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Canada

Pesticide Risk Reduction Program Pest Management Centre

Reduced-Risk Strategy for Cabbage Maggot Management in Brassica Crops

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1. Preface

Pesticide risk reduction strategies are developed under the Pesticide Risk Reduction Program (PRRP), a joint initiative of [Agriculture and Agri-Food Canada](#) (AAFC) and the [Pest Management Regulatory Agency](#) (PMRA) of Health Canada. The key objective of the program is to reduce the risks to the environment and to human health from pesticide use in agriculture. To achieve this objective, the Program works with grower groups, industry, provinces, and researchers to identify gaps in pest management and opportunities for pesticide risk reduction, and to develop and implement strategies to address these.

A pesticide risk reduction strategy is a detailed plan developed through consultation with stakeholders aiming to address growers' needs for reduced-risk management tools and practices for specific pest issues. The strategy document presented herein is intended to update participating stakeholders on the activities supported by the Program in developing and implementing the strategy and new tools and practices made available through this process. Similarly, it is used as a reference document for the AAFC staff. The strategy also provides a baseline and enables tracking of advancements in pesticide risk reduction.

For more information on the activities and outcomes of the Program's strategy work to date, visit the Pest Management Centre website www.agr.gc.ca/pmc.

2. Acknowledgement

The Pesticide Risk Reduction Program acknowledges all participating stakeholders, including members of the Cabbage Maggot Working Group, for their contribution and continued collaboration in the development and implementation of a reduced-risk strategy for cabbage maggot management in Brassica crops.

3. Introduction

Under the Pesticide Risk Reduction Program, efforts are being made to address pest management and pesticide risk reduction issues related to cabbage maggot, *Delia radicum* (L.), in Brassica crops. This issue was initially identified through a gap analysis of information, and the national [Crop Profile for Brassica Vegetables in Canada](#), developed and published by the Program, indicates that it remains a serious problem with limited management options. As the cabbage maggot is identified as a major pest of all Cole crops, this reduced-risk strategy covers the entire group of Brassica vegetables.

4. Pest management and pesticide risk reduction issues

The cabbage maggot, *Delia radicum* (Diptera: Anthomyiidae), is one of the most chronic and challenging pests attacking Brassica vegetable crops in Canada. The damage is caused by the larval stages. In cabbage, broccoli, cauliflower, Brussels sprouts, and other Cole crops, the larvae feed on seedling roots, decreasing vigour of the plants, and leaving them susceptible to infection by secondary soil-borne pathogens. In rutabaga, in addition to damaging the seedlings, larvae feed and tunnel into the developing roots, damaging the marketable product.

Pupation takes place in the soil. In the fall, the pupa becomes the overwintering stage. Adult flies emerge the next spring and resemble the house fly in their appearance. After mating they lay eggs below the soil surface near the plants. The adults are characterized by a low flying habit and typical spring infestation is caused by flies arriving from adjacent fields.

The cabbage maggot has 1 to 3 generations per year, depending on region and temperature. In Alberta, for example, it completes only one generation but there will be two peaks of flying adults: the first one in the spring and the second one later in the summer, as the first generation completes its life cycle.

In cabbage and broccoli, only the first generation is considered economically damaging as the plants have a good tolerance once they develop 4 to 5 true leaves. In rutabaga, damage by the second or third generation is considered significant as even a slight tunnelling into the developed root renders the crop unmarketable.

Conventional control of cabbage maggot relies on the application of organophosphate insecticides. Currently, Chlorpyrifos is the only remaining insecticide registered in Canada for that pest; however, insect resistance to this pesticide is increasing. In 2013, 75% of populations tested in British Columbia were found to be chlorpyrifos-resistant.

5. Cabbage Maggot Working Group

The Cabbage Maggot Working Group was established in 2009 with the participation of commodity experts, pest management researchers, and stakeholders of the Brassica crops industry across the growing regions. The group has been working on the development and implementation of a pesticide risk reduction strategy, with emphasis on the prioritization of potential solutions and research needs. Discussions are ongoing throughout the development of the strategy and take place by phone calls, email correspondence, teleconferences, and face-to-face meetings. Some members of the Working Group are also collaborators in various projects put in place to implement the strategy.

6. Priority issues and gaps

The following key issues and gaps were identified through discussions with the Working Group:

- Need to establish ‘knowledge base’ on management approaches of cabbage maggot from around the world
- There is lack of knowledge on the prevalence of *Delia* species in Brassica growing areas in Canada
- The sensitivity *Delia* species to chlorpyrifos is largely unknown. This needs to be tested in as many Brassica growing areas as possible
- There is lack of knowledge about the possibility of controlling cabbage maggot adult flies by attract-and-kill technology
- Need to continue the development of exclusion fence and assess its efficacy as a physical barrier to prevent cabbage maggot flies from entering the field
- Need to test various materials applied to the soil that may be suitable for use as physical barriers to prevent cabbage maggot female flies from reaching their oviposition sites
- Need to evaluate whether European technologies of insect netting (row covers) could be suitable as physical barriers against cabbage maggot adult flies under Canadian conditions
- Need to continue the breeding of rutabaga to develop commercial-grade lines resistant to cabbage maggot
- Need to test biopesticide candidates and determine their potential use for management of cabbage maggot
- Need to communicate knowledge about effective new technologies to growers and stakeholders

7. Strategy Action Plan

Four strategy goals related to reduced risk cabbage maggot management, and potential solutions prioritized through stakeholder consultations and by the working group led to the development of a pesticide risk reduction strategy action plan for cabbage maggot in Brassica crops. The plan is centered on obtaining lower risk control tools and practices that reduce reliance on insecticides while offering effective, economically-feasible pest management options. The table below outlines the goals, the milestones and the implementation activities completed or underway in support of this strategy.

Action plan table including goals, milestones and activities for implementing the reduced-risk strategy for cabbage maggot management in brassica crops in Canada

GOAL 1: Establish knowledge base on management approaches

Milestone	Status	Implementation Activities	Completion date
Literature survey of available pest management approaches	Complete	AAFC's project PRR06-690 : Cabbage maggot management and research around the world: a status report and development of IPM strategies for Canada . Information obtained through published sources and discussions with leading experts revealed national and regional differences in the approach to <i>Delia</i> management, which vary with the type of crop (canola/vegetables), damage (direct vs. indirect), scale (farm/field size) and production system (organic vs. conventional). As no single available method provides full control of the pest, the development of several management tools under an integrated approach will be necessary to control infestations in a sustainable manner.	March 31, 2007
Examine prevalence of <i>Delia</i> species and their sensitivity to chlorpyrifos	Ongoing	AAFC's project PRR15-020 : Species survey and testing of resistance to chlorpyrifos in <i>Delia</i> species in brassica vegetable growing areas in Canada . The project will survey species of <i>Delia</i> flies in vegetable Brassica crops across Canada, determine which of them causes damage to the crops, and assess the level of resistance to chlorpyrifos in these populations.	March 31, 2017
Explore the possibility of controlling cabbage maggot adult flies by Attract-and-kill technology	Future	This approach is currently considered low priority by the Working Group. Future studies may help determine whether this is a viable option to control the pest.	

GOAL 2: Develop physical barriers for cabbage maggot management

Milestone	Status	Implementation Activities	Completion date
Asses the efficacy of exclusion fence as a barrier to prevent cabbage maggot flies from entering the field	Complete	AAFC's project PRR09-050: Development and demonstration of a multi-tactical IPM toolbox for cabbage maggot control in Brassica crops . Project includes a commercial-grade exclusion fence developed with industry and demonstrated to growers in various research and commercial sites. The project identified issues and developed recommendation for the optimal use of this technology.	March 31, 2012
Communicate the technology of exclusion fence to stakeholders	Complete	A factsheet titled <i>Exclusion fence technique for cabbage maggot management in Brassica vegetable crops</i> has been developed and will be posted on AAFC's website. It presents the method and provides criteria for the selection of fields where this technology may be implemented.	
Test physical barriers applied to the soil as barriers against cabbage maggot adult flies seeking oviposition sites	Complete	AAFC's project PRR10-170: Physical barriers to control cabbage maggot (Delia radicum L.) in brassica vegetable crops . Various types of barriers including liquid and biodegradable mulches, diatomaceous earth, and kaolin clay, were tested. None was found to provide sufficient protection under the conditions assessed.	March 31, 2012
Test commercial row covers ('insect netting') as barriers against cabbage maggot adult flies seeking oviposition sites. Identify issues and develop recommendations for the use of this technology.	Complete	AAFC's project PRR10-220: Row covers as physical barriers in Brassica crops for cabbage maggot management . Conducted in the Atlantic provinces, the technology was found effective in protecting the crop at a similar level to – or better than – conventional insecticides. In some rutabaga fields, weeds are problematic when using row covers.	March 31, 2013
	Ongoing	AAFC's project PRR14-010: Evaluating row covers for early season management of cabbage maggot in brassica vegetable crops . Work to establish best management practices for early-season control of cabbage maggot is underway in the Atlantic provinces and BC.	March 31, 2016
Communicate the technology of row covers to stakeholders	Future	Develop a factsheet that introduces the row covers ('insect netting') and recommends practices for optimal use of this technology as a management tool for cabbage maggot.	November 30, 2016

GOAL 3: Develop rutabaga lines resistant to cabbage maggot

Milestone	Status	Implementation Activities	Completion date
Breeding to obtain BC-3 (third back-cross) generation resistant to cabbage maggot	Ongoing	AAFC's project PRR10-140 : Development of rutabaga cultivars resistant to Cabbage maggot . The commercial cultivar 'Laurentian' with resistance to cabbage maggot is expected to be available by the end of this project. The currently available generations are tested for resistance and horticultural traits in the lab and in the field.	March 31, 2016
Field-testing of resistant rutabaga lines	Ongoing	AAFC's Project PRR12-110 : Field testing rutabaga cultivars for resistance to cabbage maggot . Tests with lines developed under PRR10-140 conducted in several rutabaga growing regions across Canada.	November 30, 2015
Promote grower adoption of resistant cultivar	Future	AAFC's project PRR10-140 : Development of rutabaga cultivars resistant to Cabbage maggot . If found effective in the field, information concerning the resistant lines will be communicated to growers, potential commercial seed producers, and other stakeholders.	November 30, 2016

GOAL 4: Evaluate potential for biopesticides as cabbage maggot management option

Milestone	Status	Implementation Activities	Completion date
Laboratory testing of biopesticide candidates for management of cabbage maggot	Complete	AAFC's project BPI08-010: Biological control of soil insect pests in field crops . Aimed at evaluating commercialized fungal biocontrol products for their suitability to control <i>Delia</i> species, the project tested eight different products in laboratory scale experiments and identified one <i>Metarhizium</i> -based product as potential candidate for integration into IPM systems.	March 31, 2011
Field testing of biopesticides to determine efficacy and suitability for use under Canadian cropping systems	Future	This approach is considered low priority by the Working Group. No further work in this direction is planned at this time. Potential expansion of the label of the <i>Metarhizium</i> -based product for use against cabbage maggot in Brassica crops is at the discretion of the registrant.	

8. Strategy outcomes

The main outcomes expected from the implementation of the Reduced Risk Strategy for Cabbage Maggot Management include:

- Knowledge on available pest management approaches from around the world that could fit production systems of Brassica crops in Canada
- Exclusion fence developed, tested, and available for use as a physical barrier
- Best practices for using commercially-available European insect netting technologies
- Resistant rutabaga lines developed, tested, and considered for commercialization