TOP PRUNING AND BENDING BRANCHES FAIL TO AID COLLECTION AND PRODUCTION OF LOBLOLLY CONES

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Over 3,500 acres of loblolly pine (*Pinus taeda* L.) seed orchards established in the South in recent years are intensively managed to produce genetically superior seed. Collecting cones from these trees is difficult and expensive. But if trees could be kept shorter, harvesting would be less costly and more complete.

The merits of pruning pine trees to enhance cone collection and production have been debated for several years, but studies of effects of pruning and bending branches on pine cone production have been unsatisfactory. When young, open-grown slash pine grafts in Florida were moderately pruned, results were inconclusive, and heavy pruning decreased cone production *(1)*. In the same study, some trees were bent in an effort to stimulate production of female strobili. Bending did not increase the number of strobili, but more bent trees produced female strobili than pruned or check trees. Loblolly and slash pines in South African seed orchards were bent and staked down to facilitate hand pollination and yielded half as many cones as free-growing control trees *(3)*.

Removing the upper half of the crown of mature loblolly pines in a Texas seed orchard significantly reduced production of male and female strobili *(2)*. Removing the lower half of the crown increased production of female strobili, but reduced male strobili, and removing the last 2 years' growth did not affect the production of male or female strobili. Pruning 5-year-old loblolly saplings drastically reduced cone production, but yields were not reported for these trees after they were older *(2)*.

This study investigated the effects of pruning and bending branches in a loblolly pine clonal seed orchard on cone production and collection.

Methods

The seed orchard in this study belongs to Continental Forest industries and is located in Jackson Parish, Louisiana. Two age classes of trees were studied separately. When the study began in 1971, the older trees were 10- to 12-year-old grafts averaging 10.5 inches d.b.h. and 35 feet in height. The younger trees, representing the same clones as older trees, were 5 to 6 years old and averaged 6.3 inches d.b.h. and 25 feet in height. Trees in both age classes were originally spaced 15 by 30 feet, but the older trees had been rogued to approximately 30 by 30 feet in 1969. The younger trees were also rogued to this spacing in 1974.

Four study trees were selected from each of 10 clones in the older part of the orchard. Previous yields indicated that the clones ranged from good to poor as cone producers. Two randomly selected trees from each group of four were top-pruned (hereafter referred to as pruning); the other two were controls. The objective of pruning was to maintain trees at their 1971 height (about 35 feet) for several years by removing 10 to 15 feet of the bole just above a whorl of branches. But tree height was only slightly reduced because side branches swept upward. The leader on each of the side branches was removed, giving the trees a flattened appearance. Trees were initially pruned in late January 1971. Through 1975 trees were pruned annually, during late winter, to maintain approximately constant heights. Pruning of the older trees ended after cones were collected in 1975 when it became apparent that unpruned, nonsturdy trees were overtopping many of the pruned trees.

Five study trees were selected from the same 10 clones in the younger part of the orchard. Two randomly selected trees from each group of five were pruned. A third tree was bent and weighted and the other two were controls. Pruning consisted of removing 5 to 8 feet of the top and clipping back the leaders on the remaining top branches. Trees were initially pruned in early February 1971. Through 1976 trees were pruned annually to permit increases of approximately 1.5 feet in height each year. For the

weighting treatment, blocks of wood were suspended from all main branches to pull them down to a nearly horizontal position. The top 2 or 3 feet of the bole was also removed. The blocks proved unsatisfactory because they broke limbs and needed periodic adjustment. Thus, after a year, branches were tied by guy wires to stakes driven in the ground. But the wires also broke limbs and were hazardous to tractor operators mowing the orchard. Pruning and bending of the younger trees ended after cones were collected in 1974.

In 1971 tractor-mounted ladders were used for collection; in subsequent years hydraulic bucket trucks were used. In all years cones were collected with pole-mounted cone hooks. Each year the same individual collected cones from all trees to eliminate bias from personnel.

The cones produced by each of the 90 study trees were counted when they were harvested, beginning in 1971. In addition, the time spent collecting cones from each tree was recorded to determine the number of cones harvested per minute. Neither time spent picking up and bagging cones nor travel time between trees and rest breaks were recorded.

Average number of cones collected and the time it took to collect them were determined for the two pruned trees and two control trees in each clone and age class. These averages were used in analyzing data.

Heights and diameters of all trees were measured after the study was installed in 1971. The same measurements were taken again after pruning in early 1975 for the older trees and after pruning in early 1976 for the younger trees.

For the older trees, paired "t" tests were used to evaluate differences between pruned and check trees while analyses of variance were used for the younger trees. Significance was tested at the 0.05 level in all instances.

Results and Discussion

Older Trees

Cone production.—Cone yields from older trees varied widely between trees and years. As anticipated, individual clones were consistently either good or poor producers. Average yields for pruned trees ranged from 11 cones per tree in 1972 to 224 in 1973; average yields for check trees ranged from 39 in 1972 to 513 in 1975 (table 1). Although pruned trees consistently averaged fewer cones than check trees, the difference was significant only in 1975 when pruned trees averaged 199 cones and checks averaged 513. When data for the 5 years were combined, differences between pruned and check trees were not significant.

The lack of significant difference in cone production between pruned and check trees before 1975 was due to the large variation in cone production between clones. For example, in 1973 average cone production of two pruned trees ranged from three for clone 2 to 657 for clone 1. In the same year, average cone production of check trees ranged from 11 for clone 42 to 1,303 for clone 3.

These results show that continually topping trees to keep them between 35 to 40 feet high will reduce cone yields. This effect is to be expected in pines, since most cones are usually produced in the upper half of the crown. However, reduced cone yields might be acceptable if collection could be speeded up.

Collection rate.—The number of cones harvested per minute was closely associated with yields per tree. Cones were collected more rapidly from trees with large crops. Averages ranged from 2.6 cones per minute from pruned trees in 1972 to 11.1 from checks in 1975 (table 1). Differences in cones harvested per minute from pruned trees and checks were not significant until 1975, when cone yields also differed significantly. In that year, an average of 7.0 cones per minute was collected from pruned trees while the average for check trees was 11.1. When data for all 5 years were

Table 1.—*Average cone yields and collection rates by treatment and year*

Year	Pruned trees		Weighted trees		Check trees	
	Cones produced	Cones harvested/ minute	Cones produced	Cones harvested/ minute	Cones produced	Cones harvested/ minute
	number					
Older Trees						
1971	196	5.7	-[1]	-	225	5.7
1972	11	2.6	-	-	39	3.0
1973	224	7.8	-	-	306	8.8
1974	88	4.1	-	-	206	5.8
1975	199	7.0	-	-	513	11.1
Younger Trees						
1971	39	8.8	48	9.1	41	8.9
1972	3	2.2	4	3.8	5	2.7
1973	44	7.4	56	7.5	75	7.4
1974	20	3.9	38	4.3	37	4.0
1975	103	7.1	-	-	165	7.4
1976	60	5.3	-	-	217	8.4

[1] No data were collected on weighted trees.

combined, differences in collection rates between pruned and check trees were not significant.

In this study collection times were probably slower than for standard operations. In standard operations cones can usually be collected from portions of two to four trees without moving the bucket truck. However, collecting all cones from a single tree usually required moving the truck once or twice without collecting from adjacent trees during the process. The best collection time for a single tree was 96 minutes for a tree yielding 2,129 cones, an average of 22.2 cones per minute.

The study of older trees ended in 1975 when it became apparent that pruning was neither increasing cone production nor hastening collection. If tractor-mounted ladders had been used throughout the study as in 1971, pruning may have proved advantageous, since by 1975 it would have been impossible to use tractor-mounted ladders to collect most cones from the check trees.

Tree growth.—The average 4-year d.b.h. growth of check trees was not significantly greater than that of pruned trees. Pruned trees averaged 10.4 inches d.b.h. in 1971 while check trees averaged 10.6 inches. From 1971 to 1975 pruned trees' growth averaged 4.6 inches. Check trees' growth averaged 5.3 inches.

Check trees averaged 36 feet in height when the study began and 50 feet after 4 years. Initially, pruned trees averaged 33 feet in height after treatment. Younger Trees

Cone production.—Cone yields from younger trees also varied widely by year and clone. Average yields for pruned trees ranged from three cones per tree in 1972 to 103 in 1975; average yields for check trees ranged from five in 1972 to 217 in 1976 (table 1). Weighted trees averaged four cones per tree in 1972 and 56 in 1973. No data were collected from weighted trees in 1975 or 1976. Although cone yields were low in 1973, check trees were significantly more productive than pruned trees. Checks also produced significantly more cones than pruned trees in 1975 and 1976. When data were combined for the 6 years of observations, differences between pruned and check trees were not significant. Weighted trees did not differ significantly from pruned or checks in any year.

Data from younger trees confirmed findings from the older group that pruning the upper crown to reduce height growth also reduces cone yields. However, pruned tree crowns were

denser and bushier than those of checks.

Collection rate.—As with older trees, the number of cones harvested per minute was closely associated with yields per tree. Cones were collected more rapidly from trees with large crops. Averages ranged from 2.2 cones per minute from pruned trees in 1972 to 8.9 from checks in 1971. Differences in cones harvested per minute were not significant among treatments for the first 5 years. In 1976, however, collection rates were significantly different because the checks had 31/2 times more cones than pruned trees. When data for all 6 years were combined, differences in collection rates between pruned and check trees were not significant.

Tree growth.—The average 5year d.b.h. growth of check trees was significantly greater than the average d.b.h. growth of pruned trees. Initially, pruned and weighted trees averaged 6.2 inches d.b.h. while check trees averaged 6.4 inches. From 1971-76, pruned tree growth averaged 6.6 inches; weighted trees' growth averaged 7.0 inches. Control tree growth averaged 8.1 inches.

Check trees averaged 25 feet in height when the study began, and 44 feet after 5 years. Initially, pruned trees averaged 21 feet in height after treatment. Five years later pruned trees had increased an average of 7 feet in height. Weighted trees averaged 22 feet after topping in 1971 and 38 feet 5 years later.

Conclusions

Neither pruning trees nor bending branches can be recommended for increasing cone production or collection rates in loblolly pine seed orchards. The only justification for pruning trees would be to keep them at collectable heights if bucket trucks are unavailable or prohibitively expensive. If pruning is done, it should be understood that subsequent cone crops are likely to be reduced significantly.

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