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THE EFFECT OF HEXADECANOL-OCTADECANOL ON THE WATER BALANCE OF TRANSPLANTED *JUGLANS NIGRA* L

NEIL A. MILLER
Memphis State University
Memphis, Tennessee 38152

ABSTRACT

The effect of a soil application of an equal mixture of hexadecanol-octadecanol on the factors influencing the water balance of transplanted black walnut leaves (*Juglan nigra* L.) was studied by measuring stomatal movement, temperature, water potential, osmotic potential, turgor pressure, and transpiration rate in greenhouse grown plants. An average of 68% of the stomates of the treated plants remained open at mid-day each day, and the leaf surface temperature of the treated plants exceeded by 9.6°C that of the control plants. The leaf water potential of treated plants exceeded that of the control plants by as much as 7.1 bar and generally stayed greater than 2-3 bar. Turgor pressure was as much as 5.2 bar greater in the treated plants, and transpiration was reduced by 42.3%. The maintenance of high water potential and turgor pressure in leaves of treated plants tends to indicate that transpiration reduction takes place in the substomatal cavities rather than by simple root blockage.

INTRODUCTION

The success of transplanting nursery grown hardwood species is dependent upon proper nursery procedure but also on the vagaries of nature. The maintenance of the soil-root-stem-leaf-atmosphere water transfer is often a critical factor in the establishment and survival of transplanted stock.

Monomolecular films of long-chain alcohols have been used to reduce evaporation from the surface of standing water. This technique has also been applied to germinating seeds of annual plants. This investigation explores the possibility of maintaining a suitable plant water balance of transplanted hardwood perennials by reducing the water transfer at the leaf stomatal/ambient atmosphere interface.

MATERIALS AND METHODS

An equal mixture (20g each) of hexadecanol and otadecanol was added to each 25.4 cm pot of soil prior to transplanting one-year old seedlings. One year old seedlings were planted in alternate pots with untreated soil. Twelve weeks later the fourth, fifth and sixth leaves, numbered from the ground upward, were selected from 50 treated and 50 control plants. Plant and weather data were collected every 4 h in the greenhouse. Collection continued at 4-h intervals for 3 days.

Stomatal aperture was measured by the room-temperature vulcanization (RTV) technique (Miller and Ashby, 1978; Sampson, 1961; Zelitch, 1961). A mixture of 5 ml of silicone rubber (General Electric RTV-11) and 5 drops of Nuocure 28 (a catalyst) was applied to the lower epidermis of the sixth leaf of 30 treated and 30 control plants with a small meatal spatula. A positive replica of the leaf surface area was made by coating the peeled mold with two coats of clare commercial finger nail polish and acetone. A microprojector was used to examine the epidermal replicas, and the stomates were noted as open or closed. This technique is good to about 2 μm. At least 500 stomatal apertures per leaf were evaluated to determine the condition of the apertures at each collection period. Zelitch (1963)

reported as many as four successive impressions in a single day of the same leaf area with no apparent damage.

Leaf surface temperature was recorded every 4h with a Barnes Engineering Company PRT-10 infrared thermometer with a temperature sensitivity of ± 0.2°C at 20°C and a spectral sensitivity of 6.9 to 20μ. All selected leaves had the same solar surface exposure.

The Schardakow (1956) method modified by Brix (1966) and by Knipling (1967), was used to determine water potential of the leaves with a range of prepared sucrose solutions. This is a method by which the density of test solutions are compared with known densities. The fifith leaf of 30 treated and 30 control plants, excluding midveins, were cut into 4-cm squares and placed in 15 ml of test solution (Miller, 1978). Osmotic potential values of the standard sucrose solutions were taken from Ursprung and Blum (1916).

The fourth leaf of each of 30 treated and control plants were removed, placed in polyethylene bags, and immediately frozen to a −20°C; and later 50 g of leaf material were placed in a cylinder and expressed with a pressure of 350 kg cm^{-2} in a Carver hydraulic press (Gortner et al., 1916); 2 ml of expressed sap in osmomoter tubes were placed in an osmomoter. All determinations were run three times, and stanard solutions were tested before and after each series to assure proper calibration.

Turgor values were obtained by the following formula:

$\psi p \pm \psi w - \psi s$, where ψp = turgor pressure (bar), ψw = water potential (-bar), and ψ = osmotic potential (-bar).

To obtain transpiration rates in the greenhouse, 20 treated and 20 control plants with pots in sealed containers were individually weighed every 4 h. Total leaf surface area was determined with the use of compensating polar planimeter. The mean transpiration per unit time per unit area was calculated.

Results and Discussion

A more open stomatal condition was maintained by the long-chain alcohol treatment during the daylight period. Throughout the study 68% of the stomates on the treated plants remained open during mid-day while only 34% of the control plant leaf stomata were open (Fig. 1). The greater percentage of open stomates coincided with the higher pressures and water potentials in the treated plants during the hotter portion of the day. The stomatal movement of the treated plant leaves followed the same general cyclic pattern as that of the control leaves but lagged in the closing process.

The leaf surface temperature of the treated plants exceeded that of the control plants by as much as 9.6°C, but followed the same diel pattern as those of the control leaves. No difference in leaf surface temperature was noted during the late nocturnal period. The treated plant leaves consistently maintained a higher water potential from 2 to 3 bar throughout the investigation and exceeded that of the control leaves by as much as 7 bar. The osmotic potentials of the leaves of treated plants were always less than those of the control plant leaves, and a definite cyclic diurnal-nocturnal pattern was noted. The turgor pressure of the treated plant leaves remained greater than that of the control plant leaves. Differences in plant leaf turgidity values reached as high as 5.2 bar, but generally, the differences were not more than 2 bar. The plants grown in soil containing hexadecanol-octadecanol had a 42.3 reduction in water loss. The application of an equal mixture of the long-chain alcohols greatly reduced transpiration, and the water balance of the walnut leaf was affected with no noticeable effect on plant growth, development or appearance (Fig. 1).

Conclusion

The long-chain alcohol-treated plants maintained a greater leaf water potential and turgor pressure than did the control plants. This would not be expected if the transpiration reduction was caused by root impedance produced by the alcohol mixture in the soil. If impedance resulted from the alcohol treatment, then the plant uptake would lag behind the leaf water loss, and a subsequent reduction in water potential and turgor pressure would result. If, however, the alcohol treatment reduced plant water loss in the substomatal cavities through the formation of a monomolecular film, then a higher water potential and turgor pressure would be maintained—as was the case. Long chain alcohol soil treatment for trans-

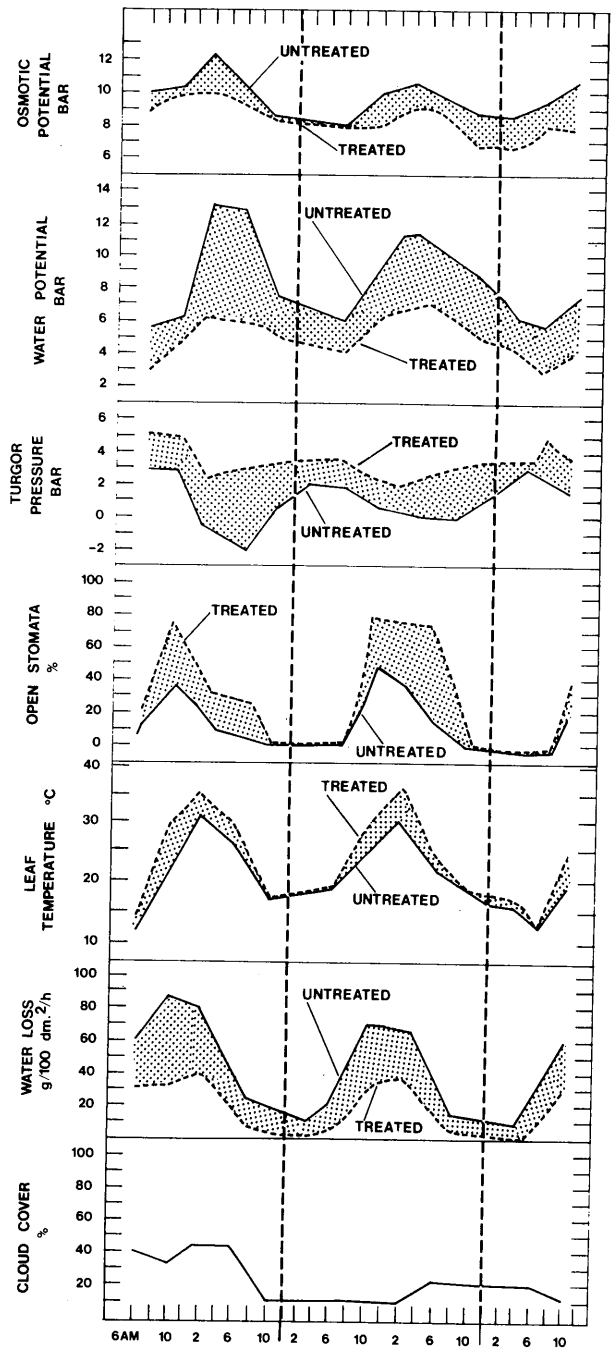

FIG. 1. *Black walnut leaf data from plants grown in soil pots to which an equal amount (20g each) of hexadecyl and octadecyl alcohol had been added. Water and osmotic potentials are negative values.*