CROWN MANAGEMENT IN CONIFER SEED ORCHARDS

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ABSTRACT

Crown architecture in northeastern conifers as it relates to the numbers and positioning of male and female cones along shoots is briefly reviewed. The importance of using knowledge of these natural patterns in developing effective methods of crown management is discussed. The benefits of adopting crown management regimes in facilitating seed orchard management operations, as well as concerns regarding the possible impacts of crown manipulation are also briefly described.

INTRODUCTION

The size, number, and configuration of branches and shoots that comprise the crowns of conifer seed orchard trees, determine the number of potential 'flowering' sites on those trees. As with all trees, only a certain percentage of the total number of buds develop reproductively and the male and female reproductive structures are not produced randomly within the crown. In fruit orchards, considerable research has been devoted to the modifying tree crowns through the use of both cultural practices e.g. pruning, and by applying chemicals (cf. Tworkoski 2004 in these proceedings). The objective of these treatments is to both increase the quantity and quality of fruit produced and to improve the accessibility to the crop that is produced. The same needs exist in conifer seed orchards however methods for crown management are considerably less well developed than for fruit trees. This paper will briefly review current practices in crown management of conifer seed orchards.

Patterns of cone production

Forest tree seed orchards are established and managed to produce regular, abundant quantities of high-quality cones and seeds. Applying gibberellic acid (GA) can successfully increase 'flowering' in most conifers, but it only affects the proportion of the total potential flowering-sites e.g., buds, that develop reproductively, and generally does not increase the number of flowering sites. If crown management regimes are to be developed that effectively result in trees with more branches, and concomitantly, more flowering sites than comparable untreated trees, the natural cone-production patterns must be known.

For spruces and firs, there exists a sexual zonation in which seed cones are generally produced on branches in the upper one-third of the crown with pollen buds being produced on branches below the female buds. In pines and larches, seed cones are typically borne on the outside of the live crown and on the vigorous lower branches (cf. Powell et al 1984;Tosh and Powell 1991).

Topping seed orchard trees

The amount by which total tree height is reduced following topping is a function of how much stem per leader is removed, the time of year when the tops are cut, the age (height) of the trees when topped, and how often the trees are topped. The two basic approaches to topping are

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regular “light” and periodic “heavy” toppings. The terms top-pruning, or hedging, have also been used to describe the periodic removal of the main leaders to create a short compact crown.

Regular “light” toppings: On a vigorous tree, “releasing” the lateral branches from apical dominance results in their quickly become “reinvigorated.” This approach has been done effectively for meadow or miniaturized orchards in some southern pines (cf. Sweet et al. 1992) as well as in western hemlock orchards (Ross 1989).

Periodic “heavy” toppings: A severe or heavy topping, herein defined as removing more than 4 years’ growth, is usually considered to be a remedial treatment that is done when the trees have already become too tall for practical cone collection (Smith and Adam 2003). Almost without exception, severe toppings will reduce cone production in the short-to-medium term (2+ to 4+ years). However, it may be acceptable to conduct a severe topping in instances when seed is not in short supply. When necessary, severe topping is most cost-effective when done in conjunction with cone harvesting; cones can be picked from the tops that are removed.

Topping should not be considered a “one-time only” treatment. Although the term “regularly” is open to interpretation, topping to coincide with cone harvesting will likely result in orchard trees being topped every 2 to 4 years. It is also possible to set a maximum height that you will allow the orchard trees to attain. While it may not be possible (practical) to keep trees at a fixed height indefinitely, good height control can still be achieved.

Given that the position and order of branches and shoots that bear reproductive structures varies considerably among species and genera, crown management prescriptions likewise vary. Specific crown management recommendations by species are given in Smith and Adam (2003) and thus will not be discussed here.

Lateral branch pruning

Shearing, or lateral branch pruning, may be used to increase the bushiness of the crown, and by inference, increase the numbers of potential flowering sites. Research describing the effects of pruning regimes on cone production are limited. In one study with white spruce, combining topping with lateral branch pruning did not prove to be operationally practical because a) trees receiving topping plus lateral branch pruning treatments produced significantly fewer cones than those that were only topped, and b) the lateral branch pruning proved to be a very labour intensive, and thus costly, operation (Smith and Yeates 1989). “Pinching” elongating shoots in jack pine to try to increase the numbers of flowering sites (long-shoot buds) has been studied in Ontario. However, as with spruces, it is a costly effort, and a beneficial effect over topping alone has yet to be demonstrated. For more details on the procedures tested, see Atack (1994).

The following summary of crown management treatments and recommendations for western larch seed orchards are summarized from Webber et al. (2003)).

Topping and forming are two general approaches used operationally for crown management in western larch seed orchards. These two treatments are similar to the “heavy” and “light” topping treatments described previously for the spruces. Topping is used primarily for trees 5 to 6 m or taller where 25 to 50% of the crown is removed while crown forming begins on younger material (2- to 3-year-old grafts) to enhance the number of potential flowering sites and create a more compact crown. The results from this work clearly indicated the importance of starting crown management treatments when the trees are young.

Plant Growth Regulators (PGRs)

Little research has been done to evaluate the potential of PGRs in controlling tree height and crown development in conifer seed orchards. In 1993 and 1994, trees in a Norway spruce (Picea abies) clonal seed orchard were injected with different rates of paclobutrazol (Confer ® (ICI Agrochemicals, now Zeneca Agro)). Although the objective of the trial was to determine if bud development could be delayed in 'early' developing clones and thereby increase the synchronicity of seed-cone receptivity and pollen dispersal among clones within the orchard, detailed shoot growth measurements were also taken. In 1993, the injection rates of 0, 1, 5, and 10 mg of paclobutrazol per tree did not affect mean shoot length in 1993, the treatment year, and only resulted in modest reductions in mean 1994 shoot lengths, 2% and 11%, for the medium and high rates respectively. In 1994, injection rates were increased to 50, 100 and 200 mg/tree. As found in 1993, treatments had no effect the year of treatment, and only a modest effect the second year. Mean shoot length of the trees in 1995, was approximately 11% less than that for the untreated controls. (see Frame and Steeves 1995 for more details on these trials).

In canvassing seed orchard managers from 20 conifer seed orchards in North America and Europe, none reported using plant growth regulators for the purpose of crown management. Therefore, at this time, there appears to be no examples of plant growth regulators that can cost-effectively be used to regulate crown growth in conifer seed orchards.

Potential concerns with topping seed orchard trees

The following discussions on 'concerns' regarding crown management of conifer seed orchard trees have been summarized from Smith and Adam 2003).

Reduced Cone Production. When severe or remedial topping treatments are applied, cone production in the years following is often reduced. This reduction is often more pronounced in pines (cf Stoehr et al. 1995) than for spruces or larches (cf Webber et al. 2003, Smith and Yeates 1993). In the latter genera, reductions are typically modest and often short-lived e.g., 1 to 2 years following treatment. In many instances, the resulting multiple tops produced more cones than the untopped controls 3 or 4 years following topping, as observed in these trials. Further, stem injections of GA should more than offset any possible reduction in cone production in the years following topping.

Increased Selfing. Few studies have evaluated seed data following topping in seed orchards. It has been shown that in wild stands with mature trees, severe topping often reduces the numbers of sound seed per cone (i.e., it increases the numbers of empty seeds). It is generally assumed that the increased levels of empty seeds observed reflects increased levels of selfing resulting from overlapping of the branches bearing female and male flowers, e.g., bringing the flowers of the different sexes closer together. Although a reasonable concern, little research has been done to support this hypothesis. Conversely, in seed orchards, topping has not resulted in reduced seed set in jack pine (Klein and Chapman 1996) or white and black spruce orchards (Smith unpubl. data 2003). There have not been any published studies in which the long-term seed yields between topped and untopped orchard trees has been compared. Should increased selfing become a concern in orchards, supplemental-mass pollination (SMP) can be effectively used to correct any potential problems.

Increased Susceptibility to Physical Damage. Topped trees could be made more susceptible to wind breakage, wind-throw, and branch collapse because of dense foliage on branches and dense thick crowns (cf. Ho and Schooley 1995). However, this has yet to be noted in any of the Maritime seed orchards in which topping became a routine management practice over 10 years ago.

Improved Habitat for Insects. It has been postulated that orchard trees with dense compact crowns may be more susceptible to damage by cone and seed insects (cf Ho and Schooley 1995), but this has not been examined in great detail. Conversely, there was no difference between untopped and topped trees in either the incidence of cone and seed insects or their damage in white spruce clonal orchards (Mercier et al. 2000). On the positive side, the efficiency of cone and seed insect control (improved access to the cones with sprayers) is better with shorter trees (Smith and Adam 2003).

Although these issues are potential problems, the benefits to be gained from correctly applied topping outweigh the potential negatives. The benefits include reduced costs to collect cones, easier access to those cones, and increased worker safety when shorter ladders or no ladders at all are required.

ACKNOWLEDGEMENTS

I wish to thank Caroline Simpson for editing this manuscript and Laurie Yeates for technical support. Thanks also to Tom Matheson. Kimberley Clark, Nova Scotia, Howard Frame and Al Smith, Nova Scotia Dept. Natural Resources, Kathy Tosh, New Brunswick Dept. Natural Resources, and Ray Leblanc, Nexfor Fraser Papers Inc. for providing access to seed orchards.

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