04-5 **The development of encapsulated formulations of semiochemicals for the management of forest insect pests.**

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INTRODUCTION AND OBJECTIVES

The use of pheromones, kairomones and other behaviour-modifying chemicals for the management of insect pests has been proposed for over fifty years (Silversten, 1976). Atthough today there are many semiochemcial products that are available for the detection and monitoring of insect pests there are still very few commercial products for the management of insect populations (e.g. mating disruption). An analysis of the financial realities of commercializing such semiochemical-based products for the agricultural market concluded that such a project was commercially unatractive (Siddall, 1975). The challenges and constraints to the development of products for the forestry market are even greater than those in the agricultural market. The long-term cyclical nature of pest outbreaks and the challenges of being able to carry out a cost-benefit analysis for protecting a crop that may not be harvested for 40, 60 or even 80 years are just two examples. Consequently, there are few semiochemical-based products available for the management of forest insect pests.

The productivity of Canadian forests is periodically threatened by outbreaks of insect pests that can cause severe defoliation, reduced growth or mortality of trees that are needed to support an industry and provide thousands of jobs. However, at the present time there are few products of any sort registered for the management of forest insect pests in Canada. Increased public scrutiny, environmental concerns and changes in regulatory requirements have resulted in the elimination of traditional chemical pesticides for large-scale broadcast application in silviculture. At the same time regulatory requirements have been put in place to encourage the development and registration of biological pesticides that are based on semiochemicals.

In 2006 the National Forest Pest Strategy (NFPS) was launched with the intention of developing a risk-based approach to the assessment and management of forest insect pests. As part of the NFPS an initial, one-year project, was funded with the objective of using existing knowledge and expertise to develop and test a number of prototype semiochemcial formulations for the cost-effective management of forest insect pests.

MATERIALS AND METHODS

Provincial pest managers and representatives of the Canadian Food Inspection Agency that are responsible for the management of forest insect pests were contacted to identify the most important candidate pests for which to pursue the development of sprayable products.

On the basis of discussions with pest managers and technical experts a list of desirable physico-chemical characteristics for the end-use products was developed.

A review of current formulation technology for the broadcast application of pheromones was undertaken in order to develop a source of reference information that could be used as a guide for product development.

A review and compilation of information from the scientific literature, technical specialists, researchers, manufacturers of specialized encapsulation equipment and toll manufacturers of encapsulated materials for the food, pharmaceutical and cosmetics industries was carried out to identify existing controlled release formulation technology that is used in other manufacturing sectors and that could be applicable to the project.

More than forty samples of encapsulated materials were procured from toll manufacturers.

Initial screening of the samples was carried out to examine the release rate characteristics over a period of forty days. Samples of each material were placed controlled environment chambers at different temperature conditions, subsampled at intervals and analysed by gas chromatography to quantify the residual content of the active ingredient.

Following initial screening tests encapsulated preparations were formulated with inert materials. The loss of active ingredient from replicate samples of each formulation, applied to artificial sample surfaces, was evaluated over a six-week period in a controlled environmemt chamber that was programmed to simulate the natural temperature and light conditions of early- to midsummer.

Additional tests were carried out to assess the long-term stability of each prototype material under cold storage; the resilience of deposits of prototype formulations to mechanical shaking and simulated rainfall; the resistance of formulated materials to mechanical damage during spraying and the stability and loss of active ingredient from encapsulated materials in water.

RESULTS AND DISCUSSION

A list of seventeen priority pests for which Provincial pest managers would like to have additional pest management products was identified. Information on the chemical ecology of these pests was reviewed and suppliers of specific semiochemicals were identified.

Potential users identified the following preferred characteristics for the end product:

- The formulation must be sprayable using conventional spray technology.
- Controlled release of the active ingredients is required for 3 to 5 weeks under field conditions.
- The product must have a shelf life of 3 to 6 months and must be easy to handle.
- Water or oil could be the carrier liquid, water is preferable.
- The formulations must be dispersible, but not soluble in the carrier liquid. The active component(s) must not leach out of the microcapsules during the time that the diluted formulation is prepared prior to spray application (ideally 6 to 8 hours as a worst-case scenario).
- The microcapsules must not swell in the carrier liquid to the extent that they are no longer compatible with the spray system.
- The microcapsules must be able to withstand the effects of mixing and recirculation within the aircraft hopper.

A review of scientific, technical and regulatory information on semiochemcials for insect population manangement produced very little information that could be used to assist the development of sprayable formulations for the broadcast application of pheromones. This was not really surprising since most pesticide formulation technology is proprietary and confidential.

A compilation of information from the scientific literature, technical specialists, researchers, manufacturers of specialized encapsulation equipment and toll manufacturers of encapsulated materials for the food, pharmaceutical and cosmetics industries identified various types of controlled release formulation technology and manufacturing options for product development. On the basis of this information, and given the project team's lack of encapsulating equipment and expertise, prototype encapsulated materials were prepared by toll manufacturers according to specifications. Prototype materials procured to date include seven different semiochemicals encapsulated in a range of materials.

In the majority of cases more than 90% of the active compound was lost within three to five days of initial exposure at 19 ºC. This was considered unacceptable and testing of these prototype materials was terminated early. Fifteen prototype materials were considered to have desirable release-rate characteristics and these were carried to the next stage of testing.

Tests of prototype materials, formulated with inert materials to improve their handling characteristics and performance, have been encouraging. In a large number of tests significant linear correlations were found between the loss of active material as a function of six-week exposure time. In these cases amount of active material lost over the test period ranged from zero to eighty percent. In those cases where the amount of residual active material in the formulation decreased only slightly over the test period it is presumed that the formulation additives were functioning as an additional barrier to prevent the volatilization of the active substance from the encapsulated material.

In preliminary tests most of the formulations with additives that were sprayed on foliage were very resilient to mechanical shaking. Deposits of specific formulations when sprayed on glass slides were able to withstand the direct impact of 50 water droplets or the equivalent of approximately 40cm of rain without being dislodged. Tests on unformulated materials have shown that most encapsulated materials can be stored for up to one year at -25ºC and still retain a high percentage of their initial semiochemical concentration. Tests have shown most prototype materials to be resilient to mechanical damage from being sprayed, physically stable in suspension with water and exhibiting little bleed of active ingredient when mixed with water for 24 hours.

CONCLUSIONS

Results to date have been encouraging. Screening tests based on a list of preferred characteristics have led to at least five encapsulated materials that merit biological testing in the field. Initial testing of three new materials is underway.

REFERENCES

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