REDDUCING PHREATOPHYTE TRANSPERSION
by
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ABSTRACT

Transpiration rates (T) of riparian phreatophytes can be high. Antitranspirant (AT) sprays can curtail T without the ecological imbalance made by eradication. Saltcedar (Tamarix sp.) and cottonwood (Populus sp.) in 15-gal. drums enabled replicated trials on isolated plants or on canopies. T of isolated saltcedar plants could be 2x that of plants in a fairly dense canopy. T for a unit ground area of saltcedar varied from 2.2 (sparse) to 15.8 (dense-stand) mm/day in July at Davis. Extrapolation of experimental T data to field sites must, therefore, be made carefully. Wax-based ATs increased foliar diffusive resistance (R), and reduced T of saltcedar and cottonwood 32-38% initially and 10% after 3 weeks. R increased naturally in the afternoon when evaporative demand was high and if soil water was low. Nocturnal T of salt cedar was 10% of day T. AT effectiveness increased with a higher ratio of day:night hours, and with lower soil water stress. Therefore, AT will be most effective on long summer days in riparian areas where ground water is available.

INTRODUCTION

Water use by, and management of, riparian phreatophyte vegetation was recently reviewed by Ffolliott & Thorud (1975) and Horton (1976). Methods for controlling phreatophytes have included expensive physical and chemical eradication measures. However, permanent eradication is seldom achieved, and the side effects of such drastic techniques can result in a severe ecological imbalance. The antitranspirant (AT) approach seeks to curtail transpiration of phreatophytic vegetation, such as saltcedar (Tamarix sp.), without removing the vegetation or damaging the environment (Brooks & Thorud 1971; Davenport et al. 1976). This paper reports experiments by the University of California (Davis) on the use of ATs to reduce phreatophyte transpiration. It is part of a regional project funded by the Office of Water Research & Technology (USDI), and involves expertise from Arizona, California, Colorado and Idaho to study phreatophyte water use, its reduction by AT and the effects of AT on riparian wildlife.

In June, 1974, cuttings of saltcedar (Tamarix pentandra) and cottonwood (Populus sp.) were each taken from a single mother plant (to eliminate genetic variability), rooted, and transplanted outdoors in 15-gallon drums (42 cm diameter X 48 cm depth). The drums were painted white to avoid high soil temperature in summer and were filled with a light commercial potting mix to reduce dead weight. Irrigation was applied to the soil surface, and evaporation from the soil was minimized by a plastic disc on the surface of each drum. By August, 1975 the plants were over 1 meter tall. Daily transpiration per plant, measured by periodic weighing, was as much as 4 kg of water, and the accuracy of the weighing system was about 1.5% of this daily loss. Thus, even a 5% reduction of daily transpiration by the AT was easily detected. Variations of transpiration rates between plants was minimized running uniformity trials before each experiment. The advantages of the 15-gal. weighable drums for these AT/transpiration studies are: (a) cheap and manageable, permitting many units for adequate replication and several different experiments in one season; (b) big enough to produce plants with reasonably large individual canopies; and (c) larger canopies can be produced by grouping individual units, enabling measurements of transpiration, and AT coverage and effectiveness, for canopies of various densities. Most lysimeter installations do not have this much versatility and are considerably more expensive to install.

Two wax-based, food-grade ATs were used in these trials: 1) Mobileaf FG (Mobil Chemical Co., Richmond, VA.), and 2) Folicate (Crystal Soap and Chemical Co., Lansdale, PA.). These were sprayed on the foliage as emulsions with water by a Solo back-pack mist blower at various dilutions and application rates.

AT EFFECTS ON COTTONWOOD

Mobileaf FG and Folicate at 6% dilution were equally effective in significantly reducing transpiration of adequately watered cottonwoods, by nearly 40% initially, the effect decreasing with time (Table 1). Porometer measurements on the lower surfaces of the cottonwood leaves (stomata occur on both surfaces) showed the ATs had made a 4 to 5-fold increase in resistance to water vapor diffusion. The average values of 10 readings per treatment were respectively, 0.16, 0.62, and 0.87 min cm⁻¹ for Control, Mobileaf FG and Folicate.

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reduce transpiration by about 10-20%.

October, and 2) new growth on the plants. However, 2 weeks after re-spraying, the AT still appeared to

These reductions was confounded by

with 10% (low), i.e., at 375 ml/plant; the 8% and control drums were not sprayed, but transpiration

measurements were continued on them; the 3% AT, being virtually ineffective, was removed from the ex-

periments.

Spraying, the 6-12% dilutions reduced transpiration only 8-12%.

The AT effects on saltcedar in 15-gal drums were further confirmed in June, 1976, when we sprayed

10% Folicote by a back-pack mist blower on a natural stand of saltcedar on the U.S. Bureau of Reclama-

tion's 1000-ft² lysimeter tanks at Bernardo, New Mexico. After correcting for inherent differences

between tanks (caused by varying plant densities), we again observed a 30-35% reduction in water use

initially, diminishing to 10% after three weeks, with no signs of plant damage.

The importance of accounting for variations in plant size when assessing AT effects is borne out

in the following comparison of transpiration from a control and an AT-treated plant in 15-gal. drums

(Table 2). The treated plant had about 30% more foliage than the control and transpired only about 10%

less water on a per plant basis. However, when transpiration was expressed on an equal fresh or dry

weight basis transpiration reduction by AT was about 30%. It is interesting that the saltcedar could
daily transpire water equal to 10x its fresh weight or 30x its dry weight.

The preceding transpiration data on saltcedar were based on measurements from isolated plants, i.e., no foliage overlap with neighboring plants. Individual plant studies were made because they helped answer the primary question - can antitranspirants reduce saltcedar transpiration? However, it is also necessary to know the magnitude of water loss from canopies of various densities. The large numbers of saltcedar drums enabled this evaluation simply by surrounding the drums to be measured by other 'guard' drums of saltcedar at the desired spacing. In a preliminary test of this method a uniformity trial on 2 pairs of isolated drums showed approximately equal transpiration rates. When one pair of plants was moved into a 'close' canopy (no ground visible); transpiration/plant was consistently about 50% of that of isolated plants. Increasing the spacing between plants to form a 'medium-
close' canopy (some ground visible) increased their transpiration/plant to about 80% of that of isolated

plants.

It is difficult to ascertain the rate of transpiration per unit foliar surface area (A) of salt-cedar plants because of problems of accurately measuring A of the feathery foliage. The most realistic determination of A for natural stands is by aerial photographic surveys, expressing A as area of land covered by the vegetation. However, it is difficult to correct for varying plant densities to accurately estimate leaf area index. An attempt to relate saltcedar transpiration per unit of land area with
Figure 1. Effects on transpiration of saltcedar in 15-gal. drums of various dilutions of Folicote antitranspirant sprayed at 600 ml/plant or 300 ml/plant (low). (Small arrows show watering dates).
The effect of density of saltcedar canopy on its transpiration rate is shown in Fig. 2. Evapotranspiration rates from a lysimeter of mown grass, measured on the same dates as saltcedar transpiration, are shown for comparison. (The canopy density index is for saltcedar plants of 15-gallon drum size.)
Although the isolated plant studies provide a convenient means of assessing percentage transpiration reductions due to AT, the actual magnitudes of transpiration could be less than those estimated for isolated plants. Furthermore, the amount of AT spray coverage on an isolated plant, accessible from all sides, is likely to be greater than on plants in close canopies which are accessible mainly from above. However, for a plant in a dense canopy sprayed from above, most of a given volume of spray would be concentrated in the upper section of the plant where the highest rates of transpiration occur. We therefore attempted to determine if spraying AT from above (simulated aerial spray) on the top canopy only of a moderately dense stand of saltcedar (growing in a group of 15-gallon drums) was as effective as spraying each plant completely. Transpiration reduction by 10% Folicote was initially about 40% for the fully sprayed, and 30% for the top sprayed, plants (Table 3). After a week the reduction in both cases was about 23%. However, since the top spraying required about 40% less AT than the full application, the amount of water saved per unit of AT spray applied could be 30-70% more efficient for an aerial spray covering the upper portion of a moderately dense saltcedar canopy than for a spray operation aimed at coverage of the entire canopy.

Table 3. Water savings by 10% Folicote antitranspirant ('AT') on saltcedar when spraying the plant completely (Full) at 0.7 liters/plant, or from above on only the upper canopy (Top) at 0.4 liters/plant. (Davis, '76).

<table>
<thead>
<tr>
<th>Water saved by 'AT'</th>
<th>8/31-9/2</th>
<th>9/2-3</th>
<th>9/8-9</th>
</tr>
</thead>
<tbody>
<tr>
<td>% transpiration reduction</td>
<td>41</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>kg water saved/plant</td>
<td>2.03</td>
<td>1.64</td>
<td>0.89</td>
</tr>
<tr>
<td>kg water saved/liter 'AT' sprayed/plant</td>
<td>2.90</td>
<td>4.10</td>
<td>1.27</td>
</tr>
</tbody>
</table>

WATER STRESS AND STOMATAL CLOSURE IN SALTCEDAR

Although saltcedars can consume large quantities of water, van Hylckama (1970) pointed out that they do not always transpire at the potential rate. We noted in summer at Davis that diffusive resistance (measured by a porometer) of saltcedar foliage tended to increase in the afternoons, especially as soil moisture becomes more deficient. Stress in the 15-gal. drums was easily induced by withholding irrigation. Thus, after 4 days without irrigation, the transpiration rates had decreased by 75-80%, and the rate in the afternoon was 12% less than in the morning because of stomatal closure (Table 4).

Table 4. Saltcedar transpiration rate changes with time. (Davis, '76).

<table>
<thead>
<tr>
<th>Days since irrig.</th>
<th>Late A.M.</th>
<th>P.M.</th>
<th>Rel.Transp. (PM/AM x 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time</td>
<td>Temp. °C</td>
<td>Transp. g/hr/pl.</td>
</tr>
<tr>
<td>1</td>
<td>1100</td>
<td>31</td>
<td>529</td>
</tr>
<tr>
<td>2</td>
<td>1200</td>
<td>30</td>
<td>408</td>
</tr>
<tr>
<td>3</td>
<td>1100</td>
<td>25</td>
<td>259</td>
</tr>
<tr>
<td>4</td>
<td>1200</td>
<td>27</td>
<td>154</td>
</tr>
</tbody>
</table>

Porometer measurements on saltcedar indicated incomplete stomatal closure at night. However, nocturnal transpiration was only 10% of the daytime rate. Reduction of transpiration at night by the AT is therefore of little consequence. AT effectiveness was noted to increase with: 1) a higher ratio of day-to-night hours; and 2) when soil water was not limiting. Therefore, AT spraying is expected to be most effective when it is most needed for reducing water loss, i.e., on long summer days in riparian areas where groundwater is always available for transpiration. Furthermore, since transpiration transmits pure water to the atmosphere, curtailment of this loss by an AT should improve the quality of ground- and stream-water. The importance of this effect will vary with local conditions and is yet to be evaluated.

REFERENCES CITED


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