

Summary of 2008 Research

Adelgid Studies

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Background:

Adelgids (Hemiptera: Adelgidae) are conifer seed orchard pests that threaten the fulfillment of a B.C. Government goal that by 2013, 75% of forestry seed used for regeneration will be supplied from seed orchards (BC Ministry of Forests and Range 2007). Adelgids induce galls on the reproductive and vegetative shoots of spruce trees, reducing the number of future cone sites. Adelgid feeding on the cones and needles of alternate conifer hosts, such as larch and Douglas-fir, can reduce seed extraction efficiency, and cause discoloration and twisting of needles.

Roughly 60% of the spruce seedlings used for reforestation in BC are the product of seed harvested from seed orchards (BC Ministry of Forests and Range 2007a). Orchards are the link between breeding and silviculture, and they are the conduit for packaging the genetic gain. Seed orchards, such as the Kalamalka Seed Orchard, are intensively managed for frequent and abundant seed production. Losses incurred by adelgid pests are of high importance.

Research goals achieved for 2008:

The goal of our research was to clarify the role of fundatrices and gallicolae in the gall formation process, to determine if susceptibility to adelgid induced galling has a genetic basis, and to associate the different gall structures with the inducing adelgid species.

1. Verifying the role of fundatrices and gallicolae in gall formation

Through manipulative laboratory experiments (2007 & 2008) we isolated fundatrices from gallicolae to determine the influence of each life stage on the development of spruce shoots. We found that gallicolae were not able to induce a gall or survive without the influence of their fundatrix mother. Fundatrices without gallicolae did induce early galling symptoms on the shoots but a complete gall was not formed. Upon dissection of those shoots no gall chambers were visible. We have a set of rigorous results for the fundatrix without gallicolae treatment from our 2008 study only because many samples in 2007 were contaminated (gallicolae observed on the treatment buds). A set of controls, that is branches with fundatrices and gallicolae, did form complete galls with developed gall chambers. The study designs were similar for 2007 and 2008 except that in 2007 we had an additional treatment. Gallicolae (as eggs) were switched among fundatrices to determine if unrelated gallicolae and fundatrices could form a gall.

Our results demonstrated that fundatrices and gallicolae are both required to form a complete gall, yet they can be unrelated. Considering the fundatrix is required to stimulate galling it would be sufficient to include only fundatrices in a monitoring system. This supports the current management approach used by the KFC where they use fundatrix densities to recommend spring spraying for adelgid management.

Additionally, we used botanical histological techniques to section tissues from various phases of gall growth to further clarify the affects of the fundatrix and gallicolae on the developing buds. Sections suggest that fundatrices release a stimulus that initiates the proliferation of parenchyma in the sterigmata region. As the gallicolae colonize the bud their activity continues to stimulate the formation of gall parenchyma until gall chambers are formed. Gall chambers are lined with cytoplasmically dense tissues that supply the gallicolae with a nutrition source.

2. Determining if there is genetic susceptibility of spruce to gall forming adelgids.

In July and August of 2007 and 2008, the current year's adelgid galls were assessed (2007: 100% sampling, 1492 trees; 2008: 33%, 497 trees) in a 13-parent incomplete, partial diallel, replicated progeny test with 42 full sibling families. This plantation is located in the north-east corner of KFC and was established in 1995. Damage was quantified by the number of the current year's galls on an individual tree basis. We considered the adelgid attack as a binary attribute (0, 1) following a Bernoulli distribution. A generalized additive linear mixed model was fit to the response variable with logit link function. The model was run with the ASReml software by Fikret Isik (North Carolina State University) with the advice of Yousry El-Kassaby. We found strong evidence of genetic control of susceptibility with modest individual, and high half- and full-sib family narrow sense heritability. Breeding values for each spruce tree parent also suggested that parental susceptibility to adelgid galling could be selected for. The benefits of screening for adelgid galling susceptibility could be used as a screening criterion for parental inclusion into future establishment of seed orchards.

A manuscript has been submitted to the Canadian Journal of Forest Research.

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3. Relating adelgid species to the unique gall structure they form.

In the summer of 2007 we photographed and bagged a variety of adelgid galls at the Kalamalka Research Centre. We continued to expand the variety of galls in the summer of 2008. Approximately twenty galls were photographed (Dion Manastyrski), and alates were collected for characterization from the Skimikin Seed Orchard. Emerging alates were collected and identified to species. We were able to successfully characterize galls induced by *A. cooleyi* and *A. lariciatus*, however alates from *Pineus pinifoliae*, *P. boycei*, *P. similis*, and *P. floccus* showed a wide range of variation in the alate morphology and the gall structures induced by each individual species. Subsets of each alate sample were sent to Kimberly Wallin (University of Vermont) and Nathan Havill (Yale University) for DNA barcoding. DNA barcoding will determine if the morphological characteristics are in fact adequate in identifying the alates and verify the adelgids associated with the gall structures. Details from this project will be passed on to Robb Bennett.

Conclusion:

The increased depth of knowledge of adelgids and their galls will enhance current management, and will lead to new insights in adelgid biology, host response, and possibly provide new avenues for monitoring and pest control.

Thanks for all your support!! A detailed review of this research can be found in my thesis (will be available electronically through the UBC Library) or you can contact me via email (babitab@interchange.ubc.ca)

Thanks again☺

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