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# Maize response to different water, salinity and nitrogen levels: yield-water relation, water-use and water uptake reduction function

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## Abstract

Water, salinity and nitrogen are the major factors affecting maize production in arid and semi-arid areas. The objectives of this study were to investigate the effects of different water, salinity and nitrogen levels on yield-water relationships, water use, water productivity (WP), water use efficiency (WUE) and water uptake reduction function by maize hybrid SC-704 in a semi-arid area and silty clay loam soil. A split-split-plot design with three replications in two years of 2009 and 2010 was conducted. The different levels of irrigation water considered as main plot, salinity of irrigation water as sub-plot and nitrogen fertilizer rate as sub-sub-plot. Irrigation treatments consisted of $I_1$ ($1.0ET_c+0.25ET_c$ as leaching), $I_2$ ($0.75I_1$) and $I_3$ ($0.50I_1$) applied at 7-day intervals. The salinity treatments of irrigation were 0.6 (fresh water), 2.0 and 4.0 dS $m^{-1}$. There were also three nitrogen (N) treatments including 0, 150 and 300 kg N $ha^{-1}$. Results showed that the actual crop ET and transpiration (T) were significantly less in $I_3$ as compared to $I_1$ treatments as 42 and 43%, respectively. Besides, T values under $S_3$ were statistically less than that in $S_1$ treatment as 12%. The soil evaporation (E) values were 26, 31 and 27% of ET at $I_1$, $I_2$ and $I_3$ treatments, respectively and its values significantly increased with increasing salinity levels of irrigation water. The minimum and maximum amount of E occurred at $I_3S_1N_3$ and $I_1S_3N_3$, respectively. The study showed that deficit irrigation as $0.50I_1$ and 0.75 $I_1$ were the optimum levels of irrigation to access the highest WP and WUE for dry matter (DM) and grain yield (GY) respectively. Besides, $S_1$ was the optimum treatment for achievement of highest WP and WUE for DM and GY. Results also indicated that the optimum treatment for WP and WUE for GY was $I_2S_1N_3$. Furthermore, N fertilization could not statistically improve WP and WUE beyond 150 kg N $ha^{-1}$. The yield response factor to water showed that maize GY was more sensitive to water than its DM. Results also indicated that the Homaee and Feddes (1999) equation was resulted in acceptable estimation of root-water uptake reduction function [α (h,$h_o$)]. Furthermore, results showed that the FAO method underestimated the maize yield (DM/GY) at different N application rate; however, the Homaee and Feddes (1999) method resulted in acceptable prediction of the maize GY. Therefore, Homaee and Feddes (1999) equation is recommended for estimation of both α (h, ho) and maize GY.

***Keywords:*** Maize; Nitrogen levels; Root-water uptake reduction function; Salinity levels; Water use efficiency; Yield-water relationships.

## Introduction

Maize is one of the three most important cereal crops (after wheat and rice) and is grown in a wide range of climates. Maize is used as human food, animal feed and pharmaceutical and industrial materials. It is a $C_4$ plant, which is more efficient in the use of $CO_2$, solar radiation, water and N supply in photosynthesis than $C_3$ crops. Even though maize makes efficient use of water, it is considered more susceptible to environmental stress than other crops because of its unusual floral structure with separate male and female floral organs and the near-synchronous development of florets on a (usually) single ear borne on each stem (Huang et al., 2006).

Water is an important factor for crop production. Water use efficiency (WUE) is a function of multiple factors, including physiological characteristics of crop, genotype, soil characteristics such as soil water holding capacity, meteorological conditions and agronomic practices. To improve WUE, integrative measures should aim to optimize cultivar selection and agronomic practices. Managing irrigation at the field scale can improve WUE. Deficit irrigation is one strategy for maximizing WUE for higher yields per unit of irrigation water applied. This is the way of more effective and economic use of limited water supplies. The crop, for example maize, can be exposed to a certain level of water stress either during a particular period or throughout the whole growing season, without significant reduction in yields (Sepaskhah and Ghahraman, 2004). Furthermore, success with deficit irrigation is more probable in fine texture soils.

The supply of nitrogen (N) is also important for crop production as much as water. Maize has a positive response to N fertilizer application (Mansouri-Far et al., 2010). Water and N deficit lead to reductions in crop production by reducing resource use efficiency. Furthermore, an interaction between N and water supply has been demonstrated. In other words, N uptake from soil is influenced by water supply (Ercoli et al., 2008). Therefore, an optimum amount of N based on the available amount of water is needed to improve crop yield.