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SHADE BUT NOT TOP PRUNING IMPROVES SURVIVAL OF PLANTED 1-0 MONTSEY PINE

Ronald S. Adams, Samuel T. Goosard, and John R. Hitchcock¹

ABSTRACT

Tree planters in California have had variable results planting Monterey pine. Some have had poor survival, others excellent results. Two possible factors contributing to this variability are: (1) the characteristically high ratio of top-to-root weights as compared to some other species of pines (Fig. 1) and (2) seedlings rarely become winter dormant—that is they do not shed lateral buds after planting. Because of these factors, the amount of moisture transpired from the needles may be greater than roots can replenish from the soil. The tops of tender seedlings often wilt and bend over. Occasionally these wilted seedlings die; at other times they revive and start growing. Two possibilities for reducing transpiration, are to shade seedlings or top prune them.

Survival of Douglas-fir and white fir plantings have been improved by supplying artificial shade (Adams, et al, 1966). Natural white fir seedlings survived better under artificial shade also (Gonsouant, 1967).

Top pruning in some cases has improved survival (Wakelley, 1954; Strackler and Jones, 1957), while in others no benefit was derived (Wakelley 1954; Krimm, 1959). Top pruning has usually been done in nursery seed beds several weeks before lifting in order to lower the top-root ratio of seedlings and still allow some recovery before lifting and outplanting (Larquist, 1966).

^{1/} Respectively, Forester, Regeneration Silviculturist on the State Forester's staff; Forester, Merlin Park Nursery; and Forester, Ben Leland Nursery. Assistance by G. J. Eden, Forester, Supervisor of Davis Headquarters Nursery in setting out plots and collecting and evaluating data is acknowledged. Appreciation is expressed for the considerable guidance in statistical analyses provided by P. J. Hills, Extension Agronomist, University of California, Davis Campus.

METHODS

Shading and top pruning treatments were tested on 1-0 Monterey pine seedlings by the Division of Forestry in 1964. To provide a wide range of conditions for the tests, three sources of nursery stock and three planting locations were used. Stock was obtained from the Davis (Yolo County), Parlin Fork (Mendocino County), and Ben Leonard (Santa Cruz County) nurseries. The three planting locations were near the three nurseries. Table 1 describes site conditions at each nursery. Seedlings from Parlin Fork and Ben Leonard nurseries were bare root stock and were similar in appearance. The Davis stock was grown in small tar paper containers and in this particular year was chlorotic and unusually small.

Table 1. Site information for 1-0 Monterey pine planting locations where effects of shading, top pruning and stock source were tested.

Study site	Elev. (ft.)	Approx. mean ann. rainfall (inches)	Approx. mean max. temp. day to Oct. (deg. F)	Soil
Davis (Central Valley)	35	16	81.9 (dry-co fog)	Yolo clay loam pH 8.0
Parlin Fork (9 mi. from coast)	270	49	70.0 (some night & morning coastal fog)	Hugo clay loam pH 5.8
Ben Leonard (5 mi. from coast)	2,600	60	72.7 (little coastal fog)	Sheridan sandy loam pH 5.8

The shades installed after planting were stakes approximately 7 inches wide inserted in the soil so that 10 inches above ground provided shade to the seedling from the south-southwest (fig. 2). The top pruning removed 1/4 to 1/3 of the seedling crown and was done after planting. The test design at each planting site was a randomized block with five replications.

All seedlings were planted between February 28 and March 4, 1964. Planting holes were prepared with the Little Beaver soil auger. Competing vegetation was removed from the plots periodically as needed; no other maintenance was provided. Survival counts were made monthly until late December 1964.



Fig. 1. One-year-old Monterey pine seedlings. Seedling on left has high top-root ratio, one on right has been top pruned to reduce the ratio.

Fig. 2. Study plots near the Ben Leonard Nursery to test 1-0 Monterey pine from three nurseries stated and top pruned after planting.



RESULTS

Survival results of the last count are shown in table 2 and figure 3. Percent survival data were transformed to arc sine and subjected to analysis of variance. Because the Davis stock was not typical of the nursery's usual production, it was not included in the analysis with the other two sources of stock. Survival results for Davis stock are shown separately in table 3.

Table 2. First year survival (percent and arc sine transformation) of 1-0 Monterey pine at three planting locations from the Parlin Fork and Ben Lomond Nurseries shaded and top pruned after planting.

Stock source	Treatment	Planting Location								LSD ^{a/} (.05)
		Davis		Parlin Fk.		Ben Lomond		Mean		
		pct	arc sine	pct	arc sine	pct	arc sine	pct	arc sine	
Parlin Fk.	Shade	55	48.1	98	84.9	90	74.1	81.0	65.0	4.0
	Top prune	50	45.0	81	64.9	69	56.6	66.7	35.5	4.0
	No treat.	32	34.2	93	80.1	60	50.8	61.7	55.0	4.0
	Mean	45.7	42.4	90.7	76.6	73.0	60.5	69.8	59.9	2.3
Ben Lomond	Shade	91	72.2	98	84.9	98	84.9	95.7	80.6	4.0
	Top prune	68	55.6	95	80.1	89	70.9	84.0	68.8	4.0
	No treat.	67	55.2	86	69.3	94	77.5	82.3	67.3	4.0
	Mean	75.3	61.0	93.7	78.1	93.0	77.8	87.3	72.3	2.3
Mean		60.5	51.7	91.8	77.4	83.3	69.1			1.6
LSD (.05) arc sine ^{a/}			4.0 2.3		4.0 2.3		4.0 2.3			1.3

^{a/} Least Significant Difference at the .05 level of confidence. The LSD figure above the slant line in the bottom row applies to differences among planting locations x stock sources x stock treatments, e.g. the difference between top pruned and untreated seedlings from Parlin Fork planted at Davis (45.0 and 34.2). The figure below the slant line is LSD for planting location x planting stock means, e.g. the difference between Parlin Fork and Ben Lomond stocks planted at Davis (42.4 and 61.0).

LSD for the Mean column (1.3) applies to the difference between Parlin Fork and Ben Lomond stocks.

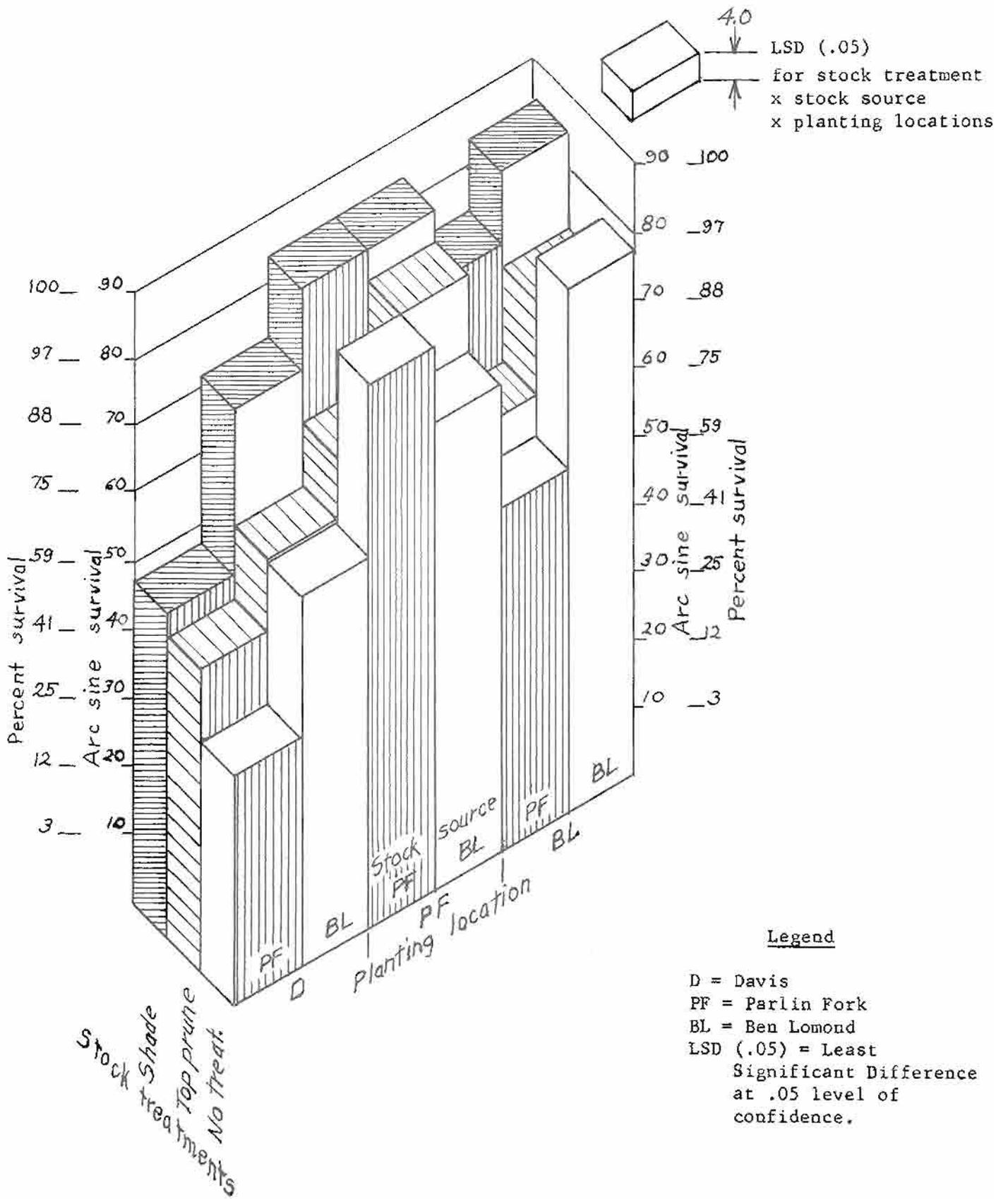


Fig. 3. Survival of 1-0 Monterey pine from 2 nurseries planted near 3 nurseries, shaded, top pruned and not treated. (Survival percents are transformed to arc sine to show Least Significant Difference.)

Table 3. First year survival of Davis 1-0 Monterey pine seedlings shaded and top pruned after planting at Davis, Parlin Fork, and Ben Lomond.

Treatment	Planting location						LSD (.05) ^{a/}	Mean	
	Davis		Parlin Fk.		Ben Lomond			pct	arc sine
	pct	arc sine	pct	arc sine	pct	arc sine			
Shade	85	67.2	84	71.0	84	69.0	12.3	84.3	59.1
Top prune	16	22.9	50	44.9	13	20.7	12.3	26.0	29.5
No treat.	24	29.3	56	48.9	14	20.7	12.3	31.3	32.9
LSD (.05) ^{a/}		12.3		12.3		12.3			7.1
Mean	41.0	39.8	63.0	54.9	37.0	36.8	7.1		

^{a/} Least Significant Difference at the .05 level of confidence expressed in arc sine transformations.

Some of the differences in the various combinations of stock treatments by stock sources by planting locations were highly significant according to the F-test, as were differences between combined means. This means that survival differences were due to treatment and not just to chance. In all instances, shading improved survival, and in most instances this increase was statistically significant. Results of the top pruning were more variable. In three instances, (1) Parlin Fork stock at Davis, (2) Parlin Fork stock at Ben Lomond, and (3) Ben Lomond stock at Parlin Fork, survival of top pruned seedlings was significantly better than no treatment. However, in two instances, (1) Parlin Fork stock at Parlin Fork, and (2) Ben Lomond stock at Ben Lomond, survival was significantly less than no treatment. Top pruning did not increase survival for any of the Davis stock. Differences between individual treatment means, because of highly significant interactions, tend to be more important than those between main factors (Little and Hills, 1963.) For example, the difference between shading and top pruning Parlin Fork stock planted at Parlin Fork (individual treatment means, table 2) carries somewhat more weight than the overall mean difference between shading and top pruning (main factors, table 4.) The influence of one factor on another (interaction) to a certain extent confounded differences between combined means.

However, the data in table 2 and 4 support strong main factor differences as follows:

1. Shaded stock survived better than top pruned and untreated stock. Top pruned and untreated stocks were nearly equal (table 4).
2. Survival of Ben Lomond stock was better than Parlin Fork stock (table 2).

3. When means of stock treatments and sources were combined, survival at the Parlin Fork planting location was better than at Ben Lomond, and Ben Lomond was better than Davis (table 4).
4. Combining the three stock treatments (table 2) Parlin Fork stock survived best at Parlin Fork, next best at Ben Lomond and worst at Davis. Ben Lomond stock survived best at Parlin Fork and Ben Lomond and worst at Davis.

Table 4. Overall means of first year survival of 1-0 Monterey pine seedlings shaded and top pruned after planting at Davis, Parlin Fork, and Ben Lomond.

Treatment	Planting location			Mean
	Davis	Parlin Fk.	Ben Lomond	
	-----percent-----			
Shaded	73.0	98.0	94.0	88.3
Top pruned	59.0	88.0	79.0	75.3
No treat.	49.5	89.5	77.0	72.0
Mean	60.5	91.8	83.3	

Although shading generally increased survival of planted Monterey pine seedlings, one might ask the question, "does it pay?" This can be answered by computing costs for each surviving shaded and unshaded tree. If it is assumed that the planting cost is 10¢ a tree and installation of shades 4¢ a tree, the costs per surviving tree of stock from the two nurseries planted in the three locations would result in costs as shown in table 5. These costs are recent contract planting costs.

Table 5. Costs per surviving tree of shaded and untreated stock, based on percent survival from table 2.

Stock source	Treatment	Planting location		
		Davis	Parlin Fk.	Ben Lomond
		-----cents-----		
Parlin Fk. Nursery	Shade	25.5	14.3	15.6
	No. treat.	31.2	10.7	16.7
Ben Lomond Nursery	Shade	15.4	14.3	14.3
	No. treat.	14.9	11.6	10.6

The greater the survival of unshaded trees the greater must be the improvement from shading to make it pay. For the costs quoted, the break even point for 67 percent survival of unshaded stock is a 27 percent improvement in survival by shading. Costs must be balanced against desired stocking goals of course.

CONCLUSIONS

1. Shade improves survival of 1-0 Monterey pine seedlings. However, if experience has shown that 65 percent or better survival can be obtained without shade, any improved survival from shading may not pay where costs are computed on a surviving tree basis. Excluding results of Davis stock, shading paid off in only two out of six planting stock-planting location combinations; these were where survival of unshaded stock was very poor. This further emphasizes the axiom that top quality stock is the most economical, other factors being equal.
2. Top pruning results of this study indicate that there may have been a slight advantage in removing part of the seedling top. There is a trend evident that bears further investigation:
 - a. Top pruning improved survival of Parlin Fork and Ben Lomond stock planted in locations other than near the originating nurseries.
 - b. Survival of stock from these two nurseries planted locally was not improved by top pruning.

Results from top pruning Davis stock can be discounted because of its poor condition at the time of planting.

3. Although there was no indication that fungi infected freshly-cut top-pruned stems, this factor should be considered (Toumey and Korstian, 1947).

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CALIFORNIA DIVISION OF FORESTRY
1416 Ninth Street
Sacramento, California 95814