SUSTAINABLE CROP PROTECTION:

Results from the Pesticide Risk Reduction Program

STERILE INSECT TECHNOLOGY: A DIFFERENT WAY TO MANAGE ONION MAGGOT

The onion maggot (*Delia antiqua*) is a major pest of Allium crops such as onions, green onions and shallots. Onion maggot flies lay their eggs near onion plants, and when the eggs hatch into larvae they bore into onion bulbs causing damage to the plants (Figure 1). If not properly managed, onion maggot can cause up to 30% crop loss for Canadian onion growers.

Options for managing this pest effectively are limited since it is difficult for control products to reach the target pest. Moreover, chemical control options are becoming even more limited due to recent regulatory cancelations, ongoing phase-outs and use restrictions, as well as the development of resistance to some active ingredients. For instance, onion maggot management relies heavily upon in-furrow applications of chlorpyrifos, which is scheduled for phase-out by 2023. In addition, some onion maggot populations have already shown resistance to chlorpyrifos and other active ingredients or are at an increased risk of developing resistance as fewer options are available for use.

Onion growers are already looking for additional control options to diversify their toolbox and improve management of this pest, and alternatives are available. For instance, in recent years, the Sterile Insect Technique (SIT) has shown great promise in keeping onion maggot populations at manageable levels and reducing the need for pesticide use in onion farms in Quebec.

Through consultations within the expert working group leading the AAFC's Pesticide Risk Reduction Strategy for Root Insect Pests of Carrot and Onion, stakeholders identified SIT as a favorable alternative technology to transfer to Ontario and support onion growers in their efforts with sustainable management of onion maggot. A three year project (2018-2021) was conducted to demonstrate and evaluate SIT in commercial onion fields in Ontario.

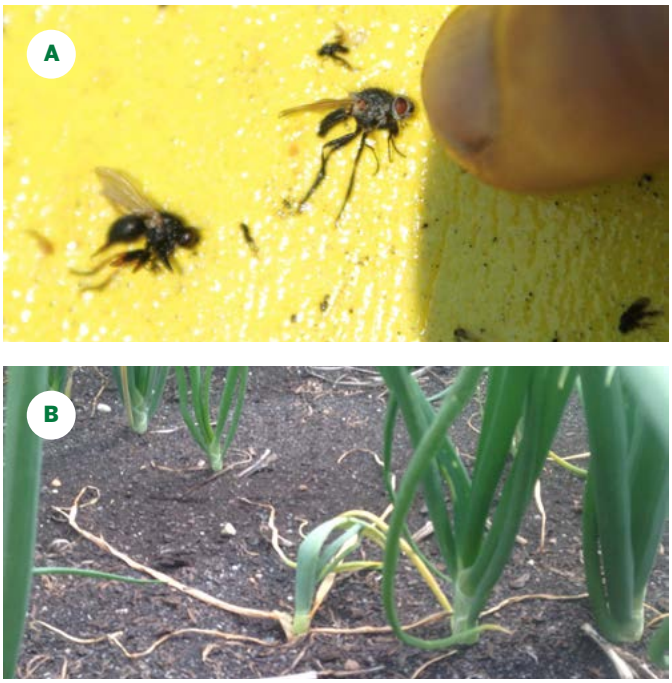

Figure 1. Onion maggot fly (*Delia antiqua*) on an insect sticky trap (**A**) and an onion plant damaged by onion maggots (**B**).
Photo credits: Travis Cranmer & Joshua Mosiondz (OMAFRA)

What is the Sterile Insect Technique?

Sterile Insect Technique is a pest management approach that was developed several decades ago, and has been used to manage or eradicate different insect pests in many regions of the world. In Canada, a sterile insect program has been successfully implemented commercially since early 90s in the Okanagan Valley, BC to dramatically reduce the natural populations of codling moth (*Cydia pomenella*). The program has successfully maintained less than 0.2% codling moth damage and has reduced the use of chlorpyrifos by over 90%. Also, the SIT approach to control onion maggot has been successfully implemented in onion farms of Quebec for over a decade reducing onion damage from 30% in some fields to below 1% with minimal or without use of pesticides.

The technique consists of rearing and sterilizing, through irradiation, a large number of the target insect (usually males). Sterilized insects are then released in the areas to be protected. When the sterilized males mate with the fertile wild females, no viable offspring are produced (Figure 2). As a result, in each generation, populations of the pest decline, which protects crops from future infestation by lowering the overall pest population density.

How successful has SIT been for onion maggot?

In the Netherlands, SIT has been successfully applied since 1981 by the firm De Groene Vlig (The Green Fly) to control onion maggot and now covers an area of more than 10 000 hectares. The technique was transferred to Quebec by Phytodata Research Company Inc., who also added a pink colouring step to the technique to distinguish sterilized flies. As an affiliate of the PRISME Consortium, Phytodata Company has been working on the development and implementation of SIT for the control of onion maggot since 2005. Phytodata's state of the art plant in Sherrington, Quebec is currently the only commercial producer of sterile onion flies in North America selling directly to growers.

In Quebec, the technique continues to grow in popularity since the first commercial release in 2011, and in 2021 was applied to about 988 ha of onion fields in the region. Using SIT has contributed to elimination of the need for chlorpyrifos soil treatment at planting and in many cases several foliar sprays throughout the season, while maintaining onion yields comparable to pesticide-based programs. The SIT also led to a large reduction of chlorpyrifos contamination in nearby watersheds. Between 2006 and 2019, the maximum chlorpyrifos concentration was reduced from 2.2µg/L to no detectable quantities.

There is also a long term economic benefit to applying this technique. Since it contributes to reducing future generations of fertile onion maggot populations, a decreasing number of sterile flies need to be released each year to achieve the same level of control. Studies in Quebec has shown that required release rates can decrease by approximately 90% (from ~106,000 to 15,000 flies/ha) within 5 years of repeated use in the same area. It has been estimated that the costs associated with SIT are essentially equivalent to those of a conventional insecticides regimen, when averaged over a five year period.

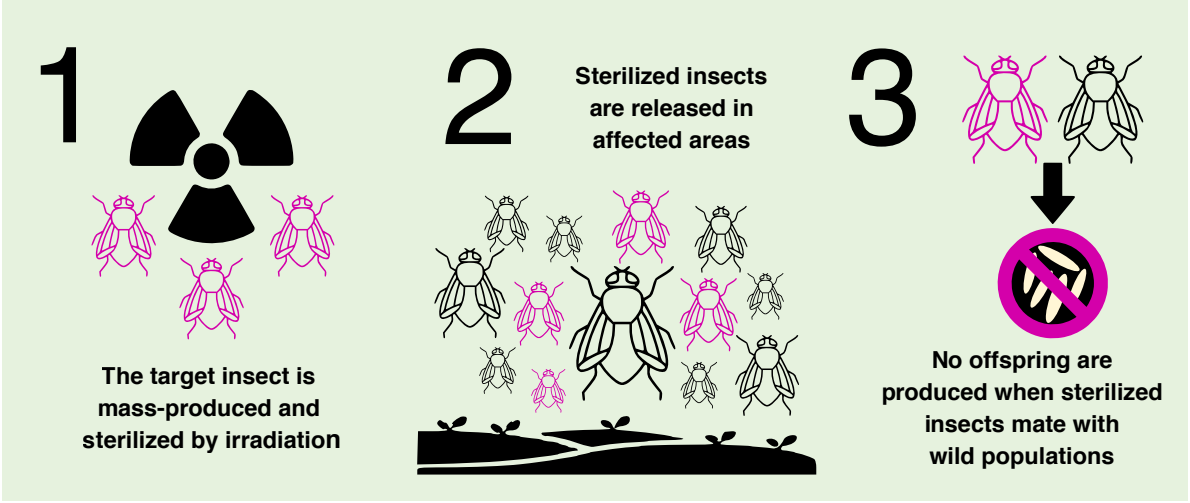

Figure 2. The steps involved in the Sterile Insect Technique process.

How was the technology transferred in Ontario?

To demonstrate SIT in the south-western region of Ontario, a team consisting of Phytodata and Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) specialists compared control commercial onion fields of onion sets and dry bulb onion with fields where sterilized pink onion flies were released. Control fields received standard pesticide treatments and were situated at distances ranging from 100 m to 17 km away from release fields. Onion sets were seeded at a high density and dry bulb onions were transplanted as seedlings at an average density in late spring. Blue insect sticky traps were placed on each side of every field (Figure 3), and monitored weekly to track onion maggot populations throughout the growing season. Onion samples were harvested at various time points to assess maggot damage throughout the season.

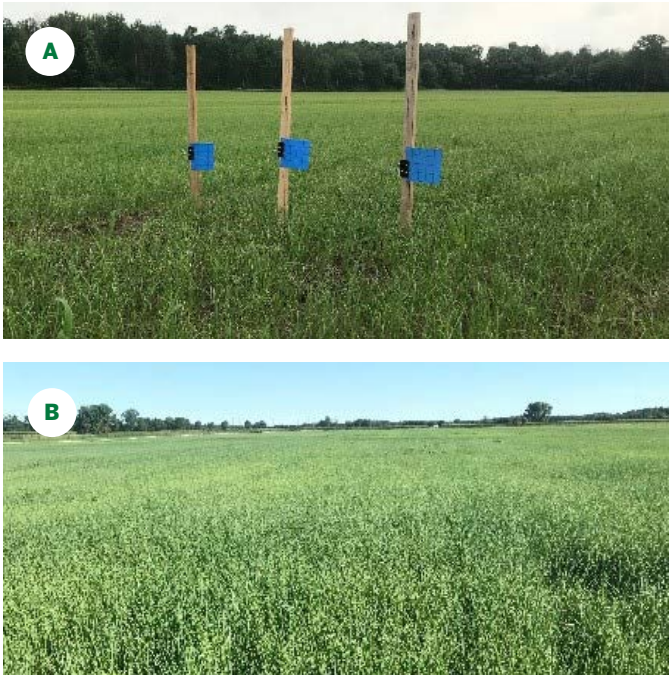

Figure 3. Onion crop at the release field on 13 June 2018 (**A**) and the control field on 17 July 2018 (**B**). Photo credit: Travis Cranmer (OMAFRA)

The sterile onion flies were supplied by Phytodata. Following irradiation at Nordion (Canada) Inc., the sterilized pupae were shipped in plastic containers to cooperating growers in Ontario and then loaded into emergence boxes (Figure 4). The flies emerged one to three days later and were fed a powder mix and distilled water until they were released into the field. Weekly releases of sterile flies began shortly after onions were sown and continued until harvest at an average rate of 100,000 flies/ha. Release quantities varied throughout the season following natural population curve. Releases were lower at the beginning and at the end of the field season and increased as pest pressure increased, with the peak release rates corresponding to the peak in pest populations.

Figure 4. Sterilized pupae that have been coloured pink (**A**); pupae being added to the emergence box with food and water containers (**B**); and sterilized pink onion maggot flies emerged from pupae prior to release (**C**); flies being released into the crop (**D**). Photo credit: Phytodata

During the first year (2018) of this demonstration, the SIT resulted in a greater than 50% reduction in the 2nd generation of fertile onion maggot fly population peak from an average of 27 flies/trap/week in the control field compared to 11 flies/trap/week in the release field near Exeter, ON. In the third year (2020) of this demonstration, population peaks of onion maggot flies were approximately equal in the control and release fields near Exeter, ON. The control and release fields in 2020 were situated approximately 100 m apart, which may have resulted in some displacement of the sterile flies into the control field and impacted the pest populations that were observed. Typically repeated plantings of onions in same areas for consecutive years would result in an increase in onion maggot fly populations. However, when the SIT was applied in the fields in this location, the peak populations of fertile flies remained steady from 2018 to 2020 despite repeated planting of onions in adjacent fields seeded with at a high density for onion set production (Figure 5).

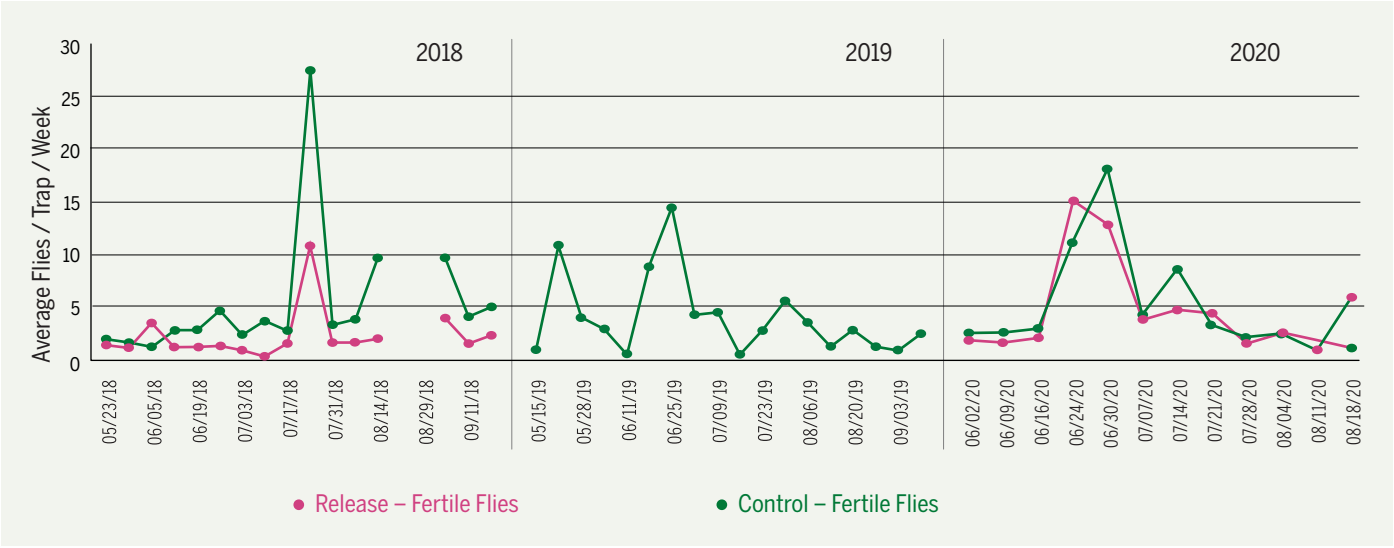

Figure 5. Average flies per insect sticky trap per week at the field site near Exeter, ON (2018-2020). No control was included at this location during the 2019 field season.

Additional field sites at a different location in Ontario (Scotland, ON) were included in the demonstration trials for the second and third year. In 2019, two onion fields (one release and one control) were included and in 2020, three onion fields (two release and one control) were monitored in this location. The population peaks in these fields varied between fields and years. The additional fields were located in high onion growing areas and were adjacent to other onion crops grown that year or previous years. This likely impacted the interactions between the sterile flies and the fertile fly populations in these fields. Near Scotland, ON in 2020, both fields where sterile flies were released had more than double the fertile population compared to the control field, for the 1st generation of fertile flies (mid June). This showed that the starting pest pressure was not comparable between these field sites. However, despite the higher initial population in the release field for the 1st generation, the 2nd generation (early August) as higher in the control field than the release fields (Figure 6). There was also no significant onion maggot damage observed despite the moderate to high fertile fly populations in all field sites at this location.

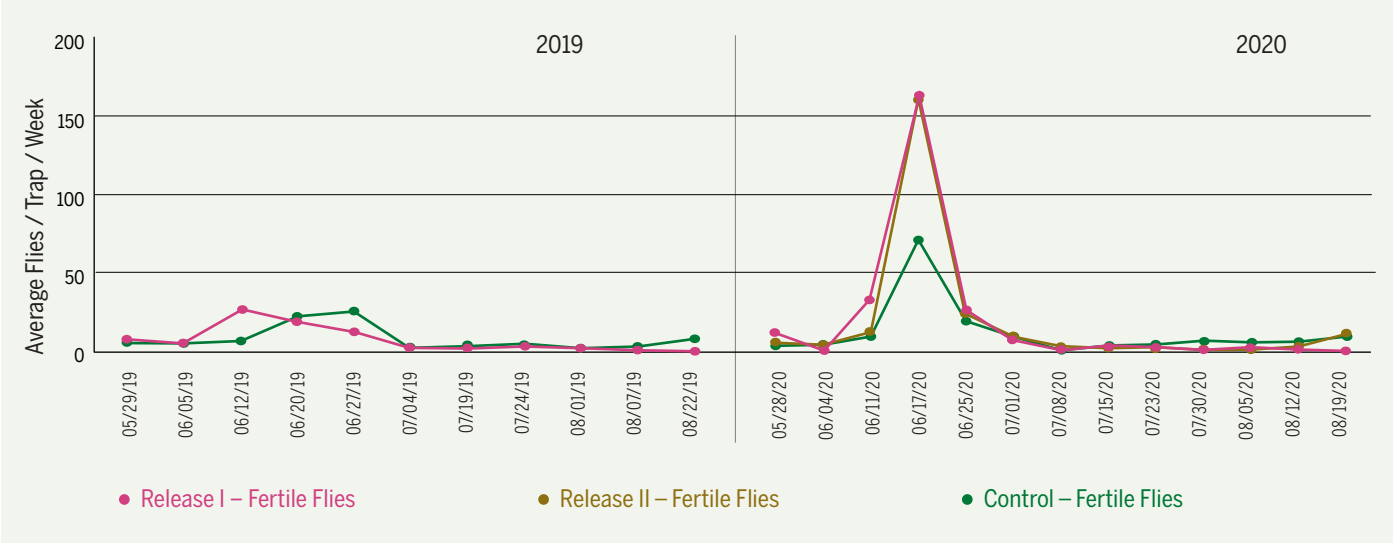

Figure 6. Average flies per insect sticky trap per week at the field sites near Scotland, ON (2019-2020).

Conclusions

Overall, the level of onion maggot damage observed in all onion fields and years included in this demonstration trial was low despite moderate to high levels of fertile flies. There was little onion maggot damage observed in 2018 and 2019 relative to previous years, and no damage was observed in 2020. The levels of fertile maggot fly populations during this study were moderate for the first two years at all locations and high at the Scotland, ON site in 2020; populations ranged from 11-27 flies/trap/week at peak times in 2018 and 2019 and 15-160 flies/trap/week in 2020. This trial showed a population difference of less than 50% of the of fertile onion maggot flies at the release field compared to the control field for the 2nd generation, within a single year in one of the locations. Overall, results from these demonstration trials showed that the SIT technology has promise as an alternative option for onion maggot control. This is especially true for the 2nd generation of flies, which are difficult to control using existing approaches. Continued and widespread adoption of this technique in multiple farms may improve success in concentrated onion growing areas and will most likely lead to a reduction in the need for chemical treatments. This approach may also complement other Integrated Pest Management (IPM) practices in instances where pest pressure is very high. Following project completion in 2020, there continues to be interest in this technology from the onion grower community in Ontario as growers are continuing with SIT releases in their crops throughout the growing season. In addition to evaluating the commercial fit of this new management approach in Ontario, this study contributed new knowledge about the distribution and population dynamics of *Delia* spp. in this region.

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About the Pesticide Risk Reduction Program at Agriculture and Agri-Food Canada

The Pesticide Risk Reduction Program delivers viable alternative solutions for Canadian growers to reduce pesticide risks in the agricultural and agri-food sector. The Program achieves this goal by coordinating and funding integrated pest management projects and risk reduction strategies developed in consultation and in partnership with scientists, pest management experts and industry stakeholders.

The Program also facilitates the transfer of alternative pest management knowledge and technologies to stakeholders by organizing on-farm demonstrations, information sharing events and through written publications like this technical factsheet. To learn more about the Program's activities, visit: Pesticide Risk Reduction at the Pest Management Centre.

To consult other factsheets in this series, visit: Sustainable Crop Protection.

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Paru également en français sous le titre *Technologie de stérilisation des insectes: un moyen différent de lutter contre la mouche de l'oignon*.
For more information, reach us at www.agriculture.canada.ca or call us toll-free at 1-855-773-0241