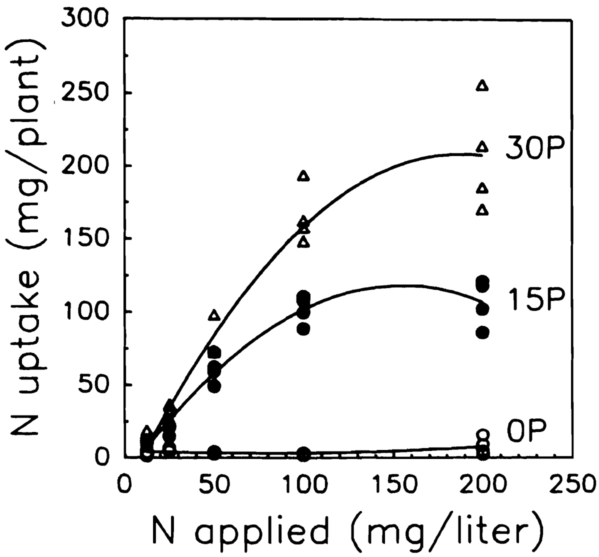

Fig. 3. **N uptake by blackfoot daisy at 3 P fertilizer rates.**

southwestern United States. It must be produced by nurserymen before it can be made available in quantities sufficient to meet consumer demands. These research findings furnish nitrogen and phosphorus fertilizer guidelines for container production of this resource-efficient native landscape plant.

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Damage Caused by Wind-Borne Salts to Landscape Plants and its Prevention by a Wind-Controlled Sprinkler System[1]

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Abstract

Ocean spray carried by wind was shown to be the main cause of leaf scorching of vegetation along the Mediterranean coast of Israel. An overhead sprinkling system was designed to be activated when wind velocity reached a critical level. It was shown to reduce leaf scorching. The degree of protection depended on plant species. Plants showed different degrees of sensitivity to wind-borne salts in the following increasing order: Japanese Pittosporum (*Pittosporum tubira* Ait.), Thorny Elaeagnus (*Elaeagnus pungens* Thunb.), Common Oleander (*Nerium oleander* L.), Tamarisk, Athel (*Tamarix aphylla* Karst.).

Index words: sea, ocean, irrigation, salt tolerance, salt toxicity, salt spray

Species used in this study: Japanese pittosporum (*Pittosporum tubira* Ait.), thorny elaeagnus (*Elaeagnus pungens* Thunb.), common oleander (*Nerium oleander* L.), tamarisk, athel (*Tamarix aphylla* Karst.).

Introduction

The main reason for the destruction of landscape plants in parks located on the Tel Aviv coast is the damage caused by wind-borne salts (1). Foliar injury by air-borne sea salt was described and studied previously (3, 4). As indicated by Boyce (2), a critical level of wind velocity of 7.0 m/sec (23 ft/sec) is required in order to create wind-borne salt. In a preliminary study (1) we demonstrated that this damage can be prevented by a wind-controlled overhead sprinkler system which washes the air-borne salt from the leaves during dry storms.

[1]Received for publication November 14, 1988; in revised form March 2, 1989. Contribution from the Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel. Financial support was provided by the Atarim Co. and by the City Council of Tel Aviv.

The purpose of the present work was to study the relative sensitivity of four commonly grown landscape plants to wind-borne salts, and to evaluate the effectiveness of wind-controlled overhead sprinkling in preventing leaf scorching in these species at various distances from the sprinkling system.

Materials and Methods

Experimental plots were set up in the "Atzmaut" and "Clore" parks located along the Tel Aviv coast. The plots in Atzmaut Park were located on a sandstone cliff overlooking the sea at a height of 20 m (66 ft) above sea level starting 30 m (100 ft) from the shore. In Clore Park, plots were located on flat sandy land, 3 m (10 ft) above sea level starting 30 m (100 ft) from the shore. In each park two plots were planted, each with five parallel rows of plants, 5 m (16 ft) apart between the first four rows (west to east) and 10 m (33 ft) between the fourth and the fifth rows. Four species of landscape plants were planted in a row, 50 cm (20 in) between plants. Each row was divided into 3 blocks and each block contained 2 randomized replicates of each species. The species used were: Japanese Pittosporum (*Pittosporum tubira* Ait.), Thorny Elaeagnus (*Elaeagnus pungens* Thunb.), Common Oleander (*Nerium oleander* L.) and Tamarisk, Athel (*Tamarix aphylla* Karst.).

In each park one plot was used as the control and in a second plot an overhead sprinkler system was installed, which was operated when wind velocity reached 7 m/sec (23 ft/sec). One meter (3.3 ft) in front of the sprinkled plots and continuing for 11 m (36 ft) inland along both, north and south edges of the plot, sprinklers (120 l/h or 31.7 gal/hr) were posted 1.5 m (4.9 ft) apart and at a height of 2 m (6.6 ft).

Plants 30 cm (1 ft) tall, which had been grown in 3 L containers, were planted in the experimental plots on September 20, 1980, and watered twice a week via a drip irrigation system. The wind-controlled overhead sprinkler system was operated automatically from the date of planting, whenever wind velocity reached the critical level.

Wind direction and velocity, and the operation of the wind-controlled sprinkler system, were recorded continuously and separately for each park. The amount of salt and dust falling at various spots was determined by cheesecloth, salt- and dust-absorbing devices placed in every row (2, 5), in two replications in each block. Once a week, a 10 cm^2 (3.9 in^2) piece of the cheesecloth was cut off, rinsed in 40 ml distilled water, filtered through Whatman no. 3 filter paper. The conductivity of the filtrate was measured and recorded. The amount of dust was determined by recording the dry weight of the pellet remaining on filter paper.

Plants were evaluated visually on a scale of 1 to 5, where 1 = insignificant scorching, 3 = 50% of leaf area scorched, and 5 = dead plant. Plant evaluations were recorded weekly and before and after each storm.

Results and Discussion

Most severe dry storms occurred just before rain started. During winter 1980/81 eight storms were observed. Detailed data on the winds on stormy and non-stormy days in each of the parks (Fig. 1) showed that in the exposed Clore Park, damaging winds (velocity > 7 m/sec or 23 ft/sec) were common even on non-stormy days. Such winds were blowing in Clore for almost 10 hr during the non-stormy day of November 2. In Atzmaut, damaging winds were blowing for less than 2 hr on that day. On a stormy day (November 22), damaging winds were blowing continously in both parks throughout the course of the storm; its velocity, however, was greater in Clore. In most storms winds were coming from the west.

The amount of salt collected was greater in Clore than in Atzmaut (Fig. 2), and greater when collected after the storm of November 22 than after the non-stormy week ending November 8. In Clore more salt was collected in the control plots than in the sprinkled plots. Here, where winds blew strongly the sprinkling system was effective in washing the salt off for a distance of at least 16 m (52.5 ft—row 4) in Clore. In Atzmaut, where winds were weaker, the effectiveness of the sprinkler system diminished at distances greater

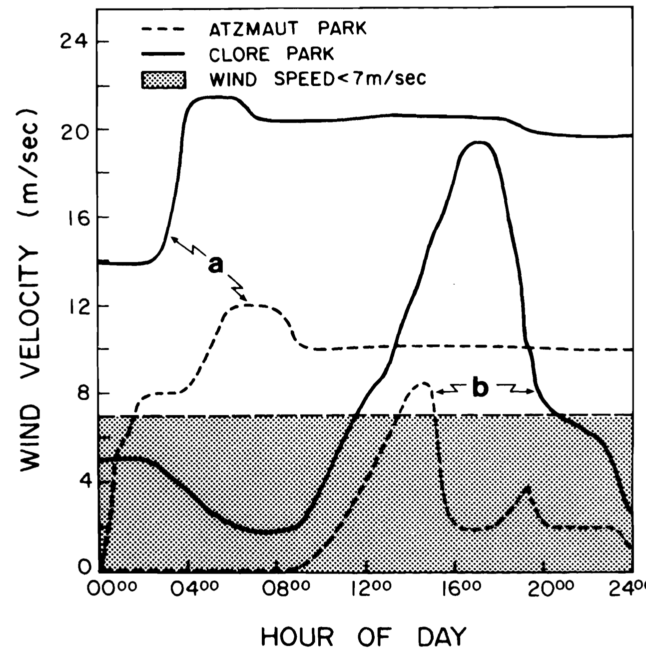

Fig. 1. Wind velocity patterns during typical stormy (a. Nov. 22, 1980) and non-stormy (b. Nov. 2, 1980) days in Atzmaut and Clore parks.

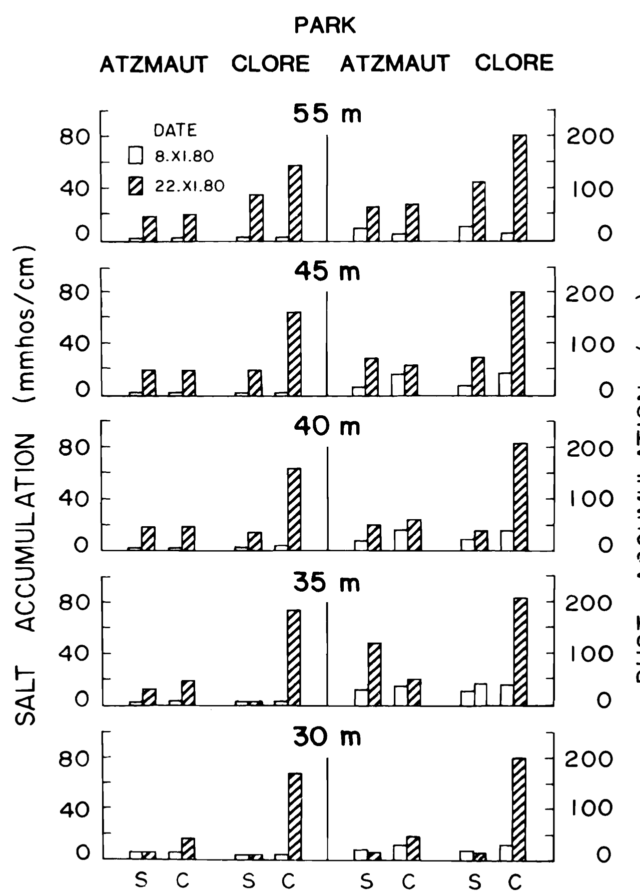

Fig. 2. Salt and dust accumulation before (Nov. 8, 1980) and just at the end of a dry storm (Nov. 22, 1980), in sprinkled (S) and control (C) plots at Atzmaut and Clore parks. Measurements are means of two collectors in each experimental block.

than 11 m (36 ft—row 3) from the sprinklers. The relative amount of dust accumulated was proportional to the amount of salt collected. It has been demonstrated that damage due to leaf scorching was closely associated with the amount of salt and dust reaching the plant. The amount of salt and dust present was related to wind velocity and duration. Winds were stronger and for longer duration in Clore Park than in Atzmaut Park. Salt and dust accumulation, and thus plant damage, were accordingly greater in Clore Park.

The damage caused to plants (Fig. 3) was closely associated with the amounts of salt and dust collected. Plants were damaged earlier and more severely in Clore than in Atzmaut. Plants showed different degrees of sensitivity to wind-borne salts, in the following increasing order: Japanese Pittosporum (*Pittosporum tubira* Ait.), Thorny Elaeagnus (*Elaeagnus pungens* Thunb.), Common Oleander (*Nerium oleander* L.), Tamarisk, Athel (*Tamarix aphylla* Karst.). In Clore, even before severe storms started, *Nerium* plants were damaged. The sprinkler system reduced damage by wind-borne salt, its effect being greater in the less sensitive plants *Elaeagnus* and *Pittosporum*.

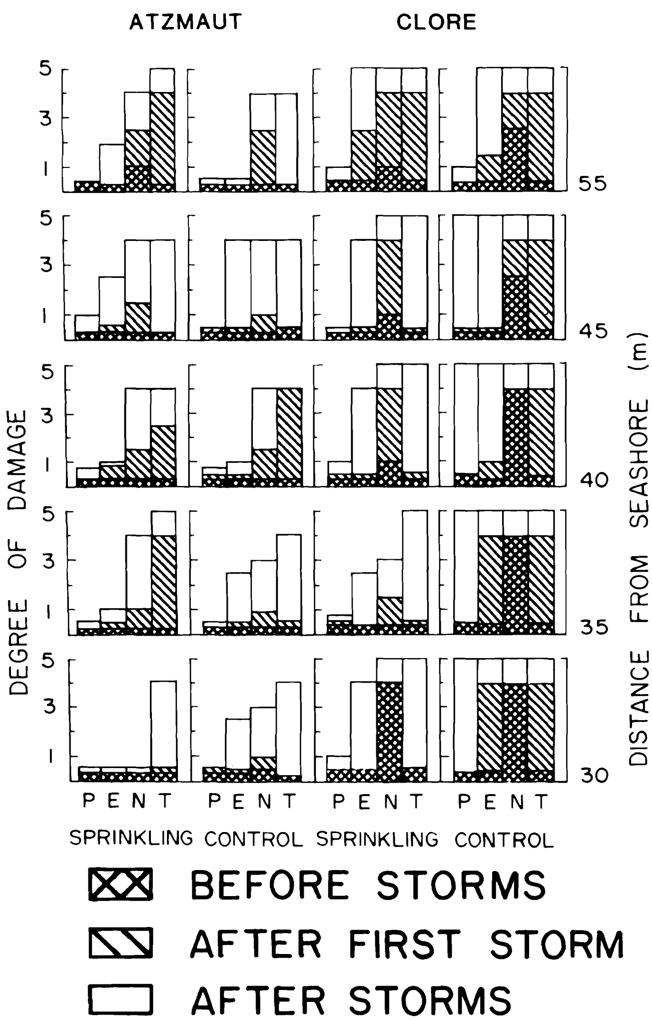

Fig. 3. Leaf scorching evaluated on a scale of 1 to 5 (1 = insignificant scorching, 3 = 50% of leaf area is scorched, 5 = dead plant) of *Pittosporum* (P), *Elaeagnus* (E), *Nerium* (N), *Tamarix* (T), plants at different distances from an overhead sprinkling system, and control plants in two parks along the Tel Aviv seashore. Plants were evaluated at three dates: before storms (hatched areas), after the first storm of the season (striped areas), and after the main storm season (blank areas).

In line with the different sensitivity of various species to wind-borne salt and dust, it was found that *Tamarix*, the most sensitive, was not helped by overhead sprinkling. With *N. oleander*, the second most sensitive, proper application of overhead sprinkling reduced damage. The most resistant species to wind-borne salt, *P. tubira*, did not suffer at all from the wind in Atzmaut and in Clore Park. With the help of the overhead sprinkler system, *P. tubira* could be grown without leaf scorching.

The sprinkler system may protect plants by (1) a water curtain, screening-out the salt from the wind and/or (2) by washing the salt from the leaves with water. This experiment was carried out under field conditions and thus distinction between the two possible means of protection was not possible. This experiment showed however that with proper selection of plant material, and with the help of a wind-controlled overhead sprinkler system, it is possible to grow landscape plants even in areas which suffer severely from wind-borne salts.

Significance to the Nursery Industry

Our work suggests the possible use of a wind-speed controlled overhead sprinkling system and resistant plants as a means to overcome wind-borne salt damage existing along seashore parks. Since there is great demand for recreation in windy seashore locations, the present work offers a practical solution for landscaping such places.

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