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Water and Osmotic Potentials of Ethephon-Treated Maize Genotypes Varying in Drought Resistance

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Abstract. Leaves of drought-resistant and drought-sensitive genotypes of maize *(Zea mays* L.) were sprayed with ethephon to determine its effect on water and osmotic potentials. With both sufficient and limited water supplies, ethephon decreased the water potential, but not the osmotic potential, of the drought-sensitive maize. It had no effect on the water and osmotic potentials of the drought-resistant maize under either water regime. The results showed that the response of a genotype of maize to ethephon depends upon its susceptibility to drought.

Additional index words: Zea mays L.; corn; ethylene; drought sensitivity.

Drought increases ethylene production by plants (Yang and Hoffman 1984). However, little work has been done to investigate the effects of ethylene on plant-water potential. Even less has been done to determine if drought-resistant plants respond differently to ethylene than do drought-sensitive plants. Kirkham (1983) found that foliar treatments with ethephon, an ethylene-releasing compound (Beaudry and Kays 1988), lowered the water and osmotic potentials of a drought-resistant winter wheat (*Triticum aestivum* L.), but did not affect the water or osmotic potentials of a drought-sensitive winter wheat. The objective of this experiment was to determine if also a drought-resistant genotype of maize had different water and osmotic potentials than a drought-sensitive genotype of maize, when both genotypes were treated with ethephon and grown under well-watered or drought-stressed conditions.

MATERIALS AND METHODS

The experiment was carried out in a greenhouse at Kansas State University. The temperature varied from 25 to 40 °C. The relative humidity was about 60 %. No extra light was added.

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The two genotypes of maize (*Zea mays* L.) used in the study were "H28" and "K731", drought-resistant and drought-sensitive inbreds, respectively (Kirkham *et al.* 1984). The plants were grown in plastic pots (21 cm diameter; 21 cm height) with a clay-loam soil.

On days 10, 11, 12, 13, and 14 after planting, the leaves in half of the pots were sprayed with a 25 mg l^{-1} solution of 2-chloroethyl phosphonic acid (lot no. 106F; Sigma Chemical Co., St. Louis, Missouri, U.S.A.).

From day 10, no more water was added to half of the pots. The other 12 pots were watered regularly with tap water.

A 1 cm length of a recently matured leaf (the third leaf), one sample per treatment, was placed in the chamber of a thermocouple psychrometer (Model 75-3AC; J.R.D. Merrill Specialty Equipment, Logan, Utah, U.S.A.). After 3 h of equilibration, the water potential was determined by using a microvoltmeter (Model HR-33T Dew Point Microvoltmeter, Wescor, Inc., Logan, Utah, U.S.A.). The tissue was frozen, thawed, and equilibrated again in the thermocouple-psychrometer chamber to determine the osmotic potential.

The *t* test was used to evaluate the statistical significance of differences.

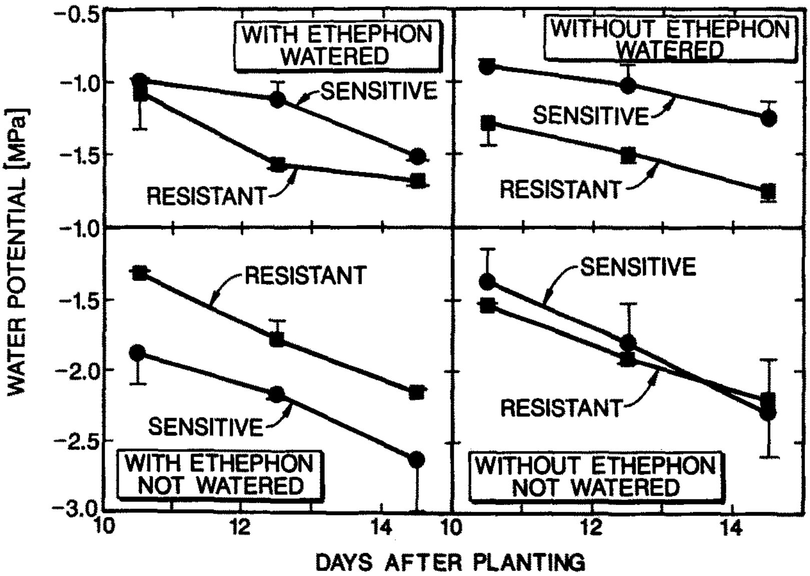

Fig. 1. Effect of ethephon on the water potential of drought-resistant (H28) (squares) and drought-sensitive (K731) (circles) genotypes of maize. Top: Watered plants. Bottom: Water-stressed plants. The means ± SD from two plants are shown. Only half of the SD bar is drawn for clarity.

RESULTS

Water Potential

Watered plants. Both with and without ethephon, the drought-resistant genotype had a lower water potential than the drought-sensitive genotype

(p at the 0.02 and 0.001 level for plants with and without ethephon, respectively) (Fig. 1, top). K731 had a lower water potential with ethephon than without ethephon (p at the 0.01 level). Ethephon had no effect on the water potential of H28. Therefore, ethephon reduced the difference in water potential between the genotypes.

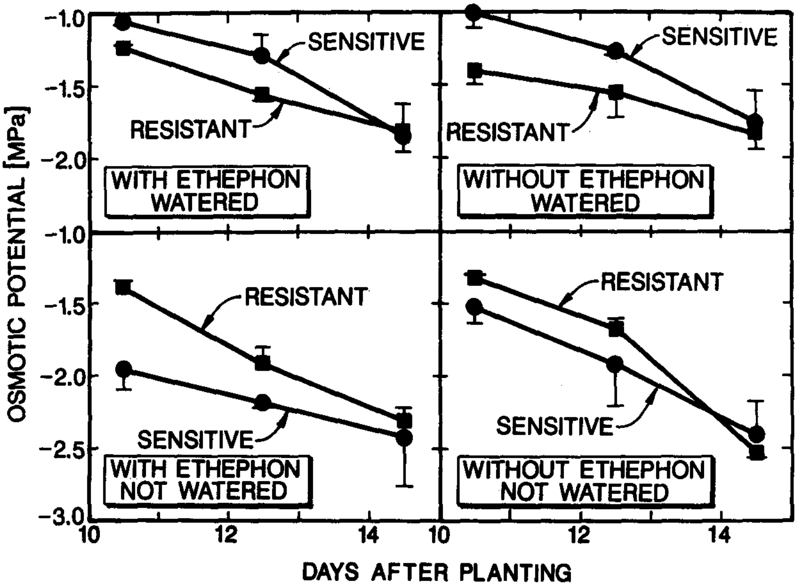

Fig. 2. Effect of ethephon on the osmotic potential of drought-resistant (H28) (squares) and drought-sensitive (K731) (circles) genotypes of maize. Top: Watered plants. Bottom: Water-stressed plants. For vertical bars, see legend of Fig. 1.

Water-stressed plants. Without ethephon, the water potential of H28 was not significantly different from that of K731 (Fig. 1, lower right). With ethephon, there was a difference between the two genotypes (Fig. 1, lower left) (p at the 0.01 level), because ethephon lowered the water potential of the drought-sensitive plants, but not that of the drought-resistant plants. Therefore, under both well-watered and water-stressed conditions, ethephon lowered the water potential of K731 but had no effect on the water potential of H28.

Osmotic Potential

Watered plants. Both with and without ethephon, H28 had a lower osmotic potential than K731 (p at the 0.05 and 0.02 level for plants with and without ethephon, respectively) (Fig. 2, top). Ethephon did not affect the osmotic potential of either genotype.

Water-stressed plants. With ethephon, the osmotic potential of the drought-sensitive genotype was lower than that of the drought-resistant genotype (p at the 0.02 level) (Fig. 2, lower left). Without ethephon, the osmotic potential of K731 was not significantly different from that of H28 (Fig. 2, lower right). Ethephon had no significant effect on the osmotic potentials of either genotype.

DISCUSSION

Ethephon lowered the water potential, but not the osmotic potential, of the drought-sensitive maize. It had no effect on the water and osmotic potentials of the drought-resistant maize. In the earlier study with wheat (Kirkham 1983), ethephon lowered the water and osmotic potentials of a drought-resistant wheat, but did not affect those of a drought-sensitive wheat. Both studies showed that ethephon lowered water potentials.

The data of this paper, plus those of Kirkham (1983), support the suggestion that C_3 and C_4 species differ in their ability to metabolize ethylene (Grodzinski *et al.* 1982). Carbon dioxide may act to regulate the retention of ethylene within plant tissues (Horton 1985). Because C_4 plants recycle carbon dioxide more efficiently than C_3 plants, it is reasonable to assume that they might respond differently to the addition of ethylene in the form of ethephon. The two studies with maize (C_4) and wheat (C_3) support this assumption. Under well-watered conditions, ethephon increased the difference in water potential between the drought-sensitive and drought-resistant wheats and decreased the difference in water potential between the drought-sensitive and drought-resistant maize genotypes. Under water-stressed conditions, ethephon increased the difference in water potential between the two genotypes of maize, but decreased the difference in water potential between the two genotypes of wheat. These results suggest that response of a plant to ethephon depends upon its drought susceptibility as well as its type of photosynthesis (C_3 or C_4).

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