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Tree Seed Working Group

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CROWN MANAGEMENT STUDIES AND PRACTICES IN CANADA

by Ron Smith

I have to start this article off with a note of thanks to everyone who took the time to reply to my request for information on crown management. To say the response was tremendous, would be an understatement (as well as a bad pun). So much interesting and valuable material came in that it was extremely difficult to read it all, let alone try to digest it, and then distill it down to a size that would be appropriate for this Newsbulletin. I also received several lovely colour photographs. Unfortunately, our illustrious Editor Hugh has neither the facilities for colour photo reproduction nor the budget. I ensure you however, that the photos haven't gone to waste and that they occupy a prominent place in my office. Again, sincere thanks.

History of early work in crown management

Some crown management work was conducted in the 1960s. This effort paralleled earlier work in the U.S. which was remedial in nature, that is, at the time the trees were topped, they had already become a problem because of their height. Most of these catch-up treatments were fairly severe (a large portion of the live crown was removed). This was necessary at the time, since cone collecting had already become prohibitively difficult, and in some cases impossible with existing equipment. The heavy topping inevitably resulted in significant reductions in cone production, and in some cases, a concomitant increase in selling further reduced seed production.

It was not until the 1970s however, that large scale applied tree improvement programs, and the establishment of seed orchards began in most of the country (acknowledging that some earlier work resulted in seed orchards being planted in Ontario and B.C. in the 1960s). Consequently, most orchards in Canada are relatively young, so that cones can still be collected using ladders or relatively small lift devices. However, this will not be the case for long!

Summary of Current Crown Management Practices

The strong interest shown in crown management across the country shows that we have learned from earlier experiences. There is certainly a consensus that it is unacceptable to wait until there is a problem with trees being too tall before beginning crown management. This awareness is particularly acute for those working in breeding halls.

Perusing Table 1 will show that most of the studies cited have two main things in common; 1) they have been started relatively recently, and 2) they are designed to keep trees at a desired size while maintaining acceptable levels of cone production. Some of the factors which influence the target height/size for the trees include breeding hall height, height of irrigation risers, and ladder or lift height.

The specific problems of crown management vary considerably with species. Three broad groups can be identified based largely on tree growth habits; 1) cedars and hemlock, 2) the spruces and firs (including Douglas fir), and 3) the pines. The groups are roughly in order of "decreasing manageability".

1) Cedars and hemlock

Work on the west coast has shown that species such as western red-cedar, Alaskan yellow-cedar and western hemlock are very management-friendly. These species can be hedged quite easily, and when hedging is combined with adjunct gibberellin treatments, a very cost effective management system can be implemented.

2) Spruces and firs

The spruces and firs both produce internodal branches quite readily, thus can usually be hedged by repeated topping treatments. Lateral branch pruning has also been used to try to increase the numbers of shoots of the 'correct vigour' for cone production. For most of the native spruces, the application of GA_{4/7} can successfully induce cones on most of the crown, including branches which would not normally bear cones. Therefore, the emphasis has been on increasing the total numbers of potential flowering sites in preparation for adjunct GA treatments. This has proven very successful. There is certainly promise even for the more recalcitrant species including Norway spruce, a species which is receiving increasing interest in eastern Canada.

3) Pines

Although there are obvious differences in growth habit between the hard and soft pines, both differ from the previous two groups in that they tend to produce relatively few internodal branches and the numbers of potential cone bearing sites are often low. Cones are usually produced on the whorl branches

subtending the leader, hence removing the main stem below the first whorl of branches also removes most of the cones on a small tree. This problem is more acute for the white pines, but also exists for species such as jack and lodgepole pines.

In order to try to increase the numbers of potential cone bearing sites in the pines, topping has been combined with treatments such as lateral branch pruning and the application of chemicals e.g., cytokinins. Most of the work to increase internodal branch production in the pines has only recently been started, hence reliable, operational systems have yet to be developed.

Related studies

I have tried to summarize the status of work directly involving crown management. There are however, a number of other related projects which have or currently are being conducted which are equally important, and in most instances, should have preceded the actual crown manipulation work. If the tree crowns are to be managed to optimise cone production you need to know where within the crown the cones are borne and on what type of branches (branch vigour). Much of this background work has been done and should be examined before undertaking any new crown management projects.

Future needs

While there are crown management studies currently underway, a number of additional study areas require investigation.

1) Little work has been published on the effects of crown management on both seed quantity, and quality. Anyone working on a crown management study, or who intends to begin one, should also examine the quantity and quality of seed obtained following treatments. Reductions in the numbers of seed produced per tree may be acceptable provided the quality of that seed is good. Seed quality assessments are particularly important when combining crown manipulation with adjunct GA treatments.

2) When evaluating any crown management project, include a comparison of the numbers of cones per tree versus the numbers of trees per hectare. Reducing individual tree size may allow you to plant at a closer spacing. A cost-benefit analysis is needed to determine the most economical balance between the two. This will prove of particular value when planning orchard area requirements for the next generation orchards.

3) There is definitely a need for further research into methods of increasing branch (fascicular bud) production in the pines. The problem of white pine grafts being spindly with few internodal branches is a universal one which has yet to be solved adequately.

4) Although much excellent work has been done combining top pruning with root pruning in potted grafts, this 'bonsai' approach needs to be developed further for many additional species, especially the pines.

5) A system for balancing seed cone with pollen cone production has yet to be fine-tuned for most of our species.

6) The field of crown management in the larches is wide open!!

In the interest of saving space, Table 1 only provides the names of the contributors (contacts). The names and addresses of the members of the Tree Seed Working Group were published in the March 1988 Newsletter (#9), and most of the contacts are listed there. If you wish to contact someone from the list but cannot obtain his/her address, contact Ron Smith.

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Table 1. Summary of crown management practices and studies in Canada.

SPECIES	CONTACT	GRAFTED (G) SEEDLING (S) ROOTED CUTTING (RC)	POTTED (P) CONVENTIONAL ORCHARD (G)	YEAR WORK BEGAN	AGE(S) TREES	AMOUNT OF TOP REMOVED	TIMING	ADJUNCT TREATMENTS	SUMMARY OF FINDINGS TO DATE
Pj	Al Nanka	G		1981	4 - 8	50% of leader	When candle was 90% elongated (approx. Mid- June)	Upper whorl shoots pruned as per leader.	1. Developed stocky stems. 2. Developed thicker and longer branches with multi-lateral shoots. 3. Numbers of female flowers increased approx. 2 and 3 fold the second and third year after pruning. 4. The same response was achieved by pruning grafts at 1m and 1.5m heights.
	Diane Roddy	G	G			1/3 to 1/2 of leader	When candle is 90% + elongated (approx. mid- June)	Upper whorl shoots pruned as per leader shoots were pruned just above the new flowers.	This level of topping/pruning did not control height growth to the desired extent, so some mild 'topping' was tried in 1989.
	Willard Fogal Hugh Schooley	S	G		5 - 10	Leader only to 3-4 years growth.			On 5 year old trees in containers: 1. Removing either 1 or 2 years of growth reduced seed and pollen cone production. 2. Pollen production was reduced to a greater extent, especially for trees topped more heavily.
	Peter Nitschke	G	G	1989	8+	1 to 1 1/2 years' growth	July	Pruning 50% growth of top whorl of branches.	1. No results as yet, the topping removed from 10 to 20 first year conelets per graft.
Paw	Cathy Nielson	G	P	1989	3	Limit leader growth to 12 inches	When needles were 50% elongated.	Tips of lateral branches removed Cytokinin applied once weekly for 8 weeks commencing at bud break.	No results as yet.
	Frank Schnckenburger	G	P	1988	2 - 3	1/3 to 2/3 of leader		Pruned from 1/3 to 2/3 of terminal shoots from either just the first whorl or from all whorls.	1. Increased production of fascicular buds. 2. Increased pollen production.
	Steve Ross Clare Hewson Maarten Albricht	G	G	1988	10 - 19	25 - 60% Live Crown	November 1988	Topped back to just above a whorl. (4 to 6 years of growth +) Some lower branches removed to improve equipment accessibility.	
PL	Steve Ross Clare Hewson Maarten Albricht	G	G	1988	10 - 19	25 - 60% Live Crown	November 1988	Topped back to just above a whorl. (4 to 6 years of growth +) Some lower branches removed to improve equipment accessibility.	
Pww	Steve Ross Clare Hewson Maarten Albricht K. Cox	S	G	To begin 1990	10	1. 2/3 total stem 2. Pruned 25 cm above whorl when trees reach 3m height	Pruning in June	Subsequent pruning to be determined. Annual shaping to be done by removing terminal buds of leaders showing dominance: target is to produce 2 - 3 stems.	

Table 1. cont'd.

D Fir	Rong Ho		G	1960's	20+				Following topping, a hole was drilled into the stem and IAA applied in a lanolin paste.	Controlled apical dominance for about five years.
	Joe Webber	S	G		10 - 12				Combination of root pruning and crown pruning.	Used to control the size of potted research stock; both height and branch vigour.
	Tim Crowder	G	G				July			Operational: to control height.
						Leaders pruned back to leave 30 to 45 cm.				
		G	G		25	Removed 25 or 50% live crown				Both severely depressed cone production however, the study was not continued long enough to be conclusive.
	Joy Parkinson	G	G		3 - 10	Leader growth restricted to 45cm	Top pruning is done in June just above a bud to maintain a single leader.	Younger trees are pruned to shape; longer branches cut back to 1/2 length.		Early pruned trees thus far have responded well; good numbers of branches on which to produce cones.
		G	G		20 - 30	Trees topped back to approx 4m.		Trees topped above a whorl. All branches except one from that whorl are also removed.		Topping alone resulted in a "Basket Top"; cone picking inside the basket proved difficult. Leaving a single whorl branch produced a crown that was workable.
Hw	Steve Ross	G	G				Pruned in the winter prior to cone induction.	Pruning is done biennially.		Pruning is done routinely to maintain grafts at a manageable size (< 2m height).
	Steve Ross R. Curell	S	G	1982	7	Removed up to 4 years growth Cut 5 - 10 cm above whorl.	February	Adjunct crown branch thinning GA 4/7 also applied.		1. Branch thinning slightly depressed height extension. 2. Male and female flowering were reduced to varying degrees depending on the level of topir and/or crown thinning.
	Tim Crowder	G	G			Topped at 2m		Laterals pruned to form a bush.		Successfully produces a 'Bush'.
	Steve Ross	RC	G	1982	7 - 8	25% or 50% live crown removed	February	Trees were repruned to varying degrees adjunct 6 Aug (7 treatments).		Successfully maintained trees at an acceptable size without a significant reduction in seed and pollen cone production.
	Joy Parkinson	G	G		5 - 10	Maintaining trees at 2 - 3m ht.	February	Trees were repruned to varying degrees adjunct 6 Aug (7 treatments).		Reduced operating costs more than offset any reduction in cone production. Can also grow more trees per hectare to compensate.
Cedars WR - YC	Joy Parkinson	G	G			Maintaining trees at 2 - 3m ht.				Reduced operating costs more than offset any reduction in cone production. Can also grow more trees per hectare to compensate.
	Tim Crowder	G	G			WR - topped at 2m YC - topped at 3m		Trees spaced at 1.1m to form a hedge.		

Table 1. cont'd.

Sw	Lynn Palmer	G	G	20	Leader and various amounts of previous years' growth				
	Joe Webber	S	P	10 - 12				Combination of root pruning and crown pruning.	1. Used to control the size of potted research stock; both height and branch vigour.
	Peter Nitschke Ron Smith	G	G	5 +	1 1/2 years' growth removed	When leader has fully elongated (mid-July).		With or without removal of terminal whorl from 1988 whorl branches.	
	Ron Smith Tom Matheson	G	G	8 +	1 1/2 years' growth removed	When leader has fully elongated (mid-July).		With or without removal of terminal whorl from 1988 whorl branches.	
	Dale Simpson	G	G	5 - 10	50% of leader + 50% of upturned laterals	September		GA 4/7	1. Increase in seed and pollen cones on trees topped once. 2. Decrease in seed cones and increase in pollen cones on trees topped 2 and 3 consecutive years.
Sb	Ray LeBlanc Doug Mathews Tom Matheson Ron Smith	S	G	8 - 10	1 1/2 to 2 years' growth removed	Various Timings 1. When leader 90% elongated (approx. late June) 2. When leader is 90% lignified (mid-August) 3. Late fall.		Treatments were repeated in 1989 in a factorial design in two locations.	1. First year results indicate that cone production the year following treatment was significantly reduced for trees in which two years growth was removed, but not when 1 1/2 years growth was removed. 2. Removing 1 1/2 years growth resulted in an increase in cone production lower in crown (slightly reduced total cone production as compared to the controls).
	Lynn Palmer	S	G	8	2/3 leader removed	End of growing season.			No results as yet
		G	G	20	Leader and various amounts of previous years' growth.				
Sw/SE (interior)	Steve Ross Clare Hewson Maarten Albrecht			17	1. 50% live crown 2. Leader back to 15cm 3. Topping back to a height of 5m	March June March		Trees to be managed operationally. Some adjunct cone induction work may be carried out.	
	Steve Ross	G	P			Pruned in the winter prior to cone induction.		Pruning is done biennially.	Pruning is done routinely to maintain the grafts at a manageable size (< 3m height).