

**Sierra Cascade Intensive Forest Management Research Cooperative Proposal 00-04,  
Stock Type/Fertilization Study**

Principal Investigator: Ed Fredrickson

Title: Improving the establishment and growth of Douglas-fir and white fir on dry sites through fertilization and stock type

Year Funded: 2000

**Executive Summary:**

A study was initiated in 2000 to determine the principal contributions of stock size and fertilization to Douglas-fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*) 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. A second objective was 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. The third objective was to determine differences attributable to site based on low and high precipitation zones.

Planting sites were provided by three Co-op members: Roseburg Resources, Sierra Pacific Industries, and Boise Cascade. All sites tested Douglas-fir; Boise Cascade also tested ponderosa pine (*Pinus ponderosa*). Seedling problems eliminated the white fir from the study after the initial planting. All three sites were planted in March, 2003. Wil-Gro briquettes (9-9-4) were used to fertilize the bare-root stock. All sites had adequate soil moisture at the time of planting and there was no snow on the ground. Each site received substantial moisture immediately following the planting and through the rest of the spring.

Root volume measurements will be made at time of lifting and at the end of the first growing season. Seedlings will be measured for caliper and height when planted and at years 1, 2, 3, 4, and 5. Seedling volume will be derived from these measurements. Survival will be noted at the time of remeasurement. Foliar nutrient samples and dry weights per 100 needles will be collected and analyzed at years 1, 3, and 5. Analysis of variance (ANOVAs) of treatment means will be used to test for treatment effects and significant differences among treatments.

**2008:** Caliper and height measurements were taken in the fall of 2008. Survival was also recorded at this time. This was the end of the sixth growing season for the study. Since this was possibly the final year for this current study, all plot corners were remonumented in case the Co-op chose to use the sites for another study sometime in the future.

**Survival:** There were no significant differences in survival among treatments on the Sierra Pacific site for **Douglas-fir** related to stock type or fertilization (Figure 1). Survival ranged from 38 percent to 62 percent at this site. The Boise Cascade Douglas-fir showed significant differences among treatments related to stock type but no differences

due to fertilization. Overall survival varied from 30 percent to 81 percent. On this site, seedlings in both 1+1 treatments had significantly higher survival than did seedlings in both the Styro 8 treatments. Douglas-fir on the Roseburg site had significant differences among many of the treatments. Survival ranged from 2 percent to 66 percent at this site. Seedlings in the 1+1 nonfertilized treatment had significantly higher survival than seedlings in all other treatments with the exception of the 1+1 fertilized treatment. The survival in the 1+1 fertilized treatment was significantly higher than seedling survival in the plug+1 fertilized, Styro 8 nonfertilized, and both Styro 20 treatments. Within stock types, there were no significant differences in survival related to fertilization.

There were no significant differences in survival in **ponderosa pine** related to stock type or fertilization on the Boise Cascade site. Survival was above 90 percent in all treatments.

**Growth:** There were no significant differences among treatments for caliper, height, or volume for **Douglas-fir** on the Sierra Pacific site. This was also the case on the Roseburg site with one exception – the 1+1 fertilized seedlings were significantly larger in caliper than the Styro 8 nonfertilized seedlings. The Douglas-fir seedlings on the Boise Cascade site showed significant differences in caliper, height, and volume (Figure 2). **Caliper:** The 1+1 fertilized seedlings were significantly larger in caliper than seedlings in both Styro 8 treatments and the Styro 20 fertilized treatment. The plug+1 fertilized seedlings were larger than seedlings in the Styro 8 nonfertilized

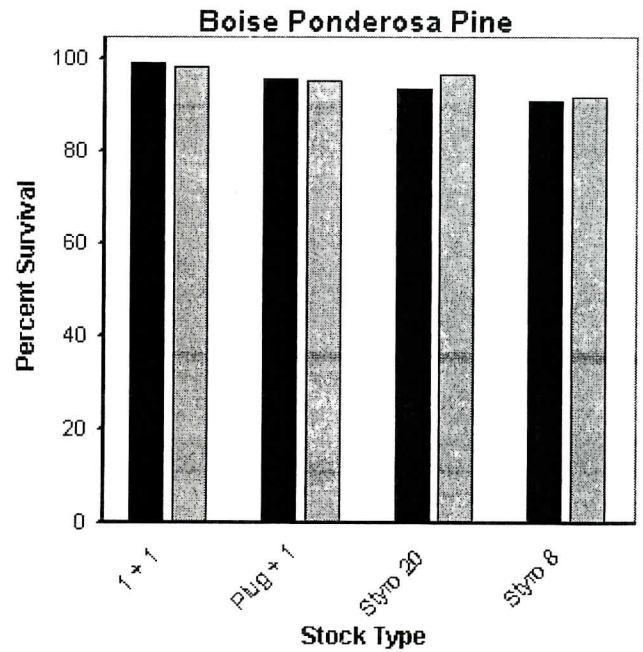
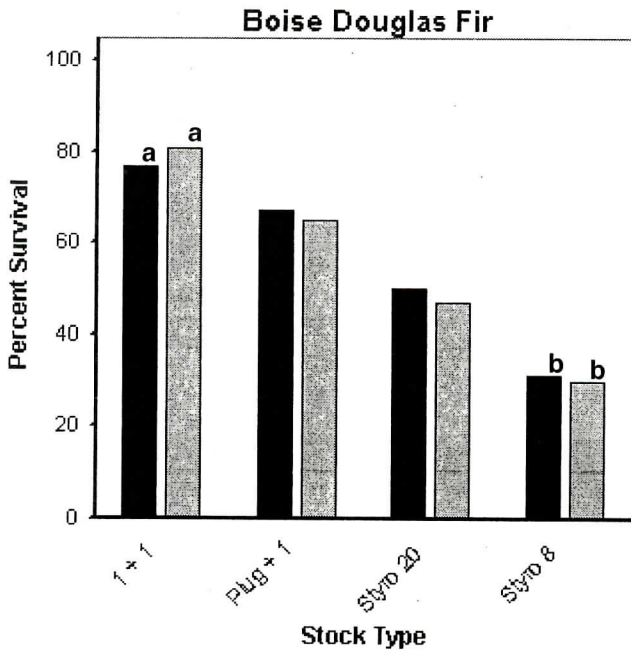
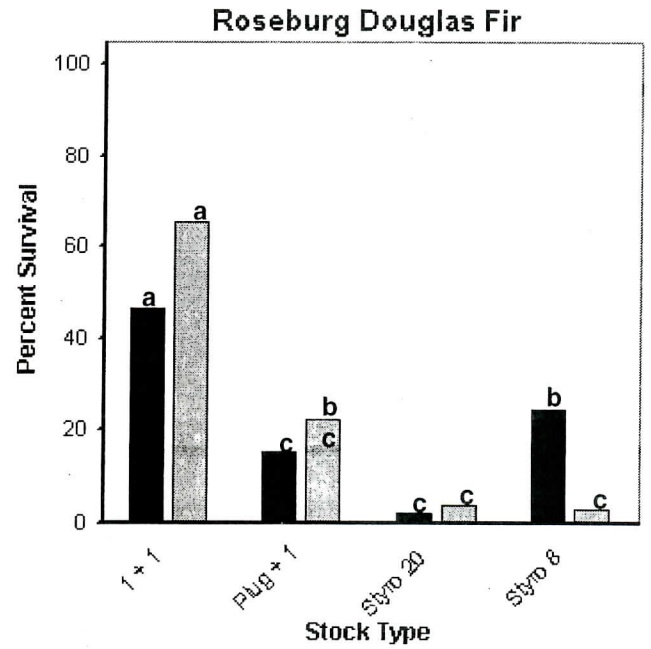
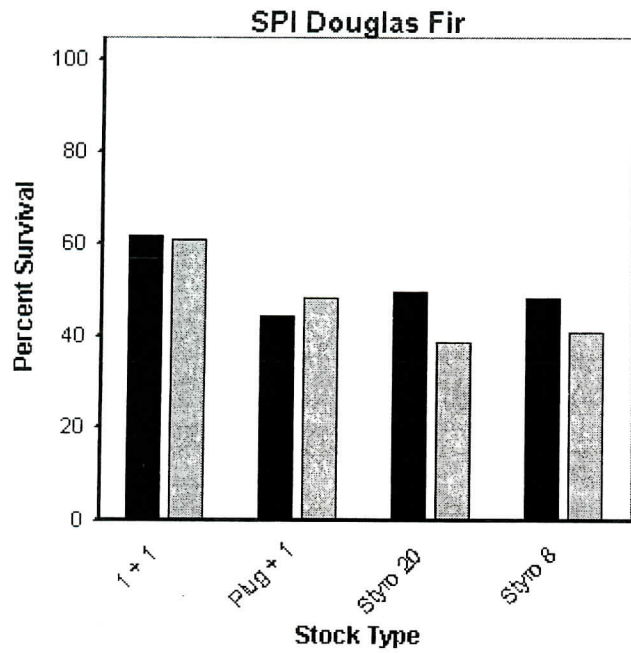
treatment. **Height:** the 1+1 fertilized seedlings were significantly taller than the seedlings in all of the Styro 8 and Styro 20 treatments. **Volume:** Plug+1 fertilized and 1+1 fertilized seedlings had significantly higher volume than seedlings in the Styro 8 nonfertilized treatment.

The Boise Cascade site was the only site that included **ponderosa pine** in the study design. There were significant differences among treatments in caliper, height, and volume (Figure 3). **Caliper:** Seedlings in the Plug+1 fertilized and plug+1 nonfertilized treatments were significantly larger in caliper than the seedlings in all the Styro 8 and Styro 20 treatments. The seedlings in the 1+1 fertilized treatment were significantly larger than seedlings in both Styro 8 treatments. And the seedlings in the 1+1 nonfertilized treatment were larger than seedlings in the Styro 8 nonfertilized treatment. **Height:** Seedlings in the plug+1 fertilized treatment were taller than the seedlings in all the Styro 8 and Styro 20 treatments. Seedlings in the plug+1 nonfertilized and 1+1 fertilized treatments were taller than the seedlings in both Styro 8 treatments. **Volume:** Seedlings in both plug+1 treatments had significantly higher volume than did seedlings in all the Styro 8 and Styro 20 treatments. Seedlings in the 1+1 fertilized treatment had significantly more volume than did seedlings in both Styro 8 treatments.

After six growing seasons the seedlings in the two stock types that were the largest at time of lifting (1+1 and plug+1) in February 2003 were still the largest in fall of 2008. There were no significant differences in size between these two stock types. But there were

significant differences between these two larger stock types and the Styro 8 and Styro 20 stock types. In turn there were no significant differences in size between the two Styro stock types. Within a stock type, fertilized seedlings are almost always larger than their counterparts in the nonfertilized treatment, but not significantly so.

**Figure 1: Percent Survival for Stock Type/Fertilization Study, Fall 2008**



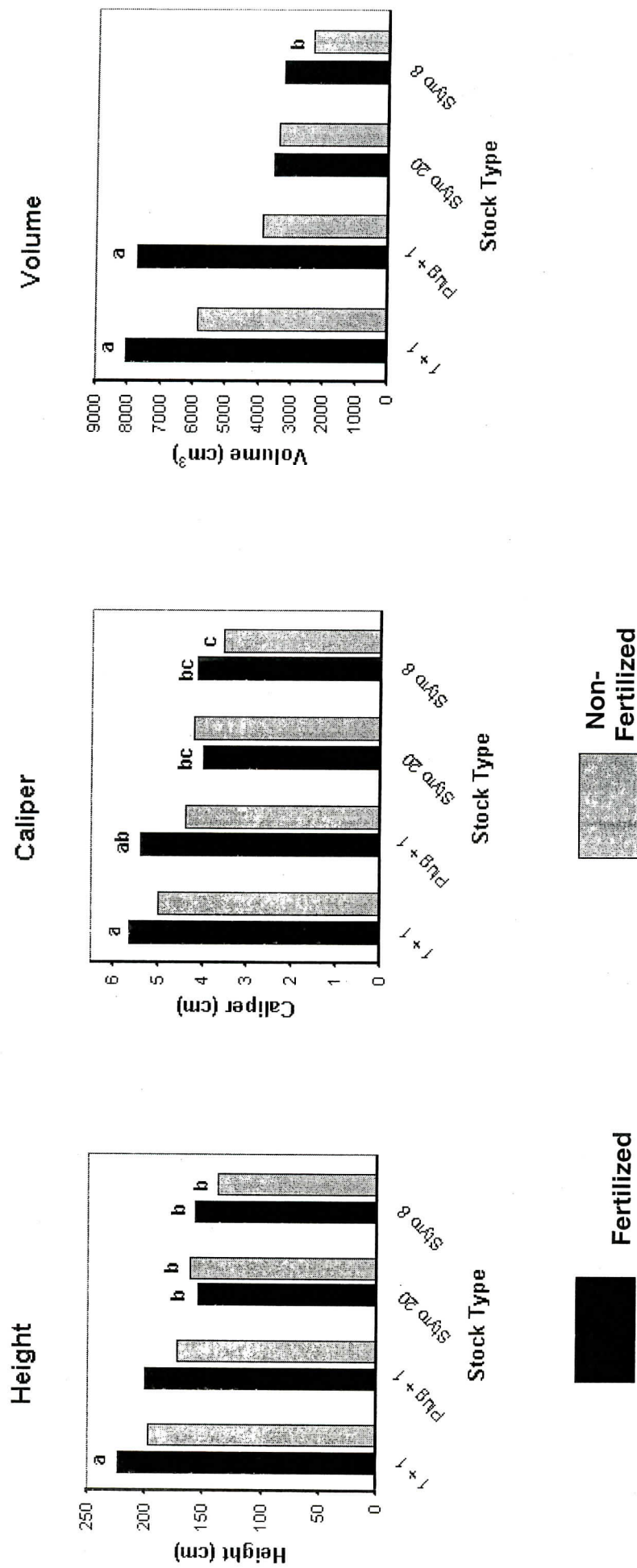
**Fertilized**



**Non-Fertilized**

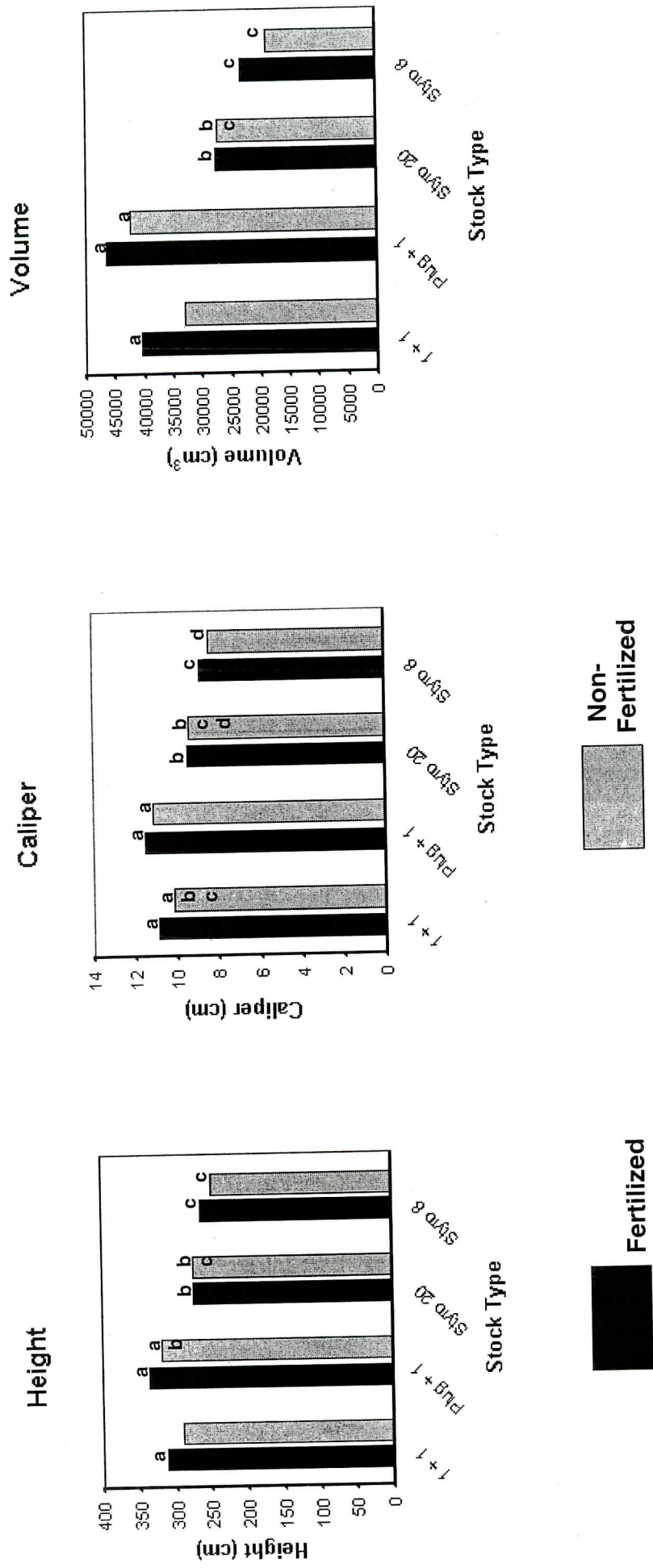
For each fertilizer rate, site and stock type, treatment means with the same letter do not differ statistically at the 0.05 level. Means with no letters do not differ.

Figure 2: Mean Height, Caliper and Volume of Douglas Fir seedlings for Stock Type/Fertilization Study, Fall 2008  
Boise Site



For each fertilizer rate and stock type combination, treatment means with the same letter do not differ statistically at the 0.05 level. Means with no letters do not differ.

Figure 3: Mean Height, Caliper and Volume of Ponderosa Pine seedlings for Stock Type/Fertilization Study, Fall 2008  
Boise Site



For each fertilizer rate and stock type combination, treatment means with the same letter do not differ statistically at the 0.05 level. Means with no letters do not differ.