Management of insect pests in a changing world

TEAGASC researchers are involved in a number of projects to reduce insect damage in Irish crops.

As 2020 is the International Year of Plant Health, it is important to evaluate how we will manage plant health into the future, a future where we will have to contend with a changing climate, and attempt to manage pests with a greater emphasis on non-pesticide approaches, in order to adhere to increasing consumer pressure to decrease the impact of agriculture on biodiversity and ecosystem services. New regulations, such as the Sustainable Use of Pesticides Directive and the 'Green Deal', will significantly impact on how we manage our crops in the decades ahead, almost certainly with fewer pesticides and a need to increase our knowledge of pest behaviour and strategies to minimise their impact. In particular, the use of insecticidal products has received significant focus in the last decade and the number of available insecticidal active ingredients has fallen sharply, with few new ingredients coming to market. It is in this context that Teagasc is working to adopt, adapt and develop a number of new integrated pest management (IPM) strategies to reduce insect damage in Irish crops.

Barley yellow dwarf virus

Barley yellow dwarf virus (BYDV) is an insect-vectored RNA virus that causes stunting of cereal crops worldwide. Once obtained from an infected plant, BYDV can persist in the aphid vector for its whole lifetime, but does not replicate within the aphid. The virus is transmitted from plant to plant through the saliva of feeding aphids. The time taken for the aphid to acquire the virus from an infected plant and inoculate a new plant with the virus varies from hours to days. In Ireland, there are three main aphid vectors of BYDV: the grain aphid (*Sitobion avenae*); the bird cherry-oat aphid (*Rhopalosiphum padi*); and, the rose grain aphid (*Metopolophium dirhodum*). The most common serotype of this virus to occur in Ireland, BYDV-MAV, usually causes visually mild symptoms of yellowing and stunting in crops, while the less common serotype, BYDV-PAV, can cause extremely severe symptoms. However, both can cause economically significant levels of crop damage, particularly if infection occurs in the early crop growth stages. The management of BYDV has largely relied on the use of pyrethroid-based insecticides in combination with sowing date, with a preferred sowing date of October and a pre-Christmas insecticide application time for autumn cereals. For spring cereals, an earlier sowing date is preferred, with an insecticide application at GS14 if required. These rules were largely developed to reduce the exposure of the crop to migrating aphids, thus reducing their exposure to BYDV. Indeed, in some years an aphicide is not required, depending on the weather conditions post planting. However, several factors have changed, which may alter this approach. There has been an emergence of partial resistance to pyrethroids in one dominant clone of the grain aphid (*S. avenae*), which is now relatively common in tillage crops (Walsh *et al.*, 2020b). We have also had the first report of pyrethroid tolerance in an Irish population of the bird cherry-oat aphid (Walsh *et al.*, 2020a). This coincided with the withdrawal of several insecticide active ingredients, leaving only two available for BYDV management (McNamara *et al.*, 2020). This scenario led to the development of the CAPTURE project, which will look to gain a better understanding of BYDV transmission and epidemiology in Irish tillage crops and, in combination with the construction of three 12.2 m high insect suction towers at Carlow, Cork and Dublin (**Figure 1**), will allow researchers to monitor and recover long-distance aphid migrants and potentially analyse them for both insecticide resistance genes and BYDV. It is envisaged that this work will build on our knowledge of BYDV dynamics and lead to a greater understanding of when and if crops require insecticide applications.

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Managing other pests

While some pest damage, such as BYDV, can be unpredictable in severity, other pests are extremely predictable in their occurrence and severity, although this does not necessarily make them easier to manage. Root-feeding diptera (fly) pests of brassicas and carrots cause significant damage, leading to high levels of crop loss and rejection. Through the FLYIPM project (CIPM ERA-NET), the use of entomopathogenic (insect-

FIGURE 1: A 12.2m high insect suction tower, which passively samples the passing air for flying insects such as aphids.

FIGURE 2: A larva of the cabbage root fly Delia radicum infected with the entomopathogenic nematode Steinernema feltiae. The nematodes are visible as white threads through the insect cuticle.

killing) nematodes to control the larvae of the cabbage root fly (*Delia radicum*), was investigated. Entomopathogenic nematodes carry a symbiotic bacteria within their gut. Once the nematode enters the insect body, it voids the bacteria from the gut and the bacteria proliferates, leading to the death of the insect. The bacteria then serve as a food source for the subsequent generations of nematodes, until the resources within the insect are exhausted and the nematodes within the insect form a second cuticle, allowing them to survive outside of the insect. These nematodes then leave the insect to search for a new host.

The use of entomopathogenic nematodes is common in protected horticulture and is the main control approach for weevil pests in soft fruit and sciarid fly larvae in mushroom production. However, their use in outdoor field production, particularly in soil as opposed to a growth medium, is less common. The entomopathogenic nematode *Steinernema feltiae* displayed good affinity for infecting and killing the larvae of *Delia radicum* (**Figure 2**) in laboratory assays across a range of relevant ambient temperatures (9 °C to 18 °C), with mortality usually occurring within five days. Field evaluations were conducted to determine their efficacy against *D. radicum* larvae. The entomopathogenic nematodes were applied as a soil drench around the plant root system, as an injection directly into the plant growing module, or as a combination of both methods. Overall, an application rate of 70,000 infective juveniles applied as a drench per plant was found to give some statistical differences in plant evaluation, such as visual root damage score and plant count, when compared to the untreated control. While not directly comparable to current insecticide control levels, when used in combination with additional control strategies such as trap crops and physical barriers, this approach may contribute to reducing pest populations and their damage to economically acceptable levels.

Conclusion

It is clear that there is a strong legislative and consumer demand for the development of pest management strategies that are less dependent on pesticides; however, it is also clear that replacement solutions and strategies are not yet available for many important pests. Therefore, while replacement strategies are being developed, particularly in the development of biopesticides and breeding for crop resistance, the use of increased monitoring and forecasting, such as insect sampling towers, will be required to improve our knowledge of pest behaviour.

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