Top Pruning White Spruce Seed Orchard Grafts

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Top pruning results in easier cone collection and no reduction in cone production in white spruce in Wisconsin.

Cone collection is a costly component of seed orchard seed. Generally, the cost increases as the cone production decreases. Any biological effort to reduce collection costs must therefore maintain or increase cone production. Cost-cutting attempts have included: (1) increasing cone production by girdling, fertilizer treatment, or hormone treatment; (2) reducing seed losses primarily by controlling insects causing abortion or seed damage; or (3) managing crown dimension for easy picking.

Efforts to keep pine crowns low for easy collection have been considered impractical (*2, 7*) as pine females are borne on new growth, and its removal may lower cone production drastically (*8*). Less drastic treatments—such as removing terminals on all vigorous limbs-markedly decrease the number of cone-bearing branches the first year after pruning, but may later increase the cone-bearing potential on secondary and tertiary branches (*6*). These treatments do not effectively reduce height (*1*), and frequent, expensive pruning would be needed. Melchior and Heitmuller (*3*) increased male conelet production on 5-year-old grafts of Scotch pine (Pinus sylvestris) by removing about one-third of the length of leaders and side shoots. The pruning timing was important; February was best. Nilsson and Wyman (*5*) found that pruned Norway spruce (*Picea abies*) had materially reduced seed crops.

Topping to collect white spruce (*Picea glauca*) seed was described by Miller and Murphy (*4*), who found that topped larger trees in seed production areas usually produced four to six new tops and another bumper cone crop within 6 years.

Grafted white spruce seed orchards pose a special problem as cone production is concentrated in the top seven to eight whorls. This makes collection difficult because grafts have small diameter stems and narrow crowns with small diameter branches. One advantage of this crown type is that it can be decapitated with a single cut at a height within reach of a short ladder. Pruning costs would be low.

This paper describes a study to determine the effects on cone production of removing the top two to five whorls of branches on grafted clones of white spruce.

Material and Methods

In November 1975, one tree in each of 52 pairs of white spruce grafts was topped immediately above a branch whorl, removing two to five whorls. The grafts were made in 1959 in the greenhouse and were kept in the nursery until the spring of 1965 when they were field planted near Rhinelander in north-central Wisconsin. Scion material for the grafts came from a central Wisconsin plantation of 38-year-old ortets. The original provenance, while uncertain, is probably central Wisconsin. The 12 clones studied were each represented by three to five pairs of trees except for one clone for which only a single pair was available. At the treatment time, the trees were 3 to 6 meters high; 1-½ to 2 meters was removed.

Severe drought occurred in 1976 in northern Wisconsin. The official weather records for Rhinelander show that precipitation in July-the critical month for flower induction—was only 41.7 percent of normal precipitation. In September 1977, cone production, which was used to evaluate treatment effects, was very good. After that bumper crop, white spruce seed production in 1978 and 1979 was predictably poor and trees in this study were no exception. No detailed counts were made, but there was no obvious shortfall on the treated trees.

In 1977, cone production was estimated based on total cone count on the largest branch in each cone-bearing whorl. Whorl age and the number of cone-bearing branches in individual whorls were also recorded. Cone production on the main stem's smaller internodal branches was ignored. Total cone production estimates were obtained by multiplying the cones on counted branches by the number of branches in the respective whorl and adding the totals. Because internodal branch cone production was not counted, the estimates are probably conservative.

Results and Discussion

The estimated mean total cone production on treated trees exceeded that of untreated trees on 9 of the 12 clones and on 31 of the 52 pairs of trees studied. The estimated total cone production was 71,636 on treated trees, 24 percent more than the 57,674 on the control trees (table 1).

The cone production zone was substantially changed by the topping: (*1*) the average number of cone-producing whorls declined from 6.4 on the untreated trees to 3.8 on the decapitated trees, and (*2*) the flowering zone was extended downwards an average of 1.1 whorls (table 2).

Table 1.—*The effect of top pruning on cone production of grafted white spruce clones-mean cone production per ramet, and total production per clone*

		Estimated mean total cone production per ramet		Estimated total cone production per clone	
Clone no.	No. pairs	Treated	Untreated	Treated	Untreated
1,885	5	1,751	530	8,754	2,650
1,887	5	555	287	2,773	1,437
1,888	5	1,214	1,092	6,072	5,462
1,889	5	1,119	768	5,593	3,838
1,890	5	1,733	1,764	8,666	8,819
2,521	5	660	733	3,298	3,664
2,520	5	3,548	2,854	17,739	14,268
2,519	5	1,510	1,291	7,552	6,455
2,517	4	530	1,006	2,119	4,024
2,522	4	1,273	1,033	5,093	4,134
1,886	1	1,158	633	1,158	633
2,518	3	940	763	2,819	2,290
	Total			71,636	57,674

Table 2.—*Changes in the flowering zone resulting from top pruning of grafted white spruce trees*

Clone no.	Mean number of whorls flowering		Flowering lowered by number of whorls
	Treated	Untreated	
1,885	5.8	5.8	3.4
1,887	2.8	5.6	1.6
1,888	3.8	6.2	.6
1,889	3.8	6.6	.4
1,890	5.8	7.6	1.6
2,521	4.5	7.5	.6
2,520	5.4	9.0	1.4
2,519	3.6	7.4	-.4
2,517	2.5	4.8	.8
2,522	2.5	5.3	1.3
1,886	2.0	4.0	1.0
2,518	3.3	6.3	1.0
Means	3.8	6.4	1.1

On untreated trees, the top whorl (extended in 1977) pro duced no cones. Cone production increased from the second to the fourth whorl, which produced an average of 85 cones per branch per whorl. The number of cones per branch below the fourth whorl decreased and no untreated tree produced cones below the tenth whorl. On the treated trees, the first whorl below the pruning was the most productive, producing almost three times as many cones as the most productive whorl on untreated trees. Whorls below the ninth one were unproductive on treated trees (fig. 1).

The relation between whorl age and productivity is shown in figure 2. On the control trees, the 1974 whorl averaged the most productive. This whorl was in its third season of growth in 1976 when conelets were initiated; older and also smaller, younger branch systems were less productive.

Stress is a major factor influencing flowering and it undoubtedly occurs within a crown as a result of competition among branch systems. The reduced number and vigor of first, second, and third order branches as whorls age attests to such competition. The third

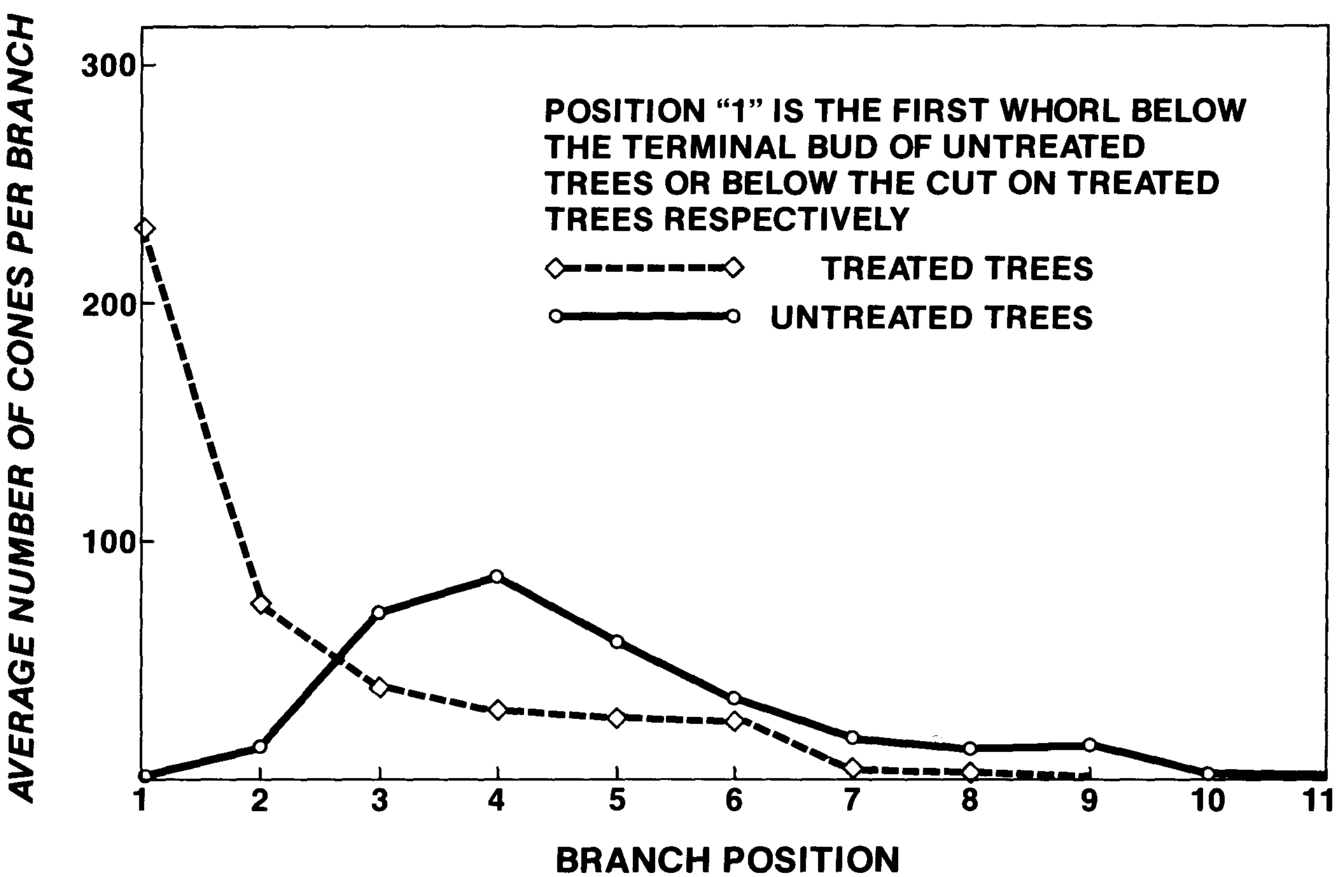

Figure 1.—*The average number of cones per branch in relation to branch position.*

whorl already shows evidence of competition; in the fourth whorl many meristems never develop and those growing on side branches produce weak shoots. This may explain the distribution of flowering on the untreated trees.

On the treated trees, the top whorl was most productive (fig. 1) regardless of age (fig. 2) and produced almost three times the number of cones than the most productive whorl on the control trees.

The study was not designed to determine the best pruning procedure. The topping point was based on tree height, not on whorl age, but in most cases three or four whorls were removed. On the average, the 31 trees with three whorls removed yielded more cones per measured branch (395 cones) than the 17 trees on which four whorls were removed (340 cones). This difference was not statistically significant, but considering the cone distribution on the untreated trees, the greater response on trees with the fourth whorl intact could perhaps be expected.

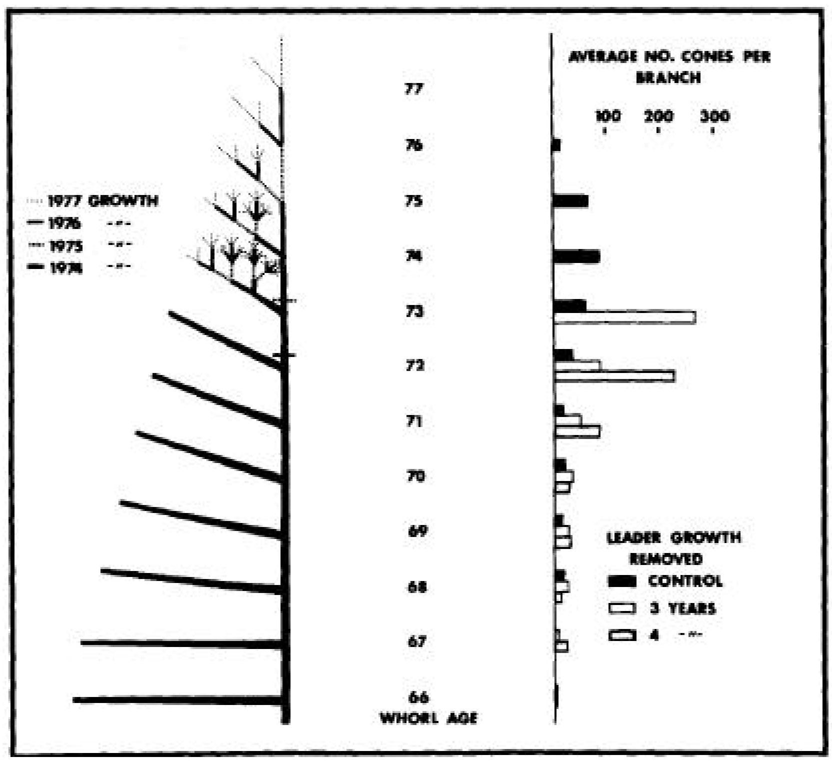

Figure 2.—*The relation between branch age and cone production in white spruce grafts.*

Top-pruned spruce trees typically rebuild their crown as one or more branches turn up and form new leaders. The time required depends on the age of the remaining top branches—the older they are the slower they respond. Repeated pruning would be needed to keep crowns low for easy cone collection.

From an operational point of view, the best treatment will increase or at least maintain seed production, maintain crowns as low as possible, and minimize pruning needs. This study has demonstrated that three to four branch whorls can be removed from 17-year-old clones of white spruce with resulting increases or at least maintenance of seed production potentials. Additional studies will be needed to develop the best procedures for continuing crown management of white spruce in seed orchards.

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