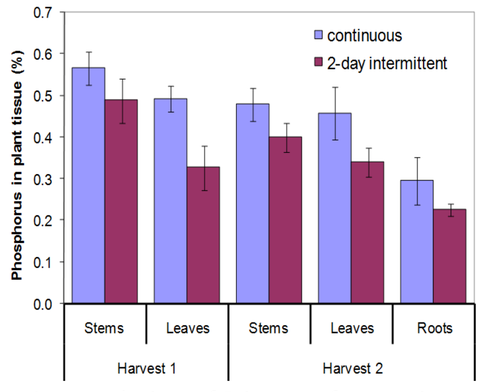
## Nutrients




Soil solution P concentrations as modeled in HYDRUS-2D at three times during a 10-d simulation for three irrigation regimes. Ben-Gal and Dudley, 2003.



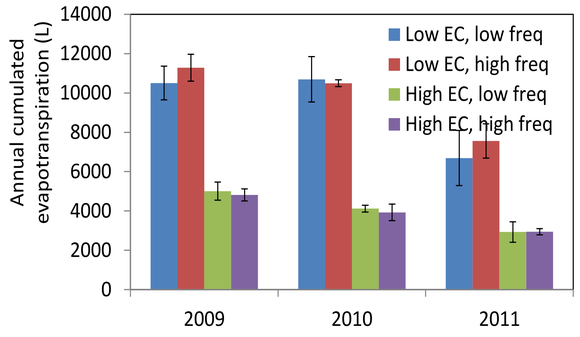

Corn biomass for continuous compared to 2-day interval irrigation. Ben-Gal and Dudley, 2003.



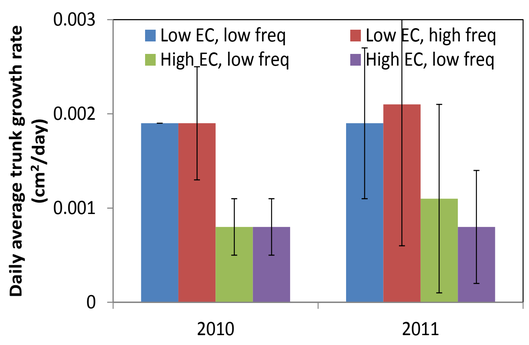

Accumulation of P in corn for continuous compared to 2-day interval irrigation. Ben-Gal and Dudley, 2003.

When application frequency increases, nutrients are more available, concentrations of easily adsorbed minerals stay higher longer in soil water solution, allowing lower application rates and less loss.

## Low quality water?




Accumulated evapotranspiration under two salinity and two frequency treatments for three years in grapevines.




Trunk growth rate under two salinity and two frequency treatments for three years in grapevines.

Low quality = high concentrations of salts. The jury is still out but conflicting - mostly not significant - results from experiments on grapes, olives, corn, peppers and radishes indicate that salt leaching is impeded under extremely high frequency or continuous water application.

## Literature

Segal, E., Ben-Gal, A., and Shani, U. (2006) Root water uptake efficiency under ultra-high irrigation frequency. *Plant and Soil*. 282:333-341.

Ben-Gal A. and Dudley L (2003). Phosphorus availability under continuous point-source irrigation. *Soil Sci Soc Am J.* 67: 1449-1456.

Rawlins, S.L. and Raats, P.A.C. (1975). Prospects for high-frequency irrigation. *Science*, 188:604–610.

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**Limits?** Even when irrigating with good quality water, the potential to increase efficiency by increasing frequency or decreasing flow rate appears not to be infinite. Depending on soil and other environmental factors, 1-8 applications per day seems to often provide optimum conditions, at least under restraints of current levels of sensitivity and alternative limiting factors. Also, dynamics of water movement and solute transport under high frequency appear to be different than those occurring under low flow rates, requiring additional study and understanding prior to practical considerations.