Basal Pruning Fraser Fir Christmas Trees

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Abstract. Fraser fir [*Abies fraseri* (Pursh) Poir.] Christmas trees were basal pruned (branches were removed from the lower 15 to 25 cm of the stem, i.e., handle) at heights ranging from 0.6 to 0.9 m up to 1.5 to 1.8 m tall, and were harvested 2 to 4 years later. Basal pruning reduced cutting time $\approx 25\%$, and baling time $\approx 10\%$. Commercial height and stem diameter were unaffected, but the average harvest weight of pruned trees 2.1 to 2.4 m tall (2 to 4 years after basal pruning) was reduced ≈ 1.4 kg.

Basal pruning is a common practice with many Christmas tree species. U.S. Dept. of Agriculture (USDA) grading rules specify that Christmas trees should have a clean (no branches) handle not < 6 inches (15 cm) and not > 1.5 inches (3.8 cm) per foot (0.3 m) of tree height (U.S. Dept. of Agriculture, 1989). Trees graded "on the stump," e.g., Fraser fir, are not required to have pruned handles. Many Fraser fir Christmas trees are sold without basal pruning because retailers and consumers use the lower branches to make boughs, roping, or wreaths. When a tree is basal pruned after harvest, the base of the crown is not as full and smooth, compared to trees pruned several years earlier. Some growers basal prune trees 0 to 2 years before harvest, and either sell the greenery or use it to make wreaths and roping.

The effect of basal pruning on growth of Fraser fir is unknown. Pruning Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] and noble fir [*Abies procera* Rehd.] when they are too small can reduce growth and increase rotation length (Douglass, 1992). We hypothesize that basal pruning might yield trees with smaller trunk diameter, which would equate with less weight per tree (Hinesley and Wright, 1989). In addition, Fraser fir Christmas trees with smaller trunk diameters are considered

less susceptible to postharvest splitting (Hart and Hinesley, 1993). Our objective was to determine the effect of basal pruning on Fraser fir in relation to variables such as 1) time required to prune; 2) yield of branch material; 3) effect on cutting time and baling time at harvest; and 4) effect on stem diameter, height, and fresh weight at harvest.

Materials and Methods

The experiment was established in 13 Fraser fir Christmas tree plantations in Nov. 1991. Commercial height classes (0.3-m increments, after shearing and shaping) ranged between 0.6 to 0.9 m and 1.5 to 1.8 m, with stands located on a variety of sites in four western North Carolina counties.

The design within each stand was a randomized complete block with four replications. There were two treatments: basal pruned and nonpruned. Each plot had three adjacent rows of trees (seven trees per row), with the restriction that the interior five trees of the middle row all had to fall within the average commercial height class for the stand. These were "measurement" trees; the others were border trees.

Pruning was done with loppers, hand clippers, and 15-cm folding saws. Loppers proved cumbersome and slow, and were soon discarded in favor of hand clippers and saws. Pruned trees had branches removed from the lower 15 to 25 cm of the trunk, depending on the location of major whorls. The total time required to prune the five measurement trees was recorded for each plot. In addition, the fresh weight of branches removed from each tree was also determined.

Final measurements were coordinated with harvesting (usually at a commercial height of 2.1 to 2.4 m). Total time required to cut the five measurement trees was recorded for each plot. Time required to bale each tree was recorded, beginning when the tree was picked up to be inserted into the baler, and ending when the last knot was tied at the terminal. Each grower supplied his own cutting and baling crews, and equipment. Fresh weight was recorded for each tree, and stem diameter was measured with calipers in opposite directions ≈ 5 cm

above the base of the stem. Where branches interfered, measurements were made as close as possible to 5 cm. Four stands were lost over the years, and final measurements were made in nine plantations (Table 1). Most stands lost during the experiment were initially in the smaller height classes, which made it difficult to test an "age" effect in the analysis.

Results were examined two ways. First, stands were analyzed individually. Second, all data were combined, and analyzed with a General Linear Models Procedure (SAS, 1990). The analysis included nine stands, 72 plots, 180 pruned trees, and 178 nonpruned trees.

Results and Discussion

Time required for pruning. Time required to basal prune individual trees increased linearly from 29 s for 0.6- to 0.9-m trees to 71 s for 1.5- to 1.8-m trees (Fig. 1). At \$6.00 per hour, this represented a cost of \$0.04 and \$0.10 per tree, respectively. Trees 0.9 to 1.2 m tall were pruned easily with hand clippers by a person standing or kneeling. Larger trees (e.g., 1.5 to 1.8 m), with their heavier branches and denser crowns, required a person to use loppers or folding saws, often while lying on the ground. This increased pruning time as well as worker fatigue.

Weight of branches removed during pruning. The weight of branches initially removed from handles increased linearly from 0.2 kg for trees 0.6 to 0.9 m tall to 2.0 kg for trees 1.5 to 1.8 m tall (Fig. 1). Branch material is commonly sold for greenery at \$0.66 to \$0.77 per kg. The value of branches removed from the handle of a 1.5- to 1.8-m tree was about \$1.10. Yield of usable greenery from 0.6- to 0.9-m trees was negligible because the lowest branches were small, and often included grass and weeds. Percent yield from 1.5- to 1.8-m trees was higher, but still less than the 50% to 60% conversion that can be obtained from well lit branches in the middle- or upper-crown (Hinesley and Snelling, 1992).

Cutting time. One might assume basal pruned trees to be faster to cut, compared to trees without pruned handles, but this was not

Fig. 1. Average time required to basal prune Fraser fir Christmas trees of varying commercial height, and average fresh weight of branches removed by pruning. Vertical bars = SE of mean. Numbers on horizontal axis represent midpoints of height class intervals.

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Table 1. Description of stands used in evaluation of basal pruning on Fraser fir Christmas trees.

Stand	Commercial ht when pruned ^z (m)	Years until harvest	Year harvested ^y
D	0.9–1.2	3	1994
S3	0.9–1.2	4	1995
J	1.2–1.5	4	1995
B	1.5–1.8	2	1993
H	1.5–1.8	2	1993
KJ	1.5–1.8	2	1993
KS	1.5–1.8	3	1994
S1	1.5–1.8	2	1993
S2	1.5–1.8	2	1993

^zAll trees were basal pruned in Nov. 1991.^yAll stands except D were harvested at a commercial height of 2.1 to 2.4 m; stand D was 1.9 to 2.1 m.

Table 2. Analysis of variance for various attributes of Fraser fir Christmas trees, as affected by basal pruning (shown for individual stands).

Stand	Dependent variable ^z				
	Ht	Wt	Diam	Cutting time	Baling time
B	*	NS	NS	*	**
D	**	NS	NS	*	NS
H	NS	NS	NS	**	NS
J	NS	NS	NS	NS	NS
KJ	NS	*	NS	NS	**
KS	NS	NS	NS	NS	NS
S1	**	NS	NS	**	NS
S2	NS	NS	NS	**	NS
S3	NS	**	**	*	*

^zHt = total length of stem; Wt = fresh weight of tree after cutting; Diam = trunk diameter in opposite directions ≈ 5 cm above the base; Cutting time = seconds required to cut a five-tree plot; Baling time = seconds required to bale a tree, beginning when the tree was picked up to be inserted in the baler and ending when the final knot was tied at the top.^ySample size: four pruned plots and four nonpruned plots in each stand; five measurement trees in each plot; total trees per stand = 40.ns, *, **Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

true for all stands (Table 2). Cutting time varied considerably, depending on the type of crew (one- or two-man), skill of the saw operator, and power of the saw.

There were significant differences in cutting time by stand and between treatments (Table 3). The significant $S \times T$ interaction resulted because the difference in cutting time was negligible in some stands, but noticeable in others. Pruned trees required an average of 25% less time to cut (Table 3).

Baling time. We hypothesized that basal pruning would reduce baling time, but this proved true in only three of the nine planta-

tions (Table 2). However, this variable was significant in the combined analysis (Table 3), averaging ≈10% less for pruned trees.

Effect of pruning on height, fresh weight, and stem diameter. Commercial height differed between treatments in only three of the nine plantations (Table 2). In the combined analysis, average height was 2.25 m in both treatments (Table 3). Where the objective is to grow 2.1- to 2.4-m trees, it appears that Fraser fir can, in most cases, be pruned at a commercial height of ≥1 m, with no adverse effect on height growth. However, one should take care with small trees not to prune too high and

remove more than 25% to 30% of the live crown; otherwise, future growth might be reduced.

Mean stem diameter 5 cm above the base averaged 9.6 to 9.8 cm for trees 2.1 to 2.4 m tall (Table 3). Basal pruning affected stem diameter in only one of the nine plantations (Table 2). In some stands, stem diameter was larger in nonpruned trees; in others, pruned trees were larger. In the combined analysis, the average difference in stem diameter for pruned and nonpruned trees was negligible (Table 3). Diameter was affected in only one of the four stands that was harvested 3 to 4 years following pruning (Table 2).

Tree fresh weight was reduced by basal pruning in only two of the nine plantations (Table 2). However, in the combined analysis, the average difference in fresh weight (1.4 kg per tree less in pruned trees) was significant (Table 3), amounting to ≈5%. The mean weight of a 2.1- to 2.4-m Fraser fir Christmas tree was 23 to 24 kg.

Effect of basal pruning on tree quality. After a tree is basal pruned, the base of the crown appears ragged and uneven. In time, new branch growth gives the base a smoother appearance. Ratings of trees according to USDA standards 2 years after basal pruning showed no difference in quality of the lower crown (data not presented), indicating that 2 years was ample time for the crown to recover.

Fraser fir Christmas trees often have numerous branches on the lower stem (Fig. 2 A–C). At harvest, the base of a nonpruned tree can be very irregular in shape, especially if the saw cut passes through the insertion point of a large branch (Fig. 2D). In the 1.5- to 1.8-m height class, branches were sometimes large, and buttressed. Basal pruning such branches often left the lower stem with prominent bumps, knots, and swellings. Two years was not enough time for these trees to completely cover all pruning wounds with new stem wood and bark. Trees pruned 3 or 4 years before harvest initially had smaller branches, and were able to heal the pruning wounds before reaching harvest age (Fig. 2E). Their stems were smoother, more round, more pleasing to the eye, and easier to grasp (Fig. 2E).

Table 3. Analysis of variance and means for various attributes of Fraser fir Christmas trees, as affected by basal pruning (combined data set).

Term in model	Variable ^z				
	Ht (m)	Wt (kg)	Diam (cm)	Time (s)	
Stand (S)	**	**	**	**	**
Treatment (T)	NS	**	NS	**	**
$S \times T$	**	NS	*	*	NS
R^2	0.71	0.49	0.39	0.84	0.52
n^y	358	358	358	72	358
Means ^x					
Pruned	2.25	22.7	9.64	30.3	17.7
Nonpruned	2.25	24.1	9.78	40.0	19.5

^zHt = total length of stem; Wt = fresh weight of tree after cutting; Diam = trunk diameter in opposite directions ≈ 5 cm above the base; Cutting time = seconds required to cut a five-tree plot; Baling time = seconds required to bale a tree, beginning when the tree was picked up to be inserted in the baler and ending when the last knot was tied.^ySample size: stands (9), plots (72), trees (358).^xSample size: pruned (180), nonpruned (178).ns, *, **Nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

Fig. 2. (A–C) Lower stems of 2.1- to 2.4-m Fraser fir Christmas trees that received no basal pruning. Note numerous large branches. (D) Cross section of harvested tree trunk illustrating the irregular shape that often occurs when trees receive no basal pruning. (E) Lower stem of a 2.1- to 2.4-m Christmas tree that was basal pruned 3 to 4 years before harvest.

Some trees produced a small number of epicormic sprouts on the lower stem after basal pruning. Sprouts, which normally arose around the margins of pruning wounds, were typically less than 10 cm long, ≈ 1 to 2 mm in diameter, and could be removed easily.

Basal pruning, when done on trees ≥ 1.2 m tall, is a cost effective source of greenery for wreaths, although foliage quality is not the best. Pruned trees are easier to insert in ringed stands, and relieve consumers of the need to prune handles. Basal pruning had little effect on height, stem diameter, and USDA grade of Fraser fir Christmas trees harvested 2–4 years later, but there was a small decrease in fresh weight. Basal pruning often decreased cutting time, but cutting time was not a limiting factor in harvest operations. Less often, baling time was reduced slightly, which could have affected harvest costs, because it involved more people than cutting. Consequently, it appears that the decision to basal prune or not prune Fraser fir depends on 1) the grower's market for greenery, 2) efficiency of the harvesting crews, and 2) preference of the buyers.

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