Water Use Efficiency of Silage Maize Under Deficit Irrigation and Nitrogen Fertilization

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Introduction
• In order to increase water use efficiency (WUE) and crop production, efficient irrigation management in conjunction with an improved fertigation practice is required.
• In many areas of Iran and regions with similar climatic conditions, scarcity of water is a limiting factor for crop growth. It is, therefore, necessary to improve the water use efficiency, particularly in the semi-arid regions.
• The objective of this study was to determine the effects of various levels of irrigation and nitrogen fertilizer applied via sprinkler irrigation on water use efficiency and yield of maize grown for silage.

Materials & Methods
• The study was conducted in 2003 and 2004 at Varamin, located in the central region of Iran (Lat: 35°20' N, Long: 51°38' E and 973 m above the sea level).
• Time and amount of irrigation were determined based on soil moisture deficit (SMD) with management allowed depletion (MAD) equal to 50% (Cuenca, 1989) for the full irrigation treatments (W3).
• The experimental layout was a strip-plot design, with randomized complete blocks.
• Hybrid single-cross 704 with a population density of 66666 Plant ha⁻¹ in 2003, and 88888 Plant ha⁻¹ in 2004.
• Nitrogen levels: No nitrogen (N0) 150 kg N ha⁻¹ (N150) 200 kg N ha⁻¹ (N200)

Measurement Indexes

WUE = \frac{Y}{ET_a} \quad \text{IWUE} = \frac{Y}{I_a} \quad (1 - \frac{Y_m}{Y_a}) = ky \times \left(1 - \frac{ET_a}{ET_m}\right)

Where WUE is the water use efficiency (kg m⁻³), Y is the total crop biomass at silage stage (kg ha⁻¹), ET_a is the actual evapotranspiration that measured by soil water balance method (mm-ha), IWUE is the irrigation water use efficiency (kg m⁻³), I_a is the gross water depth (irrigation plus rain) during the growing season (mm-ha), Y_a is the actual harvested yield (kg ha⁻¹), Y_m is the maximum harvested yield (kg ha⁻¹), ky is the yield response factor, and ET_m is the maximum evapotranspiration.

Results

Soil Moisture Profile
• Deep percolation did not occur from a soil depth of 60 cm for the deficit irrigation levels (W1 and W2) and full irrigation level (W3).
• The change in soil moisture indicated that maize extracted most of the water from a depth of 0 to 60 cm.
• Dividing the root zone into four layers, the smallest amount of soil moisture was extracted from the fourth layer of the root zone and the highest amount of soil moisture was extracted from the second layer of the root zone.

Yield Response Factor
• The minimum Ky was obtained for the N0 level and the maximum Ky in N fertilizer application (Fig. 5).

Conclusion
• The average WUE over two years indicated that the highest WUE was obtained for the second deficit irrigation level (0.85ET) for all N levels.
• IWUE increased as the amount of nitrogen fertilizer increased and the highest of IWUE was obtained for the full irrigation level.
• N fertilizer application has an effect on the sensitivity of silage maize growth to water stress.