ANTITRANSPIRANTS AS A POSSIBLE ALTERNATIVE TO THE ERADICATION OF SALTCEDAR THICKETS

by

Robert S. Cunningham, Kenneth N. Brooks and David B. Thorud

ABSTRACT

The response of saltcedar (Tamarix pentandra Pall.) to several antitranspirants was evaluated in laboratory, greenhouse and small-scale field studies using potted plants. Antitranspirants may provide a treatment alternative to the eradication of saltcedar thickets for water salvage objectives. Transpiration rates were reduced by 23 to 44 percent for 7 to 20 days in the greenhouse, and by 18 to 32 percent for 2 to 8 days in the field. No serious damage to the plants was apparent. One of the most effective antitranspirants considered for a hypothetical saltcedar thicket and a hypothetical operational treatment program, based on estimated cost data, would result in reallocated water costing approximately 55 dollars per acre foot for a single treatment. About 19 acres of saltcedar thicket would have to be treated to provide one acre-foot of reallocated water in this case.

INTRODUCTION

Plans for eradicating saltcedar along flood plains in western states have met vocal and effective opposition in some localities (Cunningham, 1971). Proponents suggest that this exotic plant transpires water which might otherwise be put to more beneficial human use. Flood control is sometimes an additional objective of eradication treatments. Opponents, on the other hand, suggest that several animal species have adapted to saltcedar thickets and that some, particularly the white-winged dove, are dependent upon the thickets for maintenance of present populations. Also, lush green thickets in otherwise dry landscapes may have aesthetic value.

A chemical antitranspirant spray, which narrows stomatal apertures of saltcedar leaves and reduces transpiration without harming the plant or environment, could perhaps be an acceptable alternative to eradication for water salvage purposes. This paper discusses the results of several controlled experiments that were designed to evaluate the response of saltcedar to treatment with antitranspirants. The results of these experiments have been projected to an operational scale to help define the economic feasibility of antitranspirant treatments for the reallocation of water. As used here, "reallocation" refers to the disposition of water by means other than transpiration; increased groundwater storage is one possibility, pumping another.

ANTITRANSPIRANT EFFECTS

Greenhouse and field experiments with saltcedar were conducted at the University of Arizona, Tucson, to determine the effectiveness of selected antitranspirants. And laboratory studies were undertaken to determine the physiological response of saltcedar plants which were sprayed with antitranspirants (Brooks, 1970; Brooks and Thorud, 1971). Previous investigations (Gale and Hagen, 1966; Stoddard and Miller, 1962; Zelitch, 1969) indicate that eight-hydroxyquinoline sulfate (8-HQS) and certain alkenylsuccinic acid derivatives may have some characteristics of an ideal antitranspirant, i.e., an agent which reduces transpiration without seriously decreasing photosynthesis or harming the plant or the environment.

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Antitranspirants in the current experiments were mixed with distilled water and a 0.5 percent concentration of the wetting agent, Triton X-100. This mixture was sprayed on foliage until drops formed and began to run off. The compounds studied were: (1) 8-HQS at a concentration of 0.01M, (2) the monomethyl ester of n-decenylsuccinic acid (MDSA) at a concentration of 350 ppm, and (3) a mixture of MDSA and the monoglyceryl ester of n-decenylsuccinic acid (GDSA) at 150 ppm each (MDSA-GDSA).

Plants used in each greenhouse and field experiment were grown in 6- or 10-inch diameter plastic pots in a sandy alluvial soil. Transpiration was measured by weighing each potted plant in the morning and evening. Soil-water content was maintained close to field capacity in all experiments. The soil surface of each pot was sealed with plastic sheeting during daylight hours to prevent evaporation.

Each experiment was conducted at a different time, with different plants, and under different climatic conditions. Therefore, only general comments and comparisons relative to the greenhouse and field experiments are appropriate.

In greenhouse experiments, the reduction in transpiration varied from 23 to 44 percent for 7 to 20 days; in field studies, the reduction varied from 18 to 32 percent for 2 to 8 days (Table 1). The experimental design did not permit comparisons between treatment responses for the different chemicals.

The tested antitranspirants appeared to be more effective in the greenhouse than in the field. This difference may have been due to varying micro-climatic conditions between greenhouse and field environments, or to different physiological responses between greenhouse and field plants.

Although the results of these experiments cannot necessarily be directly extrapolated to the environment of a natural thicket, the findings demonstrate that saltcedar transpiration can be reduced without seriously harming the plant. No serious physiolcgical response of treated saltcedar plants was revealed in several laboratory studies. However, the possibility of deleterious or hazardous effects of antitranspirants in natural environments has not been evaluated and, therefore, should not be overlooked. Furthermore, reports indicate that 8-HQS at 10^{-4}M concentration may be potentially harmful to plant and animal organisms. Eight-HQS apparently initiated chromatid-breaks in bean roots (Gebhart, 1968a), and possibly caused gaps in chromosomes of human lymphocytes (Gebhart, 1968b). No such reports were encountered for the alkenylsuccinic acids.

FEASIBILITY OF ANTITRANSPIRANT TREATMENTS

Antitranspirants must be economically feasible to be suitable as an alternative to saltcedar eradication, in addition to being effective in reducing transpiration without causing harm. However, since antitranspirants have not been tested on a natural saltcedar thicket on an operational scale, the volumes and cost of reallocated water cannot be accurately evaluated at this time. Also, the economic or aesthetic value of an intact versus an eradicated thicket is not well defined. Nevertheless, estimates of the volume and cost of reallocated water, as provided below, may be helpful in determining the potential usefulness of antitranspirants.

If it is assumed that a saltcedar thicket consumes a given amount of water as evapotranspiration (ET), and that evaporation within the thicket is a small component of ET, then the amount of reallocated water can be estimated knowing the magnitude and duration of transpiration reduction following treatment (Figure 1). For purposes of illustration, we assumed an average ET rate for an untreated thicket of 0.15 inches per day, which may be conservative. Dense, actively growing saltcedar thickets have been observed to transpire several times this amount (van Hylckama, 1970). The curves in Figure 1 are based on assumed values that encompass the experimental results (Table 1).

An operational antitranspirant program may require repeated treatments to achieve a sufficient volume of reallocated water. For example, consider a 2,000 acre saltcedar thicket with an ET rate of 0.15 inches per day. If ET were reduced by 25 percent for 14 days following

Table 1. Transpiration reduction following single applications of 8-HQS, MDSA and MDSA-GDSA, measured as percent reduction from control. Results significant at $\alpha = 0.10$.

Experiment	8-HQS		MDSA		MDSA-GDSA	
	Reduction (%)	Duration (days)	Reduction (%)	Duration (days)	Reduction (%)	Duration (days)
Greenhouse[1]	36	20	29	20	28	20
Greenhouse[2]	23	7	44	13	-	-
Greenhouse[2]	36	7	40	7	-	-
Field[1]	32	5	-	-	23	5
Field[2]	19	2	28	2	-	-
Field[2]	-	-	18	8	-	-

[1]Brooks and Thorud, 1971.

[2]Cunningham, R. S. 1972. Evaluation of transpiration suppressants as an alternative to the eradication of saltcedar thickets. M.S. thesis, University of Arizona. 56 p.

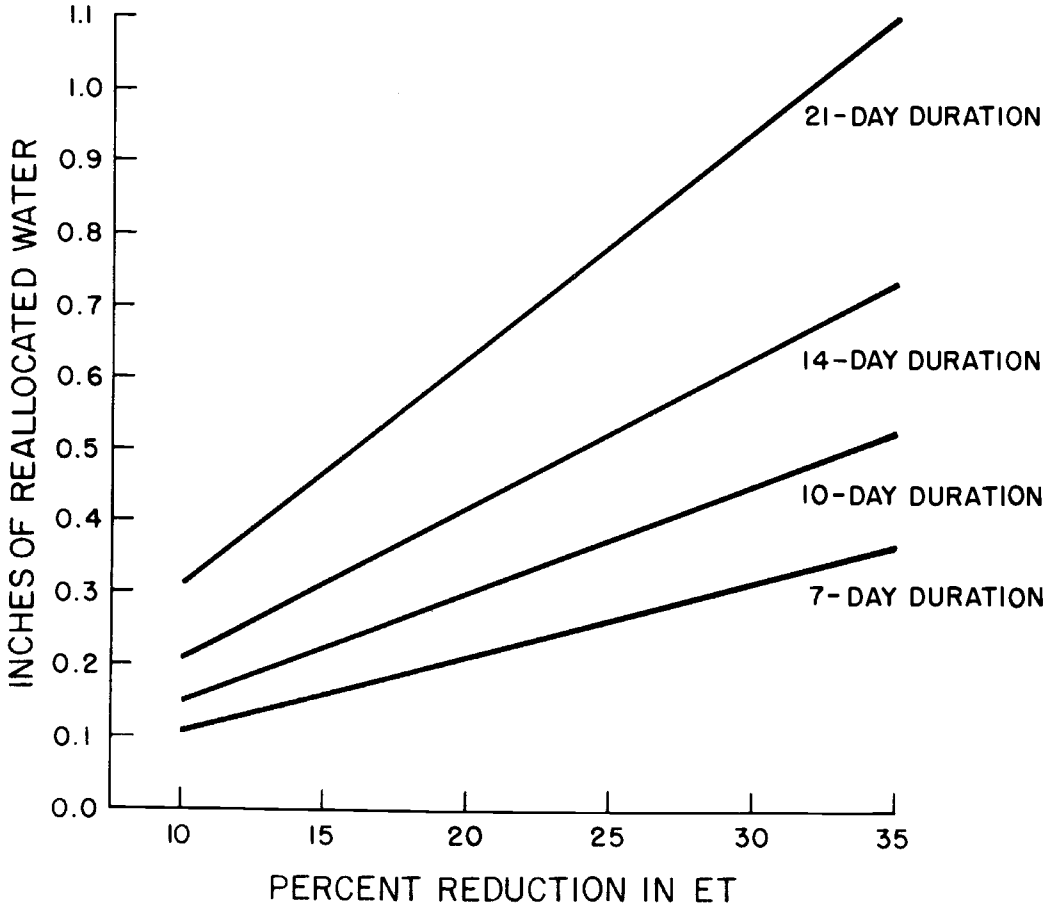

Figure 1. Estimated amounts of reallocated water assuming an average evapotranspiration rate of 0.15 inches per day for a salt-cedar thicket.

a single treatment, an estimated 88 acre-feet of water may be reallocated. Over a 6-month growing season, an estimated 1,100 acre-feet of water would be reallocated, assuming 13 similar treatments. However, the effect of repeated applications of antitranspirants on the plants and environment has not yet been investigated and should be evaluated before attempting such a plan.

An estimated cost per unit volume of reallocated water can be derived from assumed costs for an aerial treatment program. Aerial applications of antitranspirants may be more economical than ground-operated techniques, especially where saltcedar thickets are extensive and dense (Figure 2). Rental of fixed-wing aircraft, at 1975 prices[1], would cost about $2.60 per acre at an application rate of nine gallons of mixture per acre. Chemical costs of MDSA at 350 ppm and Triton X-100 at 0.5 percent are $0.06 and $0.28 per acre, respectively, at 1975 prices. Consequently, total treatment cost for one MDSA treatment is estimated to be $2.94 per acre, based on 1975 flying rates and chemical prices, and ignoring any other costs associated with a treatment program. Using these data, the cost per acre-foot of reallocated water was calculated for several assumed magnitudes and durations of transpiration reduction following a single treatment of a hypothetical saltcedar thicket (Figure 3). It was assumed that nine gallons of antitranspirant mixture per acre would adequately cover the foliage[1], and that a natural quality water would not lessen the antitranspirant effectiveness of MDSA. Only distilled water was used in our experiments.

The most effective treatment considered suggested that a 35 percent reduction in transpiration for 21 days would result in 1.1 area inches of reallocated water (Figure 1) at a cost of about $33 per acre-foot (Figure 3). A 20 percent reduction in transpiration for 21 days would result in about 0.6 area inches of reallocated water at an estimated cost of $55 per acre-foot. For these two examples, that is, 35 and 20 percent reductions for 21 days, about 11 and 19 acres of saltcedar thicket, respectively, would have to be treated to produce one acre-foot of reallocated water.

These preliminary cost estimates, if valid for natural environments, seem to eliminate antitranspirant treatments as a feasible means for obtaining supplementary water from saltcedar thickets for use on relatively low-value agricultural crops at this time. However, such costs, if supported and verified by further studies, may be acceptable if the reallocated water were utilized for municipal and industrial purposes, or for the production of relatively high value crops.

CONCLUSIONS AND SUMMARY

Laboratory, greenhouse and small-scale field experiments provided some insight on the potential usefulness of antitranspirant treatments for reducing transpiration by saltcedar. Results indicate that:

(1) Eight-HQS, MDSA and an MDSA-GDSA combination reduced transpiration rates of saltcedar by 23 to 44 percent for 7 to 20 days in the greenhouse, and by 18 to 32 percent for 2 to 8 days in the field, without causing apparent serious damage to the plants.

(2) Eight-HQS should not be considered for operational application in the field at this time because of possible health hazards. This conclusion is based upon reports which identified an apparent relationship between 8-HQS and the occurrence of cellular damage in plant and human tissue.

(3) One of the most effective MDSA treatments considered for a hypothetical saltcedar thicket would result in reallocated water costing approximately $55 per acre-foot. About 19 acres of saltcedar thicket would have to be treated to provide one acre-foot of reallocated water in this case. Such a cost level would possibly be un-

[1]Personal communication with the Marsh Aviation Company, Marana, Arizona, March, 1975.

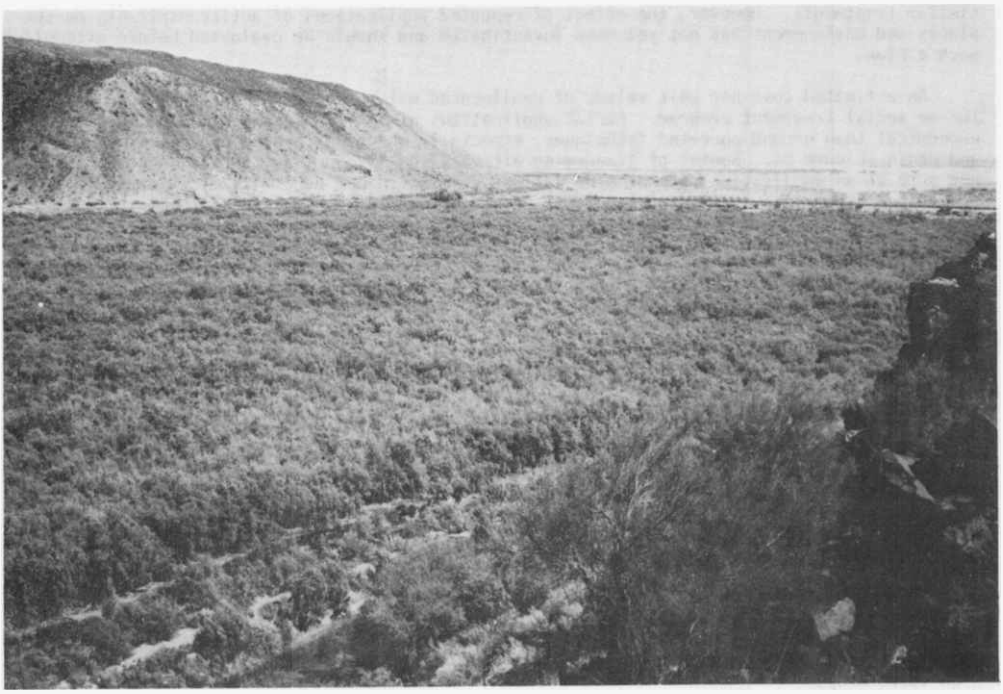

Figure 2. A dense and extensive saltcedar thicket on the Gila River in southern Arizona.

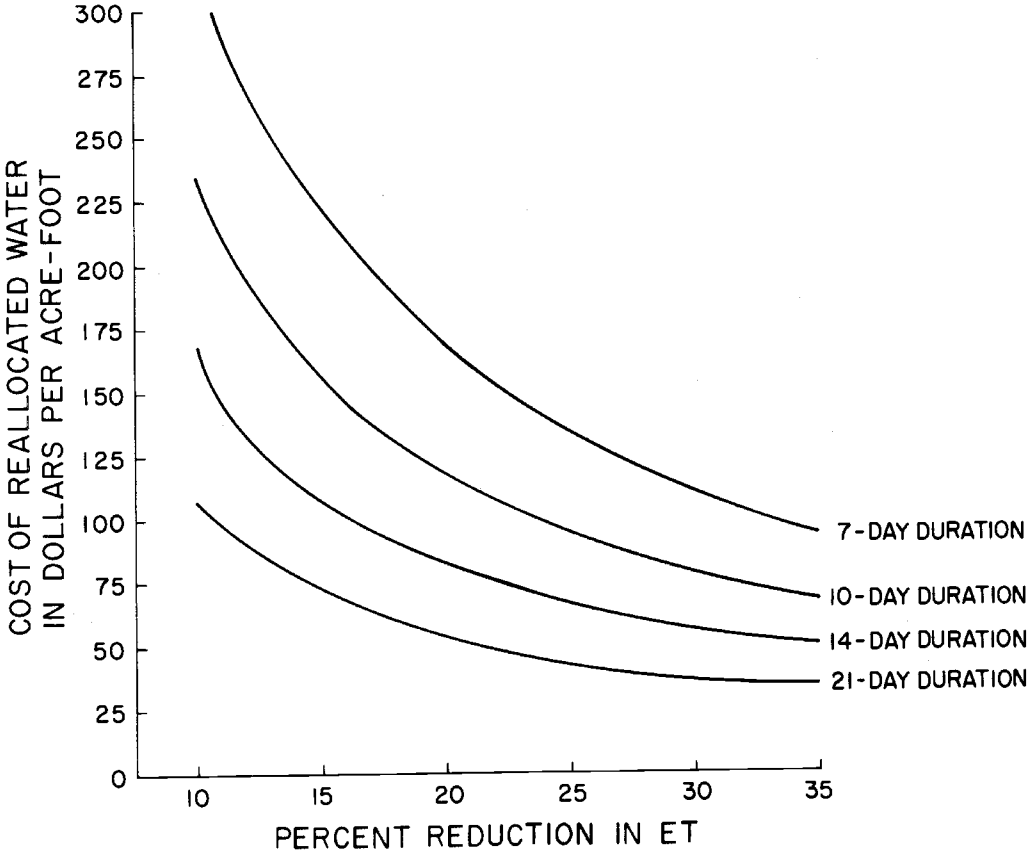

Figure 3. Estimated cost of reallocated water from a saltcedar thicket following a single treatment with MDSA. An average pretreatment evapotranspiration rate of 0.15 inches was assumed for the thicket.

economic for many agricultural applications, but may ultimately be acceptable for municipal, industrial and some agricultural applications, where a higher price can be paid for water.

(4) Field investigations of treatment effects on natural saltcedar thickets and the environment are needed to further develop the concepts and verify the kinds of assumptions discussed in this paper. Results from such studies may eventually allow the development of a management alternative for saltcedar thickets that will be mutually acceptable to water, recreation, wildlife and other interests.

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