Improving the Establishment and Growth of Douglas-fir and White Fir On Dry Sites Through Fertilization and Stock Type

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Objectives: (1) To determine the partial contributions of stock size and fertilization to Douglas-fir and white fir survival, growth and total above ground biomass on dry sites in the interior Sierra Cascade region of northern California and southwest Oregon under vegetation-free conditions. (2) To determine the partial contributions of stock size and fertilization on initial root growth and total root volume (dry weights) after the first growing season in the field. (3) To determine differences attributable to site based on low and high precipitation zones.

Douglas-fir and white fir seedlings in four stock sizes will be subjected to two fertilization regimes and out-planted on three sites. Treatments will be replicated four times per site. Twenty-five trees will be planted per replication. Assume 3 years complete vegetation control for all treatments. Root volume measurements will be made at time of lifting and at the end of the first growing season in the field. Trees will be measured (ground-line diameter, height, survival) when planted and at years 1, 2, 3, 4, and 5. Foliar nutrient samples and dry weights per 100 needles will be collected and analyzed at years 1, 3, and 5.

Status: Seedlings were grown at Pelton Reforestation, Cal Forest Nurseries, PRT, IFA Nurseries, and Fowler Nursery for outplanting in the spring of 2003. Co-op members in this study include Roseburg Resources, Sierra Pacific Industries, and Boise Cascade.

Plot establishment and lay-out was completed on the first two sites in the fall of 2002 and on the third site prior to planting in February, 2003.

All three sites were planted during March, 2003. All sites had adequate soil moisture at time of planting and there was no snow on the ground. Each site received substantial moisture following the planting, so the seedlings got off to a good start.

The sites were set up according to the revised specifications: 10' X 10' spacing, 56 trees/plot, etc.

Preplanting measurements of caliper (1 inch above ground line) and height (from ground line to tip of bud) were taken on 50 randomly selected seedlings from each stock type/fertilization treatment for every species that was to be planted on each company's land. Twenty of these seedlings were taken back to Redding where they were oven dried and root/shoot ratios determined.

The two bare root stock types that were to receive the fertilization treatment were fertilized at the time of planting by placing one Wil-Gro briquette (9-9-4) in the bottom of the planting hole.

Boise Cascade

Two clearcut blocks were used for this installation – one for the pine and one for the Doug-fir. Both blocks are located near the town of Prospect, OR,

which is about 50 miles east of Medford, OR.

The plug-1s and the 1-1s were shovel planted; all other stock types were planted with hoedads. All pine stock looked fine, although the plug-1s were very large. With the Doug-fir, the plug-1s and the styro 8 unfertilized were slightly yellow; the rest of the stock types looked fine.

The pine block has 5 replications of each treatment. There was just enough room in the Doug-fir block for 4 replications of each treatment.

Sierra Pacific Industries
Two clearcut blocks were used at this site, also, one for the Doug-fir and one for the white fir. The blocks are located near the town of Feather Falls, CA which is east of Oroville. All stock types were shovel planted. The styro 8 Doug-fir (both fertilized and unfertilized) were slightly yellow.

The Doug-fir block has 5 replications of each treatment.

The 1-1 stock type for the white fir looked very poor. Size variability was large. There were not enough good trees to plant all the replications needing 1-1s, so only the 5 replications of the unfertilized treatment were planted. The 5 plots set up for the 1-1 fertilized treatment were left unplanted.

All styro 20 white fir were fertilized despite the boxes being labeled as fertilized or unfertilized. All boxes labeled as unfertilized were opened and sampled: all were fertilized. The boxes labeled as fertilized were also fertilized. The planting was done as if the labels on the boxes were correct – seedlings from the boxes labeled unfertilized were planted in the 5 plots designated for the unfertilized treatment and seedlings from boxes labeled fertilized were planted in the 5 plots set up for that treatment. In reality, these 10 plots have the same treatment = fertilized styro 20 white fir.

The white fir styro 8 and plug-1 treatments each have 5 replications.

Roseburg Resources
Both species (Doug-fir and white fir) were planted in the same clearcut at this site. The planting site is located near Nubieber, CA.

All stock types were shovel planted.

The Doug-fir has 5 replications of each treatment.

As was the case with the stock for the Sierra Pacific site, the 1-1 white fir Roseburg stock looked very poor. There were not enough good seedlings to plant all replications needing 1-1s, so only the 5 plots of the unfertilized treatment were planted. The 5 plots designated to receive fertilized 1-1s were left unplanted.

The white fir plug-1 and styro 8 treatments each have 5 replications.

None of the styro 20 white fir were fertilized even though some of the boxes were labeled as being fertilized. A Wil-Gro briquette was placed in the bottom of the planting hole in the 5 plots designated to receive fertilized styro 20s. The 5 plots designated to receive unfertilized styro 20s received the proper seedlings.

In July, foliar samples for each species/stock type/treatment combination from all three study sites were collected. These samples were sent to the J.R. Peters Laboratory for nutrient analysis. In addition, dry weights per 100 needles were determined from these samples.

In October, representative seedlings from each species/stock type/treatment combination were dug up from each of the three sites. These samples were taken to Redding where they were washed and oven dried. Root/shoot ratios were determined from this procedure.

First year growth measurements were take on all three sites during October – December. Measurements taken included caliper (at 1 inch above ground line) and height (ground line to tip of bud). Seedling volume will be calculated from these measurements. Survival was noted at this time as well as any pest problems.

The results from the various measurement and data collection operations that were done in 2003 are reported in nine tables found at the end of this narrative.

Table 1 (page 20) shows dry weights of 100 needles by treatment and species collected from the sites at the end of the first growing season in August, 2003. In general, the fertilized treatments had the larger values when compared on a stock type basis.

Table 2 (page 21) shows plant tissue analysis results for selected macro nutrients. These samples were collected at the end of the first growing season in August, 2003. Other macro nutrients and a full set of micro nutrients were run. A full data set is on file at PSW in Redding and is available on request.

Table 3 (page 22) shows seedling survival by treatment and species at the end of the first growing season in August, 2003. The survival of the pine on the Boise Cascade site ranged from 94-100%; the Doug-fir ranged from 71-100%. The Doug-fir on the Roseburg site ranged from 38-96%; the Doug-fir on the Sierra Pacific site ranged from 42-68%. On the Roseburg site in 3 out of the 4 stock types, the seedlings in the unfertilized treatment had better survival than those in the fertilized treatment. This was reversed on the Sierra Pacific site where in 3 out of the 4 stock types, the seedlings in the fertilized treatment had a higher survival rate than did their unfertilized counterparts. On the Boise pine site, the seedlings that were fertilized generally had a lower survival rate than did the unfertilized ones in the various stock types. On the Boise Doug-fir site in two of the stock types the fertilized seedlings had a better survival rate than the unfertilized ones. In the remaining two stock types, the unfertilized seedlings survived better. There was only minor browsing damage to the seedlings on the Roseburg and Sierra Pacific sites. The Doug-fir on the Boise site showed browsing damage on 12 percent of the seedlings. The pine on the Boise site showed little browsing.

Table 4 (page 23) shows root/shoot ratios by treatment and species at the time of lifting in February, 2003. Significant differences between treatments are indicated. The bare root fertilized treatments have no values as

these treatments were fertilized at the time of planting.

Table 5 (page 24) shows root/shoot ratios by treatment and species at the end of the first growing season in October, 2003. Significant differences are indicated by letters following the numerical values. On the Boise and Roseburg Doug-fir sites there were no significant differences between the treatments. There are significant differences between treatments on the Sierra Pacific site and the Boise pine site.

Table 6 (pages 25-26) shows values for caliper, height, and volume at time of lifting in February, 2003. Significant differences within a stock type between fertilized and unfertilized seedlings are indicated. The 1-1 fertilized and the plug 1 fertilized treatments have no values as these treatments were fertilized at the time of planting. Volume is calculated by multiplying squared caliper by height. There were no significant differences in volume between fertilized and unfertilized treatments within a stock type for any species or land owner. All seedlings started out equal at planting time.

Table 7 (pages 27-28) shows values for caliper, height, and volume at the end of the first growing season, October, 2003. Significant differences within a stock type between fertilized and unfertilized seedlings are shown by letters following the numerical values. Only Boise Cascade pine showed any significant differences in volume within a stock type between fertilized and unfertilized seedlings. Plug 1 fertilized seedlings were significantly larger than their counterpart unfertilized ones. With this exception, as at time of lifting, at the end of the first growing season, the seedlings within a stock type whether fertilized or not were still equal.

Table 8 (pages 29-30) shows significant differences between treatments for caliper, height, and volume at the time of lifting in February, 2003. Volume is calculated by multiplying squared caliper by height. Volume for the bare root treatments (1-1 fertilized and plug 1 fertilized) are missing as these two treatments were fertilized at time of planting. For all ownerships and all species, volume is always significantly higher for the bare root treatments than for the container treatments. With the exception of the Doug-fir on the Roseburg site where there is no difference, in all ownerships and species plug 1 volume is always significantly higher than 1-1 volume.

Table 9 (pages 31-32) shows significant differences between treatments for caliper, height, and volume at the end of the first growing season in October, 2003. As was the status at the time of lifting, for all ownerships and all species, volume is always significantly higher for the bare root treatments than for the container treatments. But different from the results at the time of lifting, in the bare root treatments, plug 1 volume is not always significantly higher than 1-1 volume at the end of the first growing season. By land owners, the treatments with the most and the least volume were: Boise Cascade pine = plug 1 fertilized and styro 8 fertilized; Boise Cascade Doug-fir = 1-1 fertilized and styro 8 fertilized; Sierra Pacific Doug-fir = plug 1 fertilized & nonfertilized and styro 8 fertilized; Roseburg Doug-fir = 1-1 fertilized and styro 8 unfertilized.

This study is scheduled for remeasurement at the end of its second growing season which would be the fall of 2004. In general, at the end of the first growing season, the treatments that had the biggest seedlings at the time of planting still have have the biggest seedlings. The fertilized seedlings are not always larger than their unfertilized counterparts. Considering volume only, in about 60 percent of the time are fertilized seedlings larger than their counterpart unfertilized ones.

Since several of the seedlings, although still alive, were not very thrifty when measured in October 2003, survival could continue to be an issue on the Roseburg and Sierra Pacific sites for the container treatments, both fertilized and unfertilized.

Table 1—Dry weight values of 100 needles from seedlings of the Stock Type/Fertilization Proposal at end of the first growing season, August, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
		Dry Weight/100 needles (grams)		
Plug 1 No/Fert.	0.16	0.18	0.24	1.68
Plug 1 Fert.	0.17	0.21	0.18	1.92
1-1 No/Fert	0.19	0.24	0.23	1.74
1-1 Fert.	0.19	0.23	0.26	2.12
Styro 8 No/Fert.	0.14	0.21	0.22	1.68
Styro 8 Fert.	0.20	0.23	0.24	1.57
Styro 20 No/Fert.	0.15	0.18	0.21	2.49
Styro 20 Fert.	0.19	0.23	0.28	2.83

Table 2—Plant tissue analysis results for selected macro-nutrients listed by the treatments showing the high and low values for seedlings of the Stock Type/Fertilization Proposal at the end of the first growing season, August, 2003.

	Nitrogen		Phosphorus		Potassium	
			Percentage			
Boise Doug-fir						
	Plug 1 F	2.25	Plug 1 N/F	0.188	St 8 N/F	0.822
	St 8 F	1.50	1-1 F	0.109	Plug 1 N/F	0.511
Boise Pine						
	St 8 F	1.59	St 20 F	0.194	Plug 1 N/F	1.090
	1-1 N/F	1.05	1-1 F	0.134	1-1 F	0.972
SPI Doug-fir						
	Plug 1 F	2.13	Plug 1 F	0.182	St 8 N/F	0.738
	St 20 F	1.49	1-1 F	0.105	Plug 1 F	0.516
Roseburg Doug-fir						
	Plug 1 F	2.64	St 20 N/F	0.190	St 20 N/F	0.663
	St 8 N/F	1.47	1-1 F	0.121	1-1 F	0.519

F = fertilized; N/F = not fertilized.

Table 3—Seedling Survival by treatment and species for the Stock Type/Fertilization Proposal at end of first growing season, August, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
		Percent Survival		
Plug 1 No/Fert.	61	47	85	98
Plug 1 Fert.	46	42	77	98
1-1 No/Fert	96	65	97	100
1-1 Fert.	86	68	100	99
Styro 8 No/Fert.	49	42	75	95
Styro 8 Fert.	82	56	71	94
Styro 20 No/Fert.	44	53	70	98
Styro 20 Fert.	38	58	78	94

Table 4 – Root/shoot ratios by treatment and species for seedlings from the Stock Type/Fertilization Proposal at time of lifting, February, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
		Ratio		
Plug 1 No/Fert.	1.61ab	1.58bc	1.40c	1.51b
Plug 1 Fert.	*	*	*	*
1-1 No/Fert.	1.91a	1.52c	1.90a	2.07a
1-1 Fert.	*	*	*	*
Styro 8 No/Fert.	1.42b	1.60bc	1.89a	1.56b
Styro 8 Fert.	1.38b	2.01ab	1.69abc	1.21bc
Styro 20 No/Fert.	1.74ab	2.12a	1.80ab	1.08c
Styro 20 Fert.	1.85a	2.20a	1.47bc	1.04c

* Fertilized at time of planting.

For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 5 – Root/shoot ratios by treatment and species for seedlings from the Stock Type/Fertilization Proposal at end of first growing season, October, 2003.

	Roseburg Doug-fir	SPI Doug-fir	Boise Doug-fir	Boise Pine
		Ratio		
Plug 1 No/Fert.	1.89a	1.86ab	1.72a	1.87b
Plug 1 Fert.	1.84a	1.55b	1.72a	1.71b
1-1 No/Fert.	1.82a	1.49b	1.73a	2.06b
1-1 Fert.	1.66a	1.59ab	1.94a	1.83b
Styro 8 No/Fert.	1.46a	1.65ab	1.87a	3.04a
Styro 8 Fert.	1.62a	2.25a	1.83a	2.47ab
Styro 20 No/Fert.	2.01a	1.60ab	1.92a	2.05b
Styro 20 Fert.	2.00a	1.61ab	2.00a	2.48ab

For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 6—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at time of lifting, February, 2003.

Boise Pine	Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
	1-1 No Fertilizer	1.05	24.51	29.93
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.53	36.04	89.56
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.55b	25.82b	8.03a
	Styro 8 Fertilizer	0.43a	17.33a	3.37a
	Styro 20 No Fertilizer	0.54a	22.35a	6.72a
	Styro 20 Fertilizer	0.57a	20.46a	6.99a

Boise Doug-fir	Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
	1-1 No Fertilizer	0.97	43.83	44.73
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.17	37.97	53.76
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.37a	31.82a	4.46a
	Styro 8 Fertilizer	0.35a	29.27a	3.82a
	Styro 20 No Fertilizer	0.57a	37.57a	12.84a
	Styro 20 Fertilizer	0.56a	42.17b	13.94a

* Fertilized at time of planting.

This table shows significant differences within a stock type between fertilized and non-fertilized seedlings. For land-owner and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 6 contd.

Roseburg Doug-fir Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.06	45.72	57.02
1-1 Fertilizer	*	*	*
Plug -1 No Fertilizer	1.12	35.76	49.50
Plug -1 Fertilizer	*	*	*
Styro 8 No Fertilizer	0.37a	22.11a	3.12a
Styro 8 Fertilizer	0.37a	23.00a	3.22a
Styro 20 No Fertilizer	0.56a	32.30a	10.73a
Styro 20 Fertilizer	0.52a	34.27a	9.73a

SPI Doug-fir Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	0.96	35.08	34.46
1-1 Fertilizer	*	*	*
Plug -1 No Fertilizer	1.17	39.70	63.24
Plug -1 Fertilizer	*	*	*
Styro 8 No Fertilizer	0.34a	21.86a	2.55a
Styro 8 Fertilizer	0.34a	26.13b	3.12a
Styro 20 No Fertilizer	0.54a	35.54a	11.01a
Styro 20 Fertilizer	0.55a	35.47a	11.28a

* Fertilized at time of planting.

This table shows significant differences within a stock type between fertilized and non-fertilized seedlings. For land-owners and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 7—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at end of the first growing season, October, 2003.

Boise Pine

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.38a	30.17a	65.85a
1-1 Fertilizer	1.49b	31.45a	77.08a
Plug -1 No Fertilizer	1.65a	42.87a	125.37a
Plug -1 Fertilizer	1.79b	45.11a	154.52b
Styro 8 No Fertilizer	0.85a	30.11a	24.70a
Styro 8 Fertilizer	0.83a	27.24a	20.29a
Styro 20 No Fertilizer	1.04a	35.19a	41.19a
Styro 20 Fertilizer	1.07a	33.79a	44.37a

Boise Fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.06a	44.56a	55.46a
1-1 Fertilizer	1.10a	45.96a	60.95a
Plug -1 No Fertilizer	1.07a	35.24a	46.84a
Plug -1 Fertilizer	1.17b	36.41a	55.17a
Styro 8 No Fertilizer	0.62a	31.43b	13.39a
Styro 8 Fertilizer	0.54a	23.66a	7.97a
Styro 20 No Fertilizer	0.76a	41.83a	26.30a
Styro 20 Fertilizer	0.76a	39.20a	25.16a

This table shows significant differences within stock types between fertilized and non-fertilized seedlings. For land-owners and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 7 contd.

Roseburg
Doug-fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.15a	45.53a	67.33a
1-1 Fertilizer	1.21a	48.91a	78.44a
Plug -1 No Fertilizer	1.13a	35.24a	55.21a
Plug -1 Fertilizer	1.06a	31.02a	39.92a
Styro 8 No Fertilizer	0.52a	23.64a	7.19a
Styro 8 Fertilizer	0.61a	27.49a	11.26a
Styro 20 No Fertilizer	0.69a	34.81a	18.57a
Styro 20 Fertilizer	0.64a	34.38a	16.00a

SPI
Doug-fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.02a	40.88a	47.32a
1-1 Fertilizer	1.07a	39.75a	51.51a
Plug -1 No Fertilizer	1.20a	45.19a	77.01a
Plug -1 Fertilizer	1.28a	43.38a	78.92a
Styro 8 No Fertilizer	0.58a	26.59a	9.93a
Styro 8 Fertilizer	0.57a	26.96a	9.76a
Styro 20 No Fertilizer	0.67a	32.59a	16.45a
Styro 20 Fertilizer	0.79b	39.19b	26.40a

This table shows significant differences within stock types between fertilized and non-fertilized seedlings. For land-owners and species, treatment means within a stock type followed by the same letter do not differ significantly at the 0.05 level.

Table 8—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at time of lifting, February, 2003.

Boise Pine	Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
	1-1 No Fertilizer	1.05b	24.51bc	29.93b
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.53a	36.04a	89.56a
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.55c	25.82b	8.03c
	Styro 8 Fertilizer	0.43d	17.33e	3.37c
	Styro 20 No Fertilizer	0.54c	22.35cd	6.72c
	Styro 20 Fertilizer	0.57c	20.46d	6.99c

Boise Doug-fir	Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
	1-1 No Fertilizer	0.97b	43.83a	44.73b
	1-1 Fertilizer	*	*	*
	Plug -1 No Fertilizer	1.17a	37.97b	53.76a
	Plug -1 Fertilizer	*	*	*
	Styro 8 No Fertilizer	0.37d	31.82c	4.46d
	Styro 8 Fertilizer	0.35d	29.27c	3.82d
	Styro 20 No Fertilizer	0.57c	37.57b	12.84c
	Styro 20 Fertilizer	0.56c	42.17a	13.94c

* Fertilized at time of planting.

This table shows significant differences between treatments. For land-owner and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 8 contd.

Roseburg Doug-fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.06a	45.72a	57.02a
1-1 Fertilizer	*	*	*
Plug -1 No Fertilizer	1.12a	35.76b	49.50a
Plug -1 Fertilizer	*	*	*
Styro 8 No Fertilizer	0.37c	22.11c	3.12b
Styro 8 Fertilizer	0.37c	23.00c	3.22b
Styro 20 No Fertilizer	0.56b	32.30b	10.73b
Styro 20 Fertilizer	0.52b	34.27b	9.73b

SPI Doug-fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	0.96b	35.08b	34.46b
1-1 Fertilizer	*	*	*
Plug -1 No Fertilizer	1.17a	39.70a	63.24a
Plug -1 Fertilizer	*	*	*
Styro 8 No Fertilizer	0.34d	21.86d	2.55c
Styro 8 Fertilizer	0.34d	26.13c	3.12c
Styro 20 No Fertilizer	0.54c	35.54b	11.01c
Styro 20 Fertilizer	0.55c	35.47b	11.28c

* Fertilized at time of planting.

This table shows significant differences between treatments. For land-owners and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 9—Values for caliper, height, and volume of seedlings for the Stock Type/Fertilization Proposal at end of the first growing season, October, 2003.

Boise Pine

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.38d	30.17d	65.85c
1-1 Fertilizer	1.49c	31.45cd	77.08c
Plug -1 No Fertilizer	1.65b	42.87a	125.37b
Plug -1 Fertilizer	1.79a	45.11a	154.52a
Styro 8 No Fertilizer	0.85f	30.11de	24.70ef
Styro 8 Fertilizer	0.83f	27.24e	20.29f
Styro 20 No Fertilizer	1.04e	35.19b	41.49de
Styro 20 Fertilizer	1.07e	33.79bc	44.37d

Boise Fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.06b	44.56a	55.46ab
1-1 Fertilizer	1.10ab	45.96a	60.95a
Plug -1 No Fertilizer	1.07b	35.24cd	46.84b
Plug -1 Fertilizer	1.17a	36.41c	55.17ab
Styro 8 No Fertilizer	0.62d	31.43d	13.39cd
Styro 8 Fertilizer	0.54d	23.66e	7.97d
Styro 20 No Fertilizer	0.76c	41.83ab	26.30c
Styro 20 Fertilizer	0.76c	39.20bc	25.16c

This table shows significant differences between treatments. For land-owners and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.

Table 9 contd.

Roseburg
Doug-fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.15ab	45.53a	67.33ab
1-1 Fertilizer	1.21a	48.91a	78.44a
Plug -1 No Fertilizer	1.13ab	35.24b	55.21bc
Plug -1 Fertilizer	1.06b	31.02bc	39.92c
Styro 8 No Fertilizer	0.52d	23.64d	7.19d
Styro 8 Fertilizer	0.61cd	27.49cd	11.26d
Styro 20 No Fertilizer	0.69c	34.81b	18.57d
Styro 20 Fertilizer	0.64cd	34.38b	16.00d

SPI
Doug-fir

Treatment	Caliper (cm)	Height (cm)	Volume (cm3)
1-1 No Fertilizer	1.02b	40.88ab	47.32b
1-1 Fertilizer	1.07b	39.75b	51.51b
Plug -1 No Fertilizer	1.20a	45.19a	77.01a
Plug -1 Fertilizer	1.28a	43.38ab	78.92a
Styro 8 No Fertilizer	0.58d	26.59d	9.93cd
Styro 8 Fertilizer	0.57d	26.96d	9.76d
Styro 20 No Fertilizer	0.67d	32.59c	16.45cd
Styro 20 Fertilizer	0.79c	39.19b	26.40c

This table shows significant differences between treatments. For land-owners and species, treatment means in each column followed by the same letter do not differ significantly at the 0.05 level.