Evaluating Tree Protection Devices: Effects on Growth and Survival-First-Year Results[1]

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INTRODUCTION

The protection of seedlings from animal browsing is critical for the survival and growth of many tree species. This is particularly true in wildland areas and arid areas (McAuliffe, 1986), and oftentimes in urban areas. A variety of techniques and devices have been used to protect seedlings, from using straw stubble to milk cartons to plastic or metal screens. Recently, Tuley (1985) reported the successful use of "tree shelters" to protect oak seedlings in England. Tuley's tree shelters are essentially translucent plastic tubes (up to 6 feet in height and approximately 3 inches in diameter) which are placed over young seedlings. Tree shelters were found to significantly accelerate seedling height growth as well as protect them from animal injury. More recent reports (Frearson, 1987; Potter, 1989; and Bainbridge,1990)have found similar results for other species. Although other protection devices improve survival of young trees, their effects on growth (positive or negative) are not notable or not documented.

This paper reports on the effects of three protection devices on the survival and growth of four tree species. Tree shelters, plastic mesh screens, and wire screens were selected. Since many reforestation and revegetation sites in California occur in areas with little or no summer rainfall, and which frequently are not irrigated, tree survival and growth were evaluated under both irrigated and nonirrigated conditions. The study was designed to address the following questions:

1) are there notable (positive or negative) effects from these tree protection devices on survival and growth?

2) when soil moisture is limiting, are effects equivalent to the irrigated condition?

3) are effects consistent for all test species, or do species -specific effects occur?

4) do any of the devices increase or diminish seedling injury by insects or diseases?

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METHODS AND MATERIALS

Experiments were conducted at the University of California Hopland Field Station, Hopland, California (elevation 800 feet). A half-acre plot of pasture land (Sequel loam) was fenced to exclude livestock and deer. All pasture vegetation was controlled with glyphosate prior to planting. The two study plots, irrigated and nonirrigated, were separated by a 20 foot unplanted buffer strip. Using a randomized complete block design, six blocks were established in the irrigated plot and 10 in the nonirrigated plot. Seedlings of blue oak (*Quercus douglasii*), valley oak (*Q. lobata*), interior live oak (*Q. wislizenii*) and Douglas-fir (*Pseudotsuga menziesii*) were planted into auger-dug holes (5 foot centers) on March 15 and 16, 1990. Blue and valley oak-seedlings were 6 months old and growing in leach tubes (germinated Fall, 1989) while interior live oaks were 1-year-old seedlings germinated in Fall, 1988. Douglas fir were 1-year-old bare-root seedlings provided by the California Dept. of Forestry. All seedlings were irrigated and fertilized (Osmocote 14-14-14) after planting. All plants were checked for viability after 2 and 5 weeks, and dead plants were replaced. Once initial establishment was complete, treatments were installed as follows:

1) Ventilated Tree Shelters (VTS) - Tubex(R) tree shelters (2 ft. high) with six 1-inch diameter ventilation holes drilled into sidewalls at 6, 12, and 18 inch levels;

2) Nonventilated Tree Shelters (NVTS) - Tubex(R) tree shelters without ventilation holes;

3) Hopland Tents (HT) - molded plastic mesh screens (1/16 inch diameter openings) which are sealed at one end (18 inches high by 8 inches wide);

4) Wire Screens (WS) - window screening cut and fastened to form a cylinder around a seedling with the top sealed (18 inches high by 9 inches wide);

5) Controls (C) - no protection device.

All devices were secured in place with appropriate stakes. Treatments in the irrigated plot began 4/24/90 while those in the nonirrigated plot began two weeks later.

A drip irrigation system was installed to supply water in the irrigated plot. Single emitters were placed at the base of each plant, delivering water at the rate of 1 gallon per hour. Irrigation began in mid May and continued weekly through October (2 gals/plant/week). Nonirrigated plants were hand-watered three times after planting, with the last irrigation occurring in early June.

Plant height (cm) and stem diameter (mm) measurements were taken 4/24/90 and 9/12/90. Diameter measurements were taken 2 inches above ground. Height measurements were made from ground level to the apical bud or meristem of the dominant stem. In cases where codominant stems occurred, competing stems were lightly headed to promote the development of a single stem.

Weed control was maintained by mowing and hand-pulling. Planting basins were kept weed-free.

Soil moisture potentials were measured periodically in the irrigated and nonirrigated plots, and air temperatures inside and outside all tree protection devices were measured on 7/31/90 and 8/1/90.

RESULTS

Survival

Survival of all species was generally good in the irrigated plot (Fig. 1). All valley and live oak seedlings survived, as did 96 percent of the blue oaks. At 83 percent, Douglas-fir survival was lowest. Survival did not appear to be related to treatments.

In the nonirrigated plot, survival was lower (Fig.2). Across treatments, valley and blue oak survival was highest (84 and 82 percent, respectively), while live oak survival was 63 percent. Only two of 50 Douglas-fir seedlings survived. It appears that some irrigation in the summer months is critical for Douglas-fir survival. Among treatments, survival was least in unprotected control plants (45 percent), while protected plants ranged from 53 to 68 percent survival. Excluding Douglas-fir, oak survival ranged from 70 to 90 percent with protection, and 58 percent without protection.

Growth

a. Irrigated Plot

After 5 months, growth response was somewhat variable for both treatments and species (Figs. 3 to 10). In most cases there was a substantial range in height and diameter growth among replicates. Some trees grew a lot while others grew very little. Height growth of controls for all species was less than that of protected plants, while diameter growth was less in most cases. Douglas-fir showed the least increase in height for all species, while valley oak was largest in height and diameter increase.

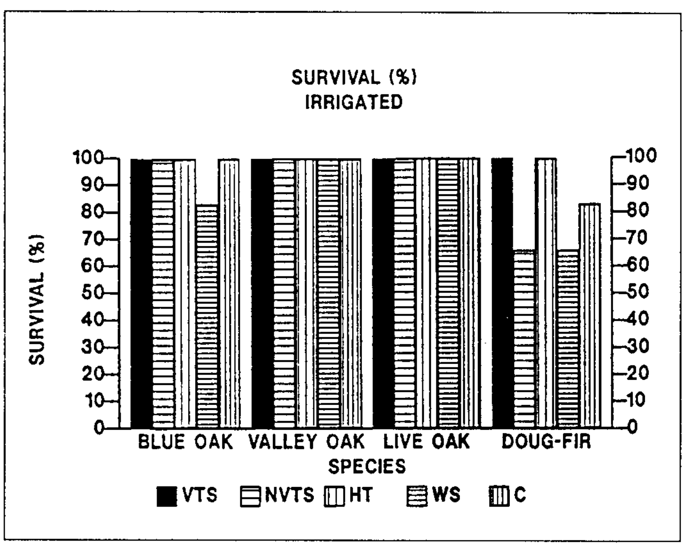
In comparing treatments, a variable diameter response occurred: largest diameter increase was found for a different treatment in each of the species. Across the species, plants in wire screens (WS) were found to have largest diameter increase, while those in non-ventilated tree shelters (NVTS) were least.

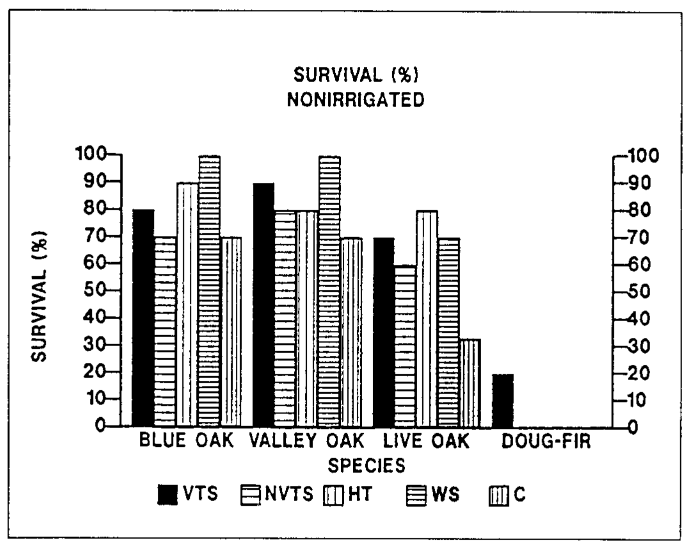
Height increase was largest in tree shelters (both NVTS and VTS) for most species. Greatest growth was found in NVTS in valley and live oak, while least occurred in Hopland tents for blue oaks. Again, all controls were less than treatments.

b. Nonirrigated Plots

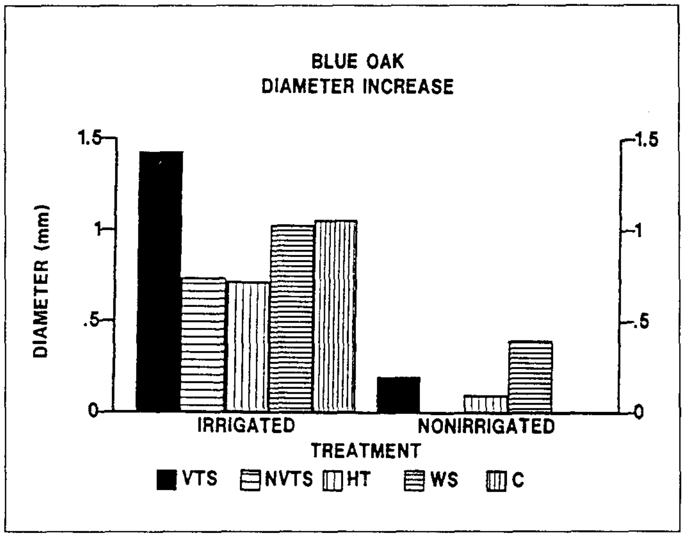
Since only two of 50 Douglas-fir seedlings survived in the nonirrigated plot, analysis of results is confined to oak species. Little growth occurred in the nonirrigated plot. Mean diameter and height differences were approximately 20 and 15 percent, respectively, of the growth found in irrigated plots. Interior live oak generated the most growth with an average 5.2 cm height increase and 0.5 mm diameter increase, while blue oak was slowest, growing only 0.5 cm in height and 0.14 mm in diameter.

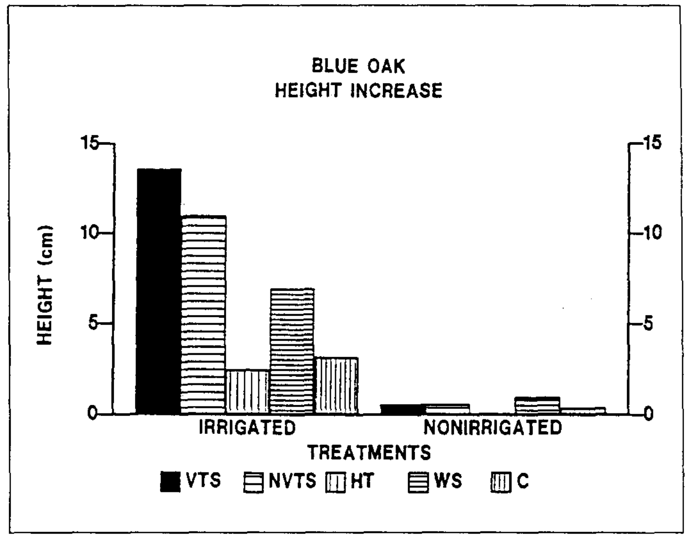
Treatment effects found that wire screens (WS) generated greatest height increases for all species. Least growth was found in ventilated tree shelters (VTS), i.e., aside from control plants which grew less than all treatments.



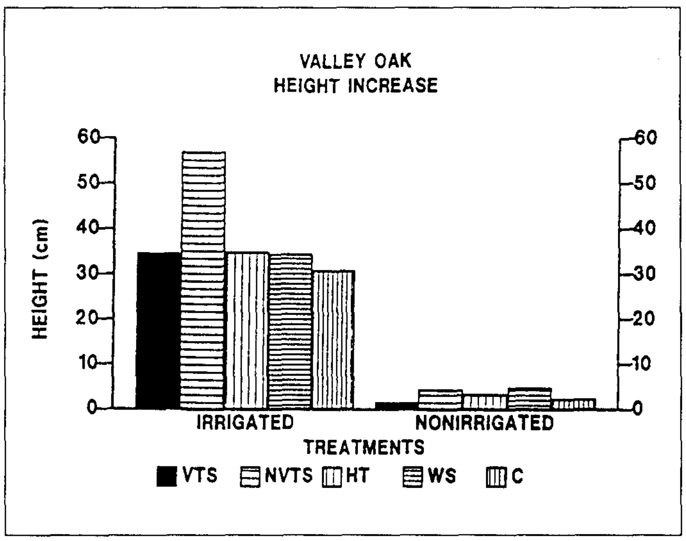


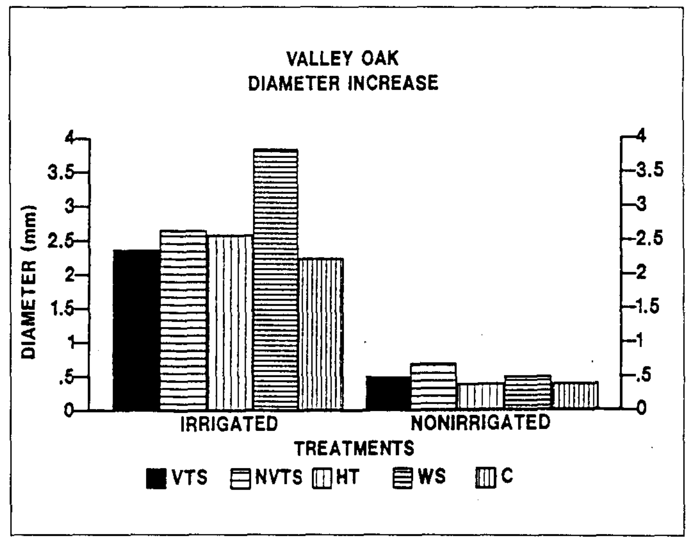
Figures 1 and 2—Percent survival of test species in irrigated and nonirrigated plots. See "Methods" for description of treatments.



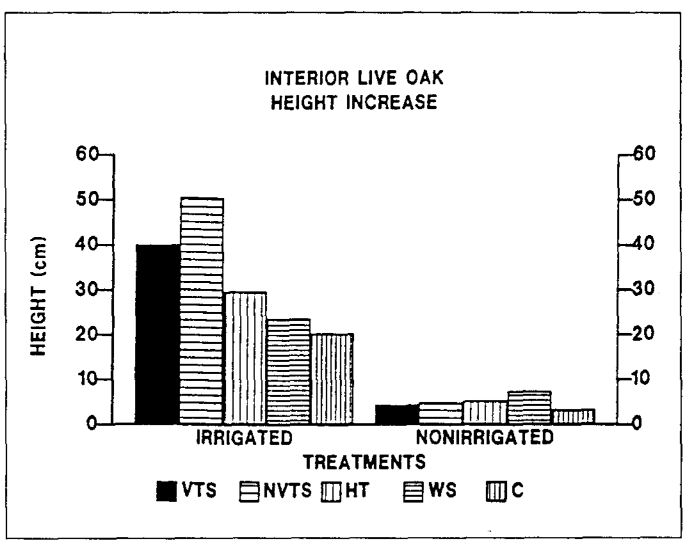


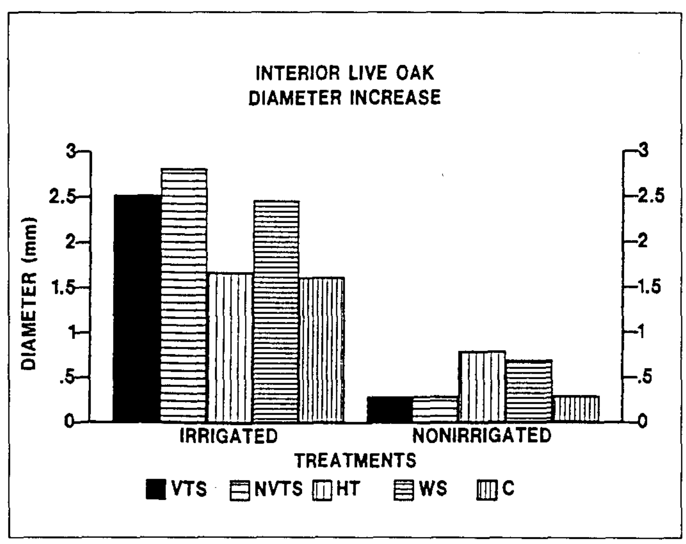
Figures 3 and 4—Height and diameter growth increase of blue oak seedlings *(Q. douglasii)* in irrigated and nonirrigated plots. See "Methods" for description of treatments.



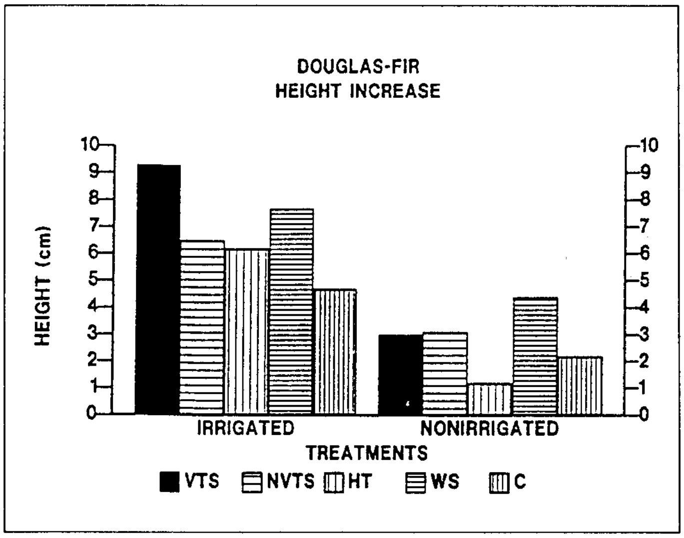


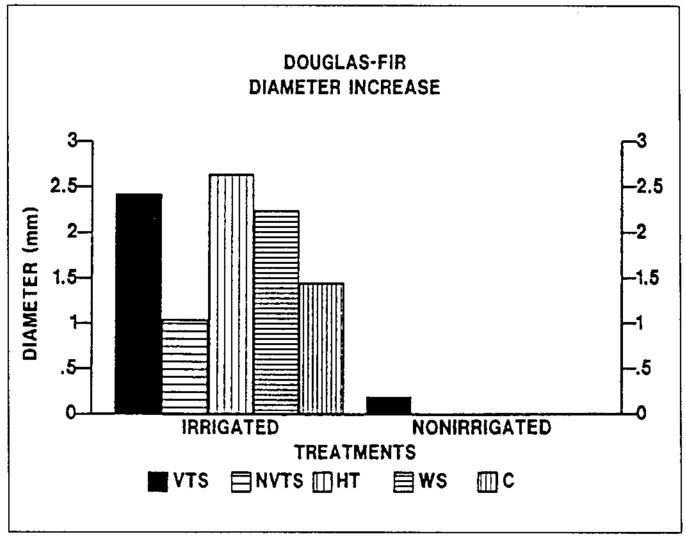
Figures 5 and 6—Height and diameter increase of valley oak seedlings *(Q. lobata)* in irrigated and nonirrigated plots. See "Methods" for description of treatments.





Figures 7 and 8—Height and diameter increases of interior live oak *(Q. wislizenii)* in irrigated and nonirrigated plots. See "Methods" for description of treatments.





Figures 9 and 10—Height and diameter increases of Douglas fir seedlings *(P. menziesii)* in irrigated and nonirrigated plots. See "Methods" for description of treatments.

Temperatures and Soil Moisture

Temperatures inside Hopland tents and wire screens were approximately 4°F higher than the outside temperature (95°F) in both irrigated and nonirrigated plots. Temperatures inside treeshelters (both VTS and NVTS) were approximately 4°F higher and 7°F higher than outside temperature (97°F) in irrigated and nonirrigated plots, respectively.

Soil matric potentials were found to reach a maximum 25 cb at 10 inches in the irrigated plot, and were greater than 100 cb at 10 inches in the nonirrigated plot.

Insects and Diseases

Although grasshoppers were found in several of the protection devices, regardless of type, no significant insect or disease injury was found on any of the plants, protected or unprotected.

DISCUSSION

In nonirrigated areas, survival of all three oak species appears to be enhanced by the protection devices used. Survival of Douglas-fir was very poor without summer irrigation, regardless of whether they are protected or not. This suggests that protection devices can serve two roles:

1) physical protection from animal browse, and

2) modification of the plant environment to reduce factors contributing to plant dehydration. This second role may be particularly important in harsh environments (windy, hot, dry) where both "physiological" and physical protection may be needed.

Results of treatment effects on growth must be considered preliminary at this time. The first five months after planting is often considered an "establishment" period, where root growth is likely a "higher priority" during this phase than top growth. It is interesting to note, however, that protection devices generally did enhance top growth during this time. Of particular interest is the indication that tree shelters accelerate height growth in the oaks studied. This effect would be of significant value in reducing the time required for oaks to develop shoots above the deer browse line. Once established to this point, little or no protection may be needed. This would certainly accelerate many reforestation or revegetation timetables.

In nonirrigated areas, some protection appears helpful in promoting growth. The implication being that these devices allow plants to maintain a more satisfactory internal water balance than unprotected plants. Perhaps water deficits are not as frequent and/or severe when plants are protected. Considering the response of Douglas fir to irrigation, however, this is likely a species specific response, i.e., water deficits which merely slow the growth of one species may be fatal to another.

Treatment effects on growth may be more pronounced in subsequent years. Tuley (1985) found a dramatic increase in height growth of *Quercus petraea* protected by tree shelters in the second and subsequent years. In this study, height and diameter growth will be monitored for another two years.

FURTHER RESEARCH

Naturally occurring seedlings should also benefit from protection. Certainly, physical protection from animal injury would be of value, while growth enhancement would accelerate the establishment period for many species. Studies are, therefore, planned to evaluate the usefulness of these devices on naturally-seeded tree species.

ACKNOWLEDGMENTS

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