

## INTERACTIVE EFFECTS OF N-, P-, K- AND WATER STRESSES ON ROOT AND SHOOT DEVELOPMENT OF MAIZE SEEDLINGS

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**SUMMARY:** Maize plants were grown for 2 to 3 weeks at different levels of N, P and K under limited and adequate soil moisture conditions. In contrast to shoot development root growth was barely affected by water stress as a consequence of efficient osmotic adjustment. Under limited water supply different soil nutrient levels had no significant influence on biomass production. With N-fertilization shoot turgor was comparatively more reduced than in the other treatments, and K-fertilization seemed to reduce root turgor. Drought stress as well as adequate K nutrition clearly increased water use efficiency.

**1. INTRODUCTION:** Water stress influences plant growth not only by limiting water supply but also by reducing soil nutrient availability. Root growth is known to be an important factor in improving the plants capability to respond to the unfavorable conditions established by water stress. The combined action of multiple nutrient and water stresses is poorly documented. Therefore, in this study the effects of different levels of soil nutrient supply on plant growth under limited and adequate soil moisture conditions were investigated.

**2. MATERIALS AND METHODS:** Pregerminated maize seeds were sown in pots containing a silty soil with different levels of N, P and K. Half the pots were watered regularly ( $\psi_s > -0.03$  MPa) while the other half were allowed to dry to a soil matric potential  $\psi_s$  of  $-0.4$  MPa. Soil matric potential was monitored by means of tensiometers and gypsum blocks and further determined from gravimetric measurements and a previously established soil water retention curve. Well watered and stressed plants were harvested when the soil matric potential of the 'dry' treatments reached  $-0.4$  MPa (15-19 days after planting). Shoot and root fresh and dry weight as well as xylem water and osmotic potentials of roots and shoots were measured as described by Schmidhalter et al. (1991) and root:shoot ratio, turgor of shoots and roots and water use efficiency were calculated.

**3. RESULTS:** Water stress reduced shoot growth (fresh and dry weight) significantly (Fig. 1). Root development on the other hand was enhanced under limited soil moisture conditions. Shoot turgor of stressed plants at harvest was almost zero in all treatments (Fig. 2). Root turgor at harvest was not influenced by water stress as a consequence of osmotic adjustment. Therefore stressed plants showed a significant increase in root:shoot ratio (Fig. 1).

Different soil nutrient levels had less significant effects on the plant parameters examined. N and P fertilization increased shoot growth only under well watered conditions (Fig. 1). Root dry weight was not affected by any fertilizer treatment whether well watered or drought stressed. Leaf turgor was barely affected by different soil nutritional levels although any addition of nutrients improved osmotic adjustment (Fig. 2). Only K-fertilization seemed to affect root turgor.

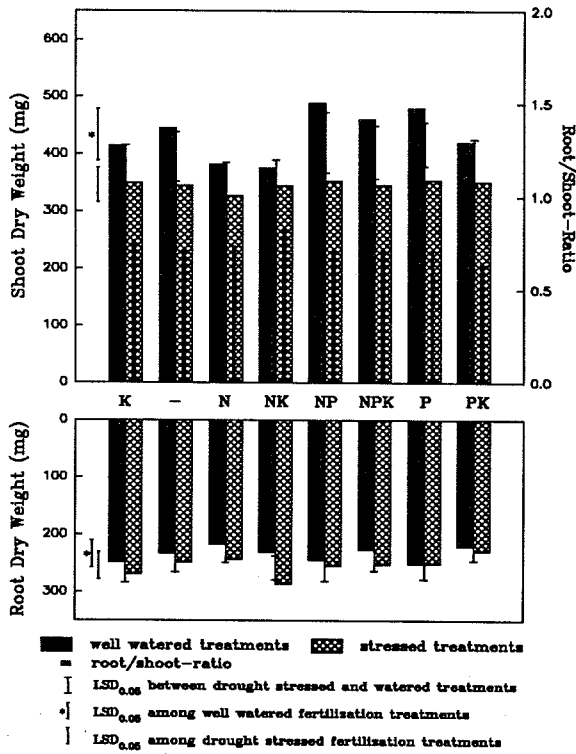


Fig. 1: Effects of different fertilization treatments on shoot and root dry weights of well watered and stressed maize seedlings

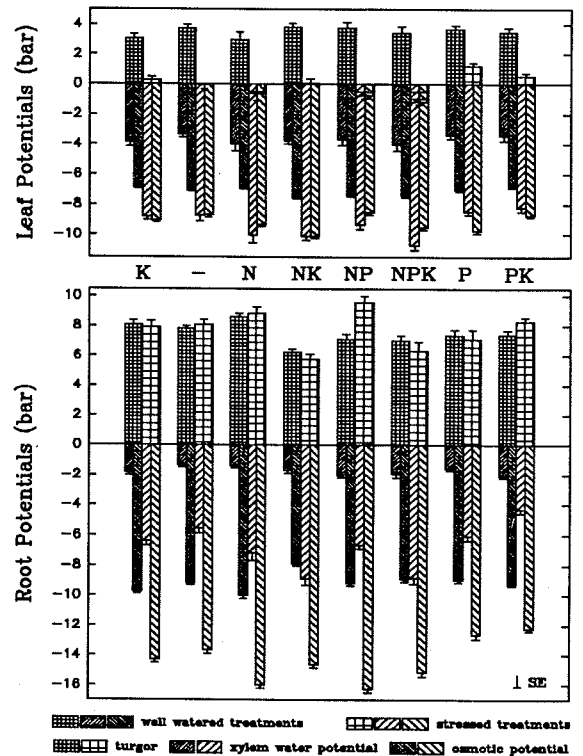
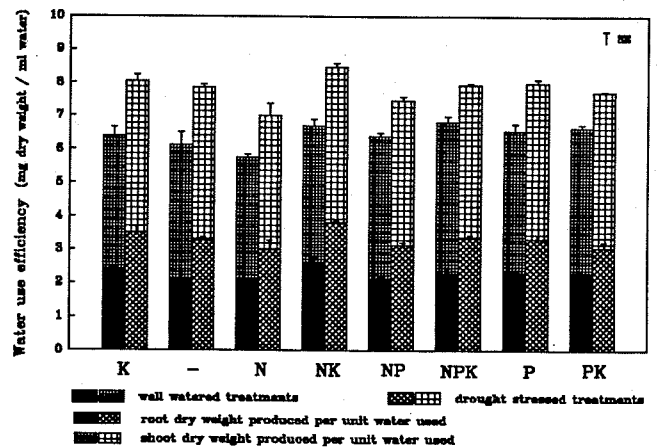


Fig. 2: Effects of different fertilization treatments on water potential components of shoots and roots of well watered and stressed maize seedlings

Water use efficiency (WUE) significantly increased under limited soil moisture supply (Fig. 3). Additional K increased WUE with or without N and P fertilization under both water regimes. N and P additions had no positive effects on WUE unless combined with K fertilization.

Fig. 3: Effects of different fertilization treatments on water use efficiency of well watered and stressed maize seedlings



REFERENCES: Schmidhalter, U., Evéqoz, M., Oertli, J.J., 1991. Osmotic adjustments of roots and shoots (current proceedings)

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