

## QUESTIONS ABOUT THE ROLE OF SEED BUG HERBIVORY IN PRODUCTION COMING FROM INTERIOR LODGEPOLE PINE SEED ORCHARDS

Herbivory by the western conifer seed bug (*Leptoglossus occidentalis*) has been assumed to be the principal cause of substantial annual shortfalls of seed coming from lodgepole pine orchards located in the interior of British Columbia. The difference between the number of filled seeds per cone (FSPC) produced in cones protected from seed bug attacks (by being enclosed inside nylon-mesh bags) and the numbers of viable seeds coming from cones left open in the environment has been used as an indicator of the amount of seed bug herbivory taking place in these orchards. This is the 'Seed Bug Model' for losses occurring in this cropping system. Operational production records from Kalamalka lodgepole pine Seed Orchard 307 for 2001 to 2010, taken with bagging trial results from this orchard for the same years, allow us to make numerical estimates of whole-orchard FSPC shortcomings occurring annually during the past decade. These results are discussed in the context of whether they are, or are not, consistent with a Seed Bug Model.

For over fifteen years, concerted efforts have been made to establish a relationship between the number of seed bugs observed in Orchard 307 and the FSPC losses attributed to seed bug herbivory. These efforts have not been successful as no seed bug density:crop damage relationship and no economic threshold have ever been established for this cropping system. Without an economic threshold, pesticide treatments for seed bugs have never been conducted in a manner consistent with the modern practice of Integrated Pest Management. Beyond this consideration, comparisons of FSPC values derived from annual crop production statistics with FSPC values for cones held in bags show that applications of the pesticide Sevin for seed bug control never have raised operational seed yields to the levels obtained inside the bags. In fact, seed deficits of one-third or more of the crop occurred in each of eight years in which pesticides were applied for seed bug control. These results were not consistent with expectations coming from the Seed Bug Model. If FSPC losses were being caused by insect herbivory, why did treatments by an insecticide fail to increase FSPC numbers close to those seen inside the bags?

Work done by Dr. Joe Webber and colleagues in 2010 showed that major FSPC losses occurred in cones that were not enclosed inside bags during the month of August. Being exposed to the environment through any two-week period from the beginning of May to the end of July did not significantly reduce FSPC values. Timing of harvest trials done in 2011 showed a similar temporal profile for FSPC declines. However, none of the cones used in the 2011 trial were held in bags during any point of the growing season. Versions of both experiments have been replicated across multiple years at several locations. Now, it is recognized that the majority of the FSPC losses observed in north Okanagan lodgepole pine orchards occur in August.

By using the FSPC deficits derived from bagging trials and multiplying this by the number of cones harvested in any given year (derived from crop production statistics), we can calculate the number of seeds 'lost' during a growing season. For 2010, this number was estimated to be about 5.4 million seeds. Bagging experiments indicate that these FSPC shortcomings occurred in August. Using this information, we can calculate the number of seed bugs needed to cause the FSPC deficits observed for Orchard 307 in 2010. Over the course of 30 days, 5,374,000 seeds were lost, eaten by seed bugs with a maximum individual daily herbivory rate of 5 seeds per day. This loss would require a minimum of 35,826 seed bugs to be actively feeding, each eating their daily maximum number of seeds on every day of the month.

Orchard 307 was harvested through August 2010. Staff members spent a minimum of 175 person-hours per week in the orchard in August and they physically handled every cone that was picked. Although workers reported seeing seed bugs, we never received any reports of seed bugs being seen in anything approaching the numbers that would be required to cause these FSPC losses under the Seed Bug Model.

In summary, there never has been a relationship established between seed bug population sizes and the FSPC damage that they reputedly cause. Pesticide treatments have never raised FSPC levels in the operational harvests to those predicted (from bagging trials) to be possible if seed bugs were causing the FSPC losses. With the

recently acquired knowledge of when the FSPC declines occur during the growing season, we can calculate how many seed bugs must be present in Orchard 307 to cause the losses attributed to them by the Seed Bug Model. Nothing even close to the number of seed bugs required to cause these deficits was observed in 2010, nor have they been observed in any other year during the past decade. It is for these reasons that I question the Seed Bug Model. I do not believe that the differences in FSPC observed between cones held inside bags and cones left exposed in the environment can be solely attributed to herbivory by seed bugs.

Currently, there are a number of investigations that are examining other aspects of this problem:

- 1) seed samples taken through the decline period are being examined microscopically to observe the physiological aspects of losses of filled seed,
- 2) the relationship between seed set, area of origin of the orchards, temperature and seed declines is being investigated in field trials,
- 3) in-cone temperatures and seed bug herbivory are being monitored on selected cones throughout the growing season,
- 4) harvesting schedules that incorporate the timing of FSPC declines by clone are being developed to maximize the yields coming from interior lodgepole pine seed orchards, and
- 5) a method to detect seed bug herbivory on individual lodgepole pine seeds is being developed.

It is hoped that this multi-faceted approach will help to address the unanswered questions that remain about seed losses occurring in interior lodgepole pine orchards.

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