STUDENT HIGHLIGHTS

This special supplement to the Poplar Council of Canada's newsletter highlights several articles from students across Canada.

Spatial Aspects of Competition between Weeds and Trees in Hybrid Poplar Plantations

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Intensive short-rotation forest plantations which target the production of pulpwood aim for high volume production. To yield high biomass over relatively short rotations of less than 20 years, plantation vegetation management relies on knowledge of interspecific competition dynamics between the understory vegetation and trees and the impacts on tree yield. Various studies report negative impacts of weeds on tree performance during the early establishment period (Wagner 2005). However, the causes of tree yield losses and the effects of weed control practices still remains an open question. The current study is investigating the dominant form of interspecific competition in order to improve vegetation management practices and thereby plantation profitability and reliability.

When tree performance is reduced in the presence of weeds, it is assumed to be a result of competition between trees and weeds for aboveground and/or belowground resources. This involves competition for light, nutrients and/or water. Furthermore, there is evidence that the impact of understory vegetation on tree performance may vary spatially and temporarily. However, little is known about the generality of interactions between above- and belowground competition and the impact of spatial variation of understory vegetation on plantation tree performance.

A study investigating hybrid poplar growth reported yield losses due to intense belowground competition for nutrients in the presence of weeds (Bachitter et al. 2007),

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while other studies concluded that aboveground competition for light dominates interspecific interactions (Sage 1999, Monteith 1977). Additionally, the spatial variation of the impact of understory vegetation on tree performance and the effectiveness of vegetation control close to the tree base is highlighted (Powell and Bork 2004, Otto et al. 2000).

The current study is assessing the spatial impacts of competing vegetation on tree performance. This includes the spatial isolation of aboveground and belowground competition as well as the spatial isolation of competition near (<50 cm) and far (50 cm to 1.4 m) from the tree bole. In order to isolate these effects, six different treatments are being applied at a 1.4 m basic radius around each assigned tree. Treatments include manual removal of aboveground competition within three different distances from the tree bole, and removal of above- and belowground competition through application of herbicides and installation of root exclusion barriers within two different distances as well as no weed removal as the control treatment. In total, 18 blocks at three sites will be assessed. Each block contains 25 assigned individuals of both "Walker" and "Okanese" poplar clones. Furthermore, the effect of root exclusion barriers on tree performance is being assessed in a supplemental study. This study contains 3 blocks, each containing 25 individuals of both poplar clones with half assigned with root barriers and half as a control.

An understanding of the relative importance of competitive interactions between trees and the understory is essential to the planning, establishment and maintenance of economically successful plantations. By assessing spatial aspects of interspecific competition dynamics and weed practices, this study will lead to target-oriented management implications for the establishment of hybrid poplar plantations.

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Alternative Establishment Systems to Enhance Tree Performance in Hybrid Poplar Plantations

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To act as a long-term, sustainable supplier for the commercial production of wood, hybrid poplar plantations need to reach high profitability. Despite existing uncertainties over potential risks, poplar plantation culture can be feasible given appropriate selection and use of planting materials, sites and silvicultural treatments (Volney et al. 2005). Alternative methods of establishing plantations may offer both economic and environmental benefits. Despite this, little is known about the overall effect of these alternative establishment systems on tree establishment, survival and growth. This was the objective of the current study, with the goal of increasing long-term plantation

productivity while simultaneously reducing the costs of plantation establishment.

At present, commercial plantation systems aim for rapid, high volume production over relatively short rotation periods (< 20 years). To achieve this, intensive and costly silvicultural practices covering the whole plantation are often used including repeated herbicide application and soil cultivation (van Oosten 2006). These treatments are founded on the concern that even low weed densities can reduce tree performance and result in fiber yield loss. Thus, standard operating practices aim for maximum weed control with a target of 90% or better weed control at planting (van Oosten 2006). The underlying assumption of this practice is that hybrid poplar performs best in a field free of competing vegetation, and that any belowground or aboveground interaction between trees and ground vegetation (weeds or cover crops) will negatively impact tree survival and yield (van Oosten 2006). However, a neighboring cover crop of herbaceous vegetation may also provide benefits, such as reduced evaporative water loss, a decreased risk of soil erosion, and a variety of environmental benefits such as carbon sequestration and the provision of wildlife habitat. Moreover, cover crops may reduce plantation maintenance costs in the form of cultivation and/or herbicide application.

This study is testing four different establishment systems and weed control practices for hybrid poplar trees in monoculture plantations. These treatments include (1) a full year of fallow prior to planting (2) the use of a short-statured, non-creeping cover crop of white clover and creeping red fescue seeded into fallowed fields at the time of tree planting (3) planting of poplars into untilled fields following vegetation suppression using herbicide, and (4) Business-as-usual, involving conventional cultivation, planting and ongoing weed suppression. A total of 15 blocks are being assessed, each containing all four treatments; each treatment plot contains 20 individuals of each of “Walker” and “Okanese” clones. Within each plot, 12 individually marked trees will be assessed for initial diameter and height; growth and survival will be monitored over two growing seasons.

Weed control practices influence weed communities by reducing plant density and altering species composition, which in turn affects tree performance. The degree of weed control necessary to optimize plantation performance depends on relative impact of specific weed control measures on weed suppression and subsequent improvements on tree performance. By quantifying the effects of different plantation establishment and weed control approaches, this study will contribute to our understanding of key factors influencing poplar tree performance. This in turn, can lead to target-oriented vegetation management practices for plantations, thereby reducing maintenance costs and increasing fiber production, and thereby increasing overall profitability.

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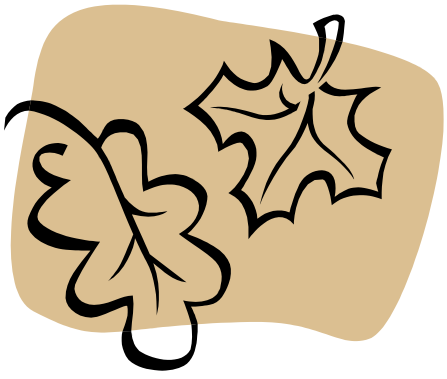

Physiological Comparison of *Salix* Cultivars Used for Decontamination of Polluted Soils

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My current research projects are part of a larger multidisciplinary study called GenoRem. GenoRem project reunites many scientists from l'Université de Montréal and McGill University in a quest for studying the different mechanisms used for phytoremediation. The development of these mechanisms is also the objective of GenoRem, again, for phytoremediation purposes. Many aspects are studied and explored; the association of different fungi, bacteria and plants carefully selected in light of their known remediation characteristics and of their tolerance to environmental stress. More specifically, many willow (*Salix*) cultivars are studied, mainly due to their ease in growing in polluted soils, their rapid growth, their phytoextraction and phytodegradation capacities and for the numerous symbiotic relationships they are able to maintain with the microbial flora.

My work focuses on the identification of willow cultivars that are particularly efficient, that have an important biomass, have a rapid metabolism and also have a strong tolerance to PAHs (polycyclic aromatic hydrocarbons) and PCPs (polychlorinated biphenyls) contaminated environment. In order to attain my objective of identification of these willows, experimental installations were installed in the summer of 2011 on soils contaminated by the activity of a petroleum refinery. These installations were composed of two main areas; one that was contaminated and one that was clean and serves as a control. The site of my study has been designed so that the blocks are localized in a randomized manner and they all contain 11 cultivars of willows (S54, SX61, Millbrook, S44, SV1, SX67, S05, S25, S365, Fishcreek and S33). This summer marks the first complete season where we will be able to observe the growth of the individuals. In order to accomplish my objectives, many different measures of physiological parameters (stomatal conductance, the dosage of leaf pigments, measure of the fluorescence of the chlorophyll and of the leaf area) will be taken throughout the season. This will be done in order to evaluate the health and establishment of the specimens of interest. Also to achieve my goals, a set of biochemical measures will be performed on the cultivars. For example, the dosage of different enzymes implicated in the plant response to abiotic perturbations, glutamine synthetase for instance, for which the concentration in the organism varies according to the stress level in the plant and affect the biosynthesis of chlorophyll pigments.

The results of these analyses will allow us to have a better idea of the appropriate cultivars to select when performing phytoremediation in the future. It will also be interesting to see if the selected willows have the capacity to associate themselves with soil microorganisms in order to amplify their decontamination capacity and efficiency.

What is more beautiful than a tree in autumn dress, than a forest aflame with colour.

- James I. Vance

Growing for the Future: Improved Weed Control in Hybrid Poplar Plantations

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Introduction

Plantations of hybrid poplar are used by the pulp industry in Canada to increase fiber supply, reduce transportation costs, and decrease dependence on naturally forested land. Alberta-Pacific (Al-Pac) Forest Industries Inc. has established hybrid poplar plantations on > 10,000 ha of land previously used for agriculture. With a target rotation of less than 20 years it is important that these plantations be managed for maximum biomass, which includes minimizing the impact of weeds.

Competitive pressure from weeds within poplar plantations is a primary reason that many trees fail to reach their full growth potential. However, there is little information available on the impact of weed composition, abundance, or spatial relations to the well-being of nearby trees. During the growing seasons of 2011 and 2012, the University of Alberta has been quantifying the influence of these factors on the growth of hybrid poplar saplings. Results of this research will greatly aid in the formation of an integrated weed-management plan for future silvicultural operations.

Experimental Approach

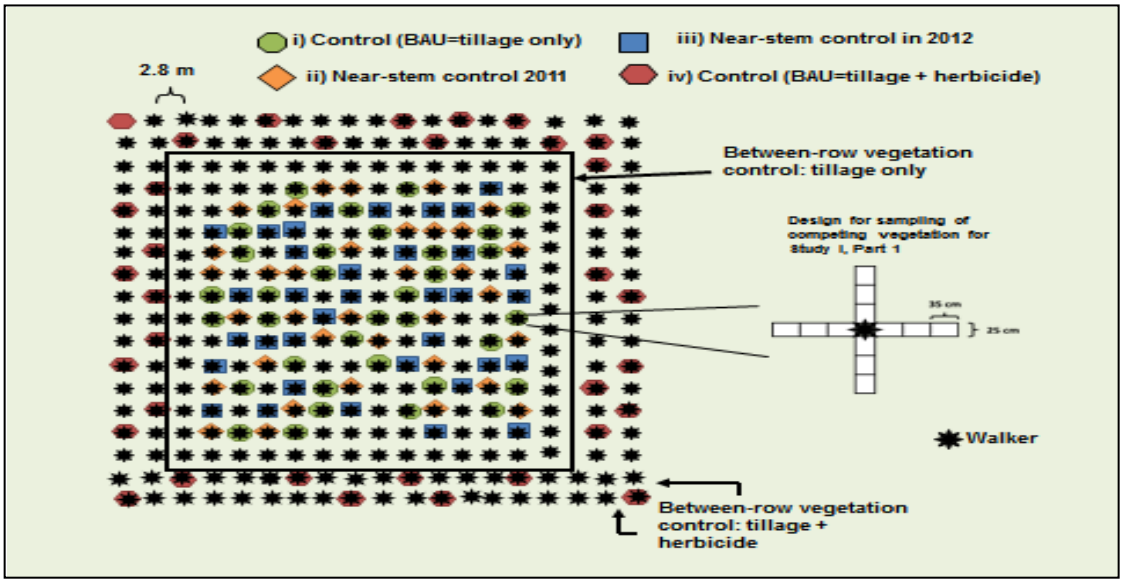
Four experimental blocks planted with 140 'Walker' trees were selected from recently established plantations near Athabasca, AB. Each tree was initially measured for height and basal diameter, and then measured again at the end of each growing season.

The first part of the study involves monitoring tree growth (height, basal diameter) and mortality, along with the abundance and composition of competing vegetation at different distances from the trees. Within each block weedy vegetation is allowed to flourish alongside developing poplar trees. Vegetation is then visually assessed for composition, abundance, and proximity to the tree in June and August of each year. Analysis of the data will quantify the effects of competing vegetation of different types and at different distances from the tree and help determine the critical point for weed control (CPWC) along with fiber yield loss under differing weed communities.

Part 2 complements part 1 by actively manipulating the weed community and observing the resulting effects on tree growth. In part 2 trees were assigned to one of four vegetation control treatments: i) control (between-row cultivation); ii) near-stem vegetation suppression in the 2nd growing season and thereafter; iii) near-stem vegetation suppression in the 3rd growing season and thereafter; and iv) 'business-as-usual'(BAU) which involves the tillage of alleyway vegetation and a spring herbicide treatment. Each study tree also receives an assessment of competing vegetation as described in part 1.

This experiment will allow for comparison of relative tree growth rates when weed control is initiated at different times after plantation establishment. Furthermore, we will be able to compare the relative effectiveness of tillage versus tillage + herbicide as operational weed control tools, with associated implications for plantation maintenance.

Figure 1. Experimental design for part 2.



Conclusion

Competition from weeds prevents hybrid poplar trees from achieving optimal growth rates and profit for the forest industry. This investigation seeks to understand the relative importance of the factors that govern the impact of weeds on poplar sapling performance during the early establishment phase. It is expected that these results will lead to improved integrated weed management plans capable of maximizing tree growth while minimizing vegetation control costs.

SAVE THE DATE:

Future Poplar Council of Canada Annual General Meetings:

2013 – Charlottetown, P.E.I. – June 17-21, 2013 - in conjunction with the Association for Temperate Agroforestry. http://2013naac.com

2014 – Vancouver, B.C. – July 20-28-, 2014 - in conjunction with the IPS VI meeting being organized by Cees van Oosten and University of British Columbia as the host organization. www.2014ipsvi.com