# Water Use by Alfalfa, Maize and Barley as influenced by available soil water

## by Ted Sammis from a paper in Agricultural Water Management (1)

The availability of soil water is one of the most important determinants of crop production. Field studies were conducted to examine the relationships between relative evapotranspiration (E/Emax) and Available water (W) for alfalfa, maize and barley. Potential evapotranspiration (Eo) was estimated using Penman's equation to characterize the evaporative demand. The Management Allowed Depletion (MAD) is the level of W that E/Emax starts to decrease. Irrigating after MAD is reached will cause a decrease in E and yield. Evapotranspiration and yield are linearly related and the relationship is the evapotranspiration water production function.

The results show that the relationships between E/Emax and W were different for the three crops.

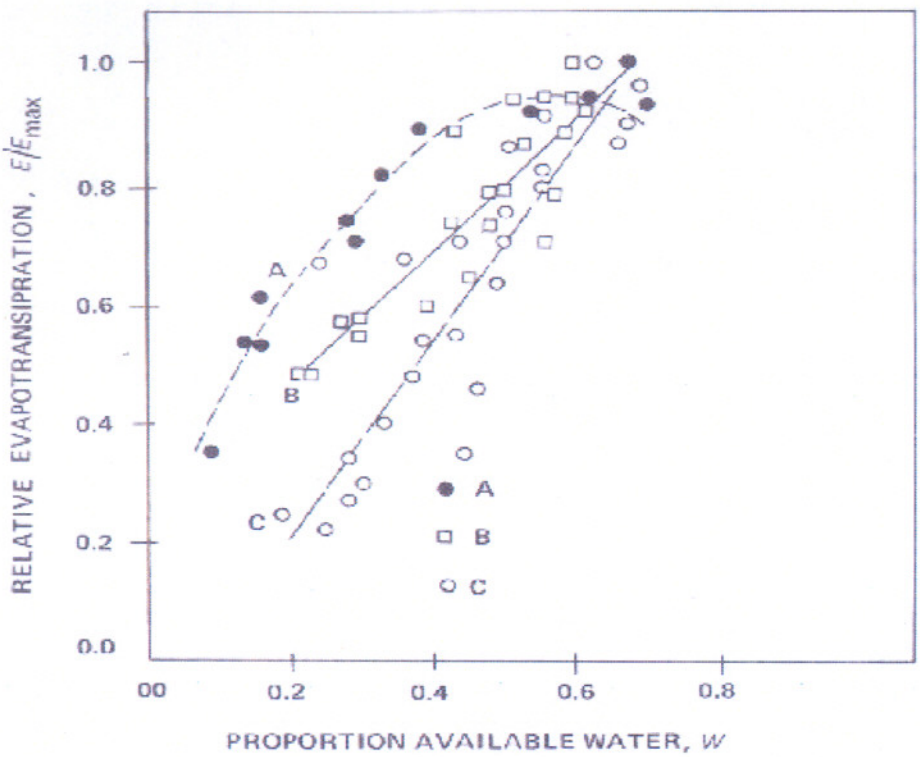


Fig. 1. Relative evapotranspiration ($E/E_{max}$) as a function of the proportion of available water ($W$) for alfalfa in soils of different textures and with different potential evapotranspiration ($E_o$).
A, sandy loam ($E_o$ = 6.3 mm/day): $E/E_{max} = 0.187 + 2.703W - 2.419W^2$, $r^2 = 0.94$
B, clay loam ($E_o$ = 6.1 mm/day): $E/E_{max} = 0.254 + 1.093W$, $r^2 = 0.74$
C, clay loam ($E_o$ = 7.6 mm/day): $E/E_{max} = 0.114 + 1.643W$, $r^2 = 0.82$

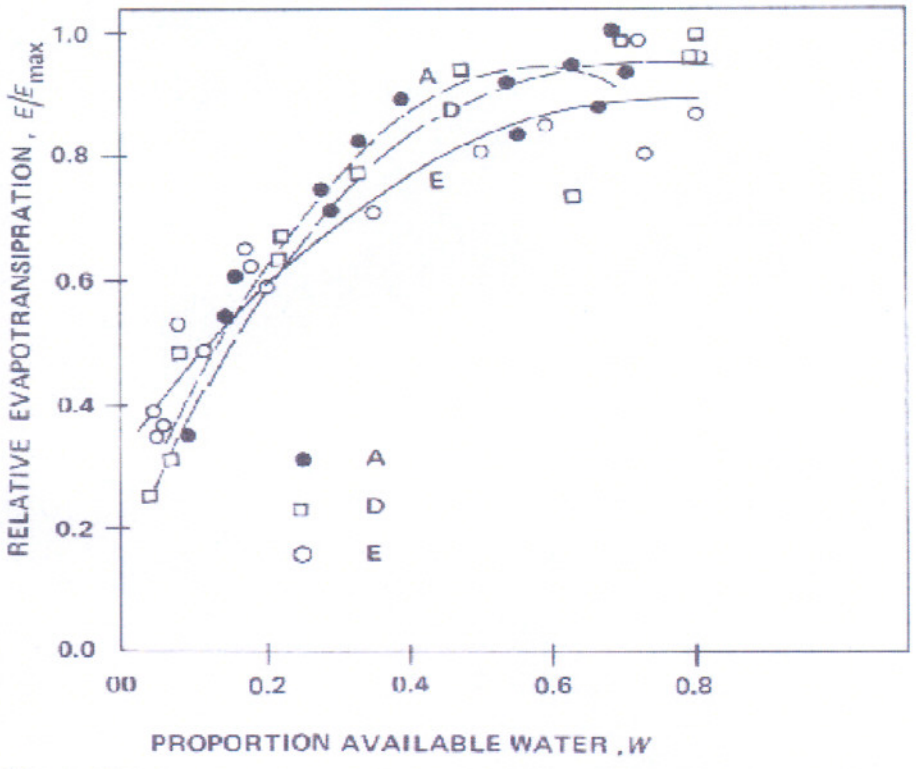


Fig. 2. Relative evapotranspiration ($E/E_{max}$) as a function of the proportion of available water ($W$) for alfalfa in a sandy loam soil with different potential evapotranspiration ($E_o$).
A, $E_o$ = 6.3 mm/day: $E/E_{max} = 0.187 + 2.703W - 2.419W^2$, $r^2 = 0.94$
D, $E_o$ = 7.5 mm/day: $E/E_{max} = 0.236 + 2.024W - 1.409W^2$, $r^2 = 0.90$
E, $E_o$ = 4.7 mm/day: $E/E_{max} = 0.338 + 1.427W - 0.975W^2$, $r^2 = 0.90$

For alfalfa, the relationship was dependent on the physical properties of the soil and on Eo. In a clay loam soil, the decline in E from Emax commenced at a higher value of W than in a sandy loam soil. Furthermore, the rate of decline in E for Emax was dependent on Eo and was greater as Eo increased. In the sandy loam soil the relationship between E/ Emax and W was not dependent on Eo.

For maize and barley in clay loam soils, E/Emax as a function of W was linear and was not dependent on Eo.

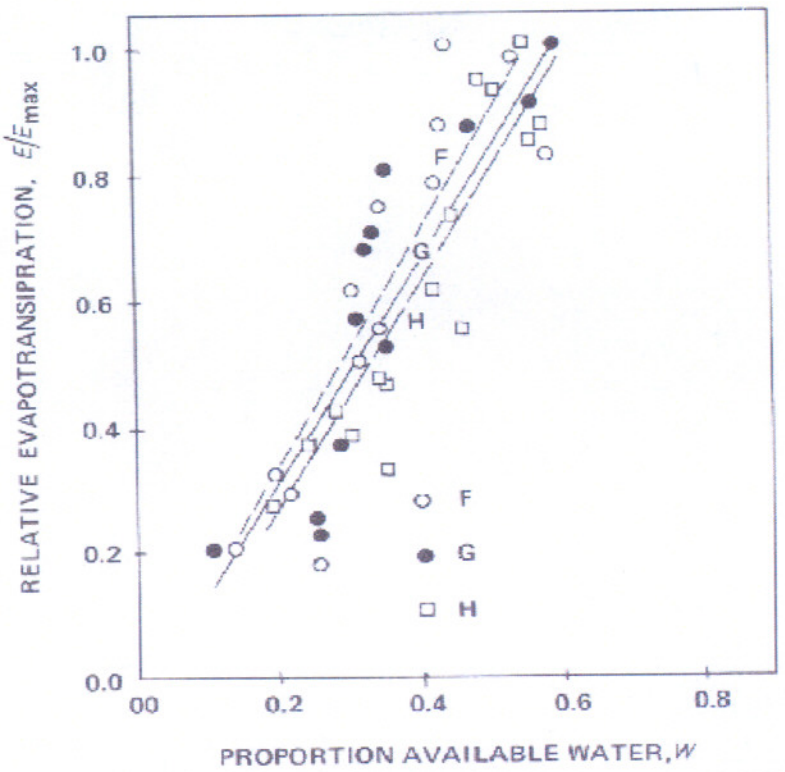


**Fig. 3. Relative evapotranspiration ($E/E_{max}$) as a function of the proportion of available water ($W$) for maize in a clay loam soil with different potential evapotranspiration ($E_o$).**
**F, $E_o$ = 8.8 mm/day: $E/E_{max} = -0.03 + 1.85W$, $r^2 = 0.85$**
**G, $E_o$ = 7.5 mm/day: $E/E_{max} = -0.03 + 1.73W$, $r^2 = 0.84$**
**H, $E_o$ = 9.8 mm/day: $E/E_{max} = -0.08 + 1.75W$, $r^2 = 0.83$**

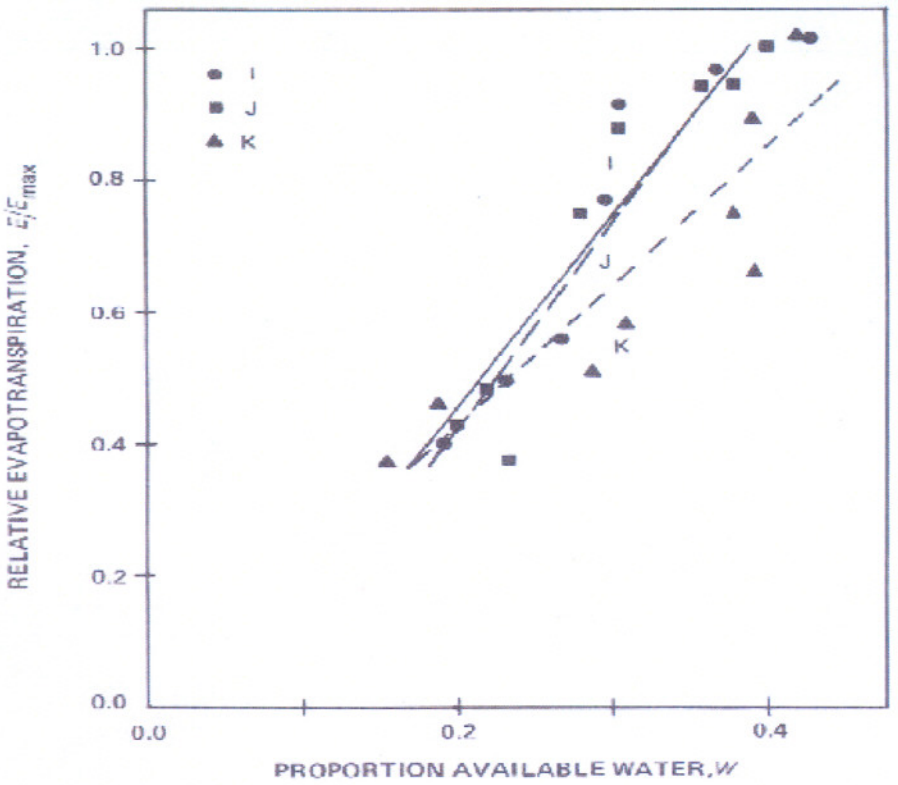


Fig. 4. Relative evapotranspiration ($E/E_{max}$) as a function of the proportion of available water ($W$) for barley in a clay loam soil with different potential evapotranspiration ($E_o$).
I, $E_o$ = 9.4 mm/day: $E/E_{max} = -0.18 + 2.95W$, $r^2 = 0.88$
J, $E_o$ = 7.2 mm/day: $E/E_{max} = -0.21 + 3.09W$, $r^2 = 0.93$
K, $E_o$ = 9.1 mm/day: $E/E_{max} = -0.02 + 2.11W$, $r^2 = 0.86$

This study was compared to results reported in the literature,

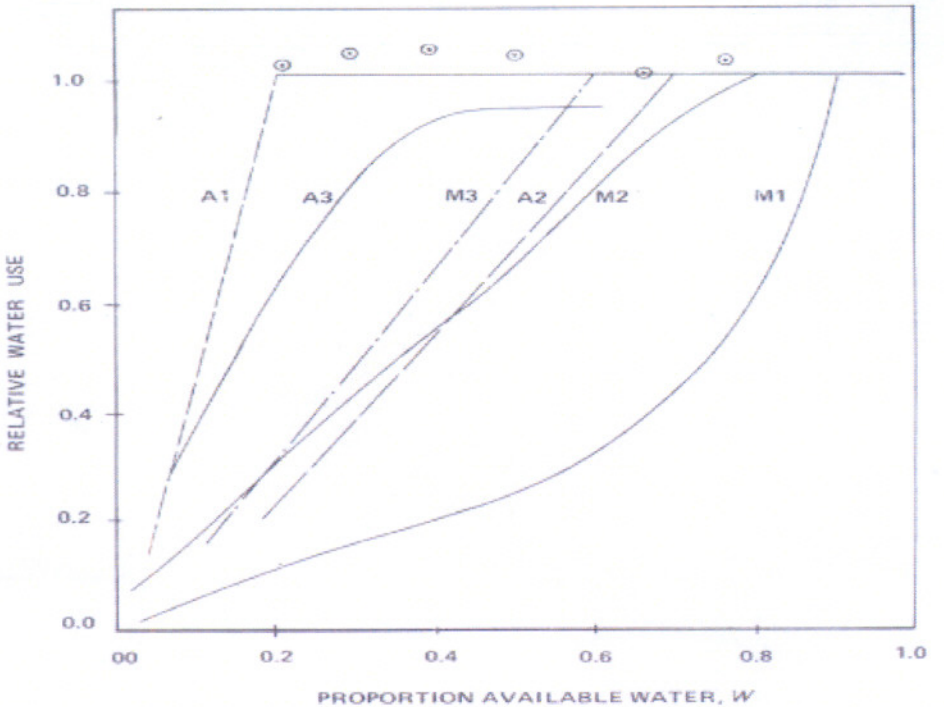


Fig. 5. Various proposals of the relationship between the relative water use by alfalfa and maize and the proportion of available water.
M1, Maize (Denmead and Shaw, 1962), silty clay loam ($E_o$ = 6.4 mm/day)
M2, Maize (Denmead and Shaw, 1962), silty clay loam ($E_o$ = 5.6 mm/day)
⊙, Maize (Ritchie, 1973), clay ($E_o$ = 6.5 mm/day)
M3, Maize (This study), clay loam ($E_o$ = 7.5—9.8 mm/day)
A1, Alfalfa (Van Bavel, 1967), clay loam ($E_o$ = 9.0 mm/day)
A2, Alfalfa (This study), clay loam ($E_o$ = 7.6 mm/day)
A3, Alfalfa (This study), sandy loam ($E_o$ = 6.3 mm/day)

and it was hypothesized that differences were related mainly to the way variation in soil moisture was introduced over the measurement period.

(1) From paper by A. S. Abdual-Jabbar, T. W. Sammis, D. G. Lugg, C. E. Kallsen and D. Smeal. 1983.Water Use by Alfalfa, Maize and Barley as Influenced by Available soil water. Agricultural Water Management, 6 : 351-363