Activity Report

on

Leptoglossus Mark-Release-Recapture Study

(BC Ministry of Forests)

May 08-March 09

Background

The western conifer seed bug, Leptoglossus occidentalis, is the most important seed orchard pest in BC. Adults and nymphs feeding on immature cones are known to cause severe reduction in seed set in lodgepole pine (Koerber 1963; Strong et al. 2001; Bates et al 2002). This species of tree has been most affected by the mountain pine beetle infestation and as a result large number of seeds are required to achieve the provinces reforestation targets. Despite multiple yearly pesticide applications, this pest still causes significant seed loss, and is therefore an economic concern for the reforestation programs in British Columbia.

While there is much information available on the biology of L. occidentalis and the seed reduction it may cause at different stages of its life cycle (Bates et al 2005; Strong 2006), little is known about the dispersal characteristics of this pest, and there is no satisfying monitoring protocol or means of quantifying the population in an infected orchard. As of yet, there are no effective trapping devices to use in determining population levels, and there has been no attempt at deriving an economic threshold. More information is required to develop efficient and effective pest management strategies.

To address the lack of adequate information, a research program designed to study movement of L. occidentalis and obtain population estimates was initiated by Drs. Desjardins and Strong. As part of this collaboration, preliminary individual mark-recapture studies were undertaken in 2006 and 2007 to assess methods of collecting, marking, and releasing insects (Desjardins 2007).

The research program was expanded this year by Drs. Desjardins, Strong, and Lindgren, to combine a series of field investigations carried out by a graduate student at UNBC, with quantitative analysis and mathematical modeling conducted by an internship student at UBCO. Progress report on the field component of this project is included elsewhere. This document gives an account of the work accomplished on the simulation model during the Fall of 2008 as part of a MITACS Internship, and includes a financial report for the funding provided to Dr. Desjardins by the Transfer Under Agreement with the Ministry of Forests, MITACS, and UBCO.

Simulation Model

Our objective was to develop a simulation model that can be used to measure the effect of different pest management strategies on the overall seed production. This model is intended for investigation of elements of the infestation process that cannot be fully understood through field experiments alone, as well as to help identify those aspects of the problem that should constitute the focus of future field experiments.

Because of the paucity of the spatial data, we have opted to limit the scope of the project to focus on the population dynamics of L. occidentalis. Using the available biological information, we have constructed and tested a mathematical model. The model monitors a closed-population of L. occidentalis during the feeding season, which extend from May to September, and includes population growth and insect survival of each life stage (mating adults, eggs, nymphs (1st -5th instars), and new adults), cumulative feeding damages from each stage, and the effect of pesticide applications.

We designed and implemented a matrix-based model using a MATLAB environment for the simulation, and for the numerical and graphical output. We used a fixed initial population, but we modeled emergence of individuals so the population increment would coincide with the arrival rate observed in an infested seed orchard in the spring and early summer. At each step, a fecundity matrix that describes daily egg production with some seasonal variability is applied to the insect population. Because egg production occurs over an extended period, we use a kernel-based approach to redistribute the population on a temporal scale according to the length of time each individual spends at a given stage. Daily survival rates based on the life stage are applied at each step, and we also build in some stochasticity with respect to the length of time each individual spends in a particular life stage.

Our population model measures seed production, the size of the insect population and its effect on seed production, and simulates the effect of one or more pesticide applications on any chosen day. The model allows for parameters or functions modeling emergence, fecundity, or duration of any life cycle to be easily modified. In addition, the design of the implementation is modular so that such factors as immigration, or movement in and out of an orchard following a spray application, can easily be incorporated.

The simulation model was used to determine the validity of the parameters obtained from previous studies. In particular, early testing has enabled us to identify gaps in the knowledge as well as weaknesses in some of the techniques used to measure survival rates and fecundity. The sensitivity analysis also indicated those parameters that had a greater impact on the population size and subsequent seed damage.

The model provides an effective means to understand the impact of an L. occidentalis infestation and the total cost of management strategies. In the absence of exact information, it can be used to generate a variety of outcomes based on variations of certain parameters. The model can therefore inform the direction of further research and ensure that limited research funds are used in a most productive manner.

We have secured funding to continue the project for an additional six-month period. During this period, the intern will complete the testing of the model and its parameters, and will consider options to incorporate the initial invasion, dispersal, and re-invasion after spray application into the model.

Financial Statement

Revenue

BC Ministry of Forests & Range		
MRR project	15,260	
BC Accelerate Internship	7,500	
total		22,760
MITACS		
BC Accelerate Internship	7,500	
total		7,500
Total Revenue		**$30,260**

Expenses

MRR project	
Student Salaries & Benefits	10,357.08
Travel & Accommodation	1139.91
Equipment & Supplies	3763.01
total	$ 15,260
BC Accelerate Internship	
Student Salaries & Benefits	10,027.02
Travel & Accommodation	1,481.36
Equipment & Supplies	3491.62
Total	$ 15,000
Total Expenses	**$30,260**