Feature

The Good, the Bad and the Ugly

In a world without neonicotinoid seed treatments, most of us are spending a lot more time looking at our crops than we have had to for many years. The need to check plants regularly for aphid numbers is critical to ensure insecticides are applied appropriately. Doing these regular checks have given us the perfect opportunity to remind ourselves of the whole array of insects living in our sugar beet crops. However, judging from the number of calls, photos and samples submitted to the BBRO Plant Clinic, many of us are very unsure of what we are finding. Even less certain, which of these are the good beneficial insects, the bad aphids, and the downright *ugly*.

In this article we have provided a guide to the Good, the Bad and the Ugly in our sugar beet crops as a guide to 'who's who' as well sharing some information on the wider knowledge around biological control of aphids and how we can support further beneficial insects in our crops.

Fig. 1. Ladybirds are great aphid predators

The Good

The term 'beneficial insects' is what we apply to species that perform valued services such as pollination and/or pest control. In this article we consider 'the Good' in terms of those insects that predate on aphids that are the vectors of virus yellows.

Encouraging beneficial insects in crops is a pest control strategy often used in organic farming and protected crop production such as in glasshouses. It can form an important part of an integrated approach to pest management in these systems. There is extensive research in some areas of biological control using insects in glasshouse production and there are companies specialising in biological pest control who market a range of beneficial insects for release, particularly in enclosed or protected environments.

We have compiled a list of some of the more common predators of aphids that we may encounter in UK sugar beet crops but by no means is this an exhaustive list.

Prof Mark Stevens
Head of Science, BBRO

Dr Simon Bowen
Head of Knowledge Exchange, BBRO

Lacewings *(Chrysopa spp.)*

The adults are delicate green or brown insects with large 'lacy' wings. Individual white eggs are found laid on the ends of inch-long stiff threads. It is the larvae (which look like little alligators) that destroy most of the pests. They are sometimes called 'aphid lions' for their habit of dining on aphids. A single larva has been shown to consume up to 300 aphids a week. They also feed on mites, other small insects and insect eggs. Alongside ladybirds, lacewing larvae are one of the most voracious of aphid feeders.

Fig. 2. Lacewing larva in action

Fig. 3. Adult lacewing

The role of Chrysopa carnea (Steph.) as a predator of the green peach potato aphid Myzus persicae (Sulzer) on sugar beet was studied by Hassen et al (1985) in greenhouse experiments using different predator/prey ratios. Each experiment continued for 4 to 5 months. Releases of early second stage Lacewing (Chrysopa) larvae at the predator/prey ratios of 1:5, 1:10, 1:20 and 1:40 successfully controlled M. persicae. ***Hassen et al (1985).***

Some research has studied the effect of improving the biological control of black bean aphid by Lacewings. Application of food sprays containing yeast hydrolysate, sucrose and molasses resulted in increased densities of eggs and adults of C. carnea in treated plots. ***Ehler et al, (1997).***

Lacewing larvae - perfect for pest control. The use of released lacewings has not been extensively studied in field crops but there are scientific studies on using lacewings in glasshouse production (and even a glasshouse study on sugar beet) and there are companies who commercially produce and supply lacewings as a biological control agent for this purpose.

Fig. 4. Ladybird larvae look very different to the easily recognisable adult

Ladybirds

Widely known as voracious aphid predators, ladybirds are beetles in the family Coccinellidae and they range in size from 1 to 10mm and are round or oval in shape. Ladybird larvae all have a similar elongated body shape with three pairs of obvious legs, most are black or dark grey, some have yellow or orange markings and many have hairs or spikes.

The ladybird life cycle begins with an egg. The female tends to lays a cluster of five to 30 eggs and usually deposits these on the underside of leaves, where there are also suitable prey for the offspring to eat when they hatch. In spring or early summer, a single female ladybird can produce more than 1,000 eggs. Scientists believe ladybirds lay both fertile and infertile eggs in the cluster. When aphids are in limited supply, the newly hatched larvae will feed on the infertile eggs.

In two to 10 days, ladybird larvae emerge from their eggs. Species and environmental variables such as temperature can shorten or lengthen this timeframe. Ladybird larvae look somewhat like tiny crocodiles, with elongated bodies and bumpy exoskeletons. In many species, the ladybird larvae are black with brightly coloured spots or bands. In the larval stage, ladybird feed voraciously. In the two weeks it takes to become fully grown, a single larva can consume 350 to 400 aphids.

Larvae feed on other soft-bodied plant pests as well including scale insects, adelgids, mites, and insect eggs. A newly hatched larva is described as being in its first instar, a developmental stage that occurs between moults. It feeds until it grows too big for its cuticle, or soft shell and then it moults. After moulting, the larva is in the second instar. Ladybird larvae usually moult through four instars, or larval stages, before preparing to pupate. The larva attaches itself to a leaf or other surface when it is ready to pupate, or metamorphose, into its adult form.

There are more than 45 species of ladybird considered as resident in Britain, about 20 of these are small (<3 mm) and dark in colour and often not recognised as ladybirds. Four of the more common ladybirds include:

Harlequin ladybird, Harmonia axyridis. A non-native species that became established in the UK in 2004, it is now one of the most commonly seen ladybirds. Adults are 8-10mm in length and very variable in colour and markings (two common forms are black with two red spots or orange with 18 black spots). Larvae reach up to about 10mm in length and are characterised by having two orange stripes and being spikey. This species feeds on aphids and other insects occasionally becoming cannibalistic. There is some evidence that it has caused declines in some native ladybirds, due to competition for food.

Two spot ladybird, Adalia 2-punctata. Adults are 4-5 mm in length and very variable in colour; common colour forms include red with two black spots and black with two red spots. The larva is dark grey with some orange markings. This species is widespread and often found in gardens feeding on aphids. It is sometimes available from biological control suppliers.

Fig. 5. Ladybird larvae and adults are voracious aphid predators

Fig. 6. Adult hoverfly

Hoverflies

Also known as syrphid fly, hoverfly or flower fly. Adults look like small bees that hover over plants and dart quickly away. They don't sting! They lay eggs (white, oval, laid singly or in groups on leaves) which hatch into green, yellow, brown, orange, or white half-inch maggots that look like caterpillars. They raise up on their hind legs to catch and feed on aphids, mealybugs and others.

About 6,000 species in 200 genera have been described. Hoverflies are common throughout the world and can be found on all continents except Antarctica. Hoverflies are harmless to most other animals, despite their mimicry of stinging wasps and bees, which wards off predators.

Often underrated as aphid predators, Hickman & Wratten (1996) studied their effectiveness in cereal fields in both the UK and North America by planting strips of Phacelia tanacetifolia in the margins of wheat fields. They then compared the hoverfly and aphid numbers found with fields with no strips. Numbers of hoverflies in yellow water pan traps were significantly higher in fields with strips and the numbers of aphids were reduced in the second year of the experiment but not in the first. The difference was related to the relative maturing rates of the wheat and oviposition (egg laying) by the hoverflies.

Seven spot ladybird, Coccinella 7-punctata. Adults are 5-8 mm in length and almost always red with seven black spots. The larva is grey with four pairs of orange markings. A widespread species often found in crops and gardens.

Fourteen spot ladybird, Propylea 14-punctata. A 3-5mm yellow ladybird with a pattern of 4 to 14 black markings. The larvae are grey with white markings. Feeds primarily on aphids but will also eat other insects.

A survey of ladybirds in sugar beet cops in eastern England was reported by Heathcote (1978) and indicated that they were one of the causes of rapid decline of aphid populations on sugar beet in August. Although no evidence was found that they play an important part in controlling the spread of yellowing viruses, it was suggested that they may prevent a crop from becoming heavily infested with aphids which are potential vectors in the spring, and they also may destroy aphids overwintering on virus-infected weeds and other sources of infection. The most common ladybirds trapped were the 2-spot and the 14-spot species.

Fig. 7. Hoverfly larva

Fig. 8. Parasitic wasp, large 'stinger' visible has been adapted to aid egg laying inside insects

Parasitic Wasps

Such wasps are parasites of a variety of insects. They do not sting! The stingers have been adapted to allow the females to lay their eggs in the bodies of insect pests. The eggs then hatch and the young feed on the pests from the inside, killing them. After they have killed the pests, they leave hollow 'mummies'.

Braconid wasps feed on moth, beetle and aphids and other insect pupae and adults. If you see lots of white capsules on the backs of a caterpillar, these are the braconid cocoons… leave the dying caterpillar alone!

Ichneumonid wasps control moth, butterfly, beetle and aphids. Trichogramma wasps lay their eggs in the eggs of moths (hungry caterpillars-to-be), killing them and turning them black.

Parasitic wasps have been used as biological control agents in protected crop production for many years. The release of Encarsia formosa for the control of whitefly and aphids in tomatoes has long been practiced. Another parasitic chalcidoid wasp (Aphidus spp.) is also widely used and has been estimated to consume over 200 aphids per week.

Fig. 9. Parasitic wasp in action

Damsel Bugs *(Nabis spp.)*

These feed on aphids, leafhoppers, plant bugs, and even small caterpillars as adults and nymphs. They are usually dull brown and resemble other plant bugs that are pests. Their heads are usually longer and narrower than most plant feeding species.

Fig. 10. Soldier beetle, one of many beneficial ground beetles

Ground Beetles

Ground beetles are common in crops and there are a large number of species in which adults will eat aphids. The common red soldier beetle is a medium-sized, narrow beetle commonly found on open-structured flowers, such as daises, cow parsley and hogweed during the summer. Adults feed on aphids and eat pollen and nectar. The adults spend much of their short, summer lives mating and can often be seen in pairs.

The common red soldier beetle has a narrow, rectangular body and longish antennae. It is bright orangey-red with black marks near the tips of the wing cases. There are about 40 species of soldier beetle in the UK, displaying various colour combinations of black, red and orange.

The potential of predators to impact the establishment of aphid vectors and reduce the spread of virus yellows was examined by Landis & Van de Werf (1997). They found that where virus spread it was lowest at the edge of sites as opposed to the interior part of fields. This was associated with higher levels of aphid predation.

Fig. 11. Virus Yellows being spread by aphids in a crop of sugar beet

Cantharis lateralis L. (Coleoptera: Cantharidae) was the most frequently observed foliar predator (>90%). It was found eating aphids on several occasions. In laboratory tests, it consumed 1.7-9.2 aphids per day.

The incidence of predators was 1.8 per plant in the field interior and 3.8 per plant near the edge. Within a field with a high number of predators towards the edge, the researchers used plastic barriers to prevent predators accessing areas of the field. Pitfall traps showed that predator densities were reduced by c.90% and virus spread was increased by about 50% in the enclosed areas compared to the open areas, highlighting how aphid predation can reduce virus spread.

So, can we encourage beneficial predation of aphids?

Beneficial insects clearly play an important role in the control of aphid populations in our sugar beet crops and this aspect of integrated control is potentially overlooked. The question is how we can support and encourage this integrated control function.

We have been asked by many growers about beneficial use and have addressed some FAQs:

Q What plant species attract beneficials?

A There is a lot of information in this area, possibly a whole article in itself. Some of the plants that appear to be common denominators for attracting a range of beneficial insects include: **buckwheat, phacelia, yallow, fennel, lavender, alyssum, coriander, dill, parsley, tagetes (marigold) borage and catmint.** The list is not exhaustive.

At a plant family level:

- Carrot family (including coriander and fennel) – especially good for parasitic wasps and flies
- Aster family (cornflower, yallow, tansy) – especially good for ladybirds and soldier beetles
- Verbena family – great for a range of beneficial insects
- Legumes – (vetchs & clover) – great for a range of beneficial insects
- Brassicas – be careful as many of these may actually encourage aphids

Q Can I grow strips or use companion cropping approaches to enhance the control of aphids in sugar beet crops?

A We know of one or two beet growers who have tried this approach. Unfortunately, there is little information on this, raising many questions about which species, timings of sowing and of course the protection of these strips from herbicides and insecticides. Planting in tramlines could be a useful approach. Indeed, BBRO is looking at this, using tramline strips of a mixture of phacelia, buckwheat and spring rape in 2020.

Q Can I release beneficial insects into sugar beet crops as biological control agents?

A There is little information specifically linked to doing this in sugar beet crops. The general view is that this could be both expensive and have limited or, at best, variable impact. What species to introduce and at what stage of development (adults versus larvae) may be key (especially to avoid insects just migrating away from the crop requiring protection). Release rates are likely to be higher and the timing of release would be critical in relation to aphid numbers. However, this is something that could be looked at in more detail in the future.

Fig. 12. Public enemy number one – *Myzus persicae* (peach potato aphid)

The Bad

The peach-potato aphid *(Myzus persicae)* is regarded as a major pest on a range of crop species including potatoes, brassicas, legumes and sugar beet. It is the most significant pest and virus vector aphid in the UK due to its wide host range and proficiency in transmitting more than 120 plant viruses. Most peach potato aphids overwinter as winged and wingless forms on weeds and brassica species. Winged individuals then migrate from winter hosts to summer hosts from late April and numbers usually peak in July. This aphid species does not form dense colonies and rarely reaches levels that cause direct feeding damage. However, its tendency to move short distances when crowded enhances its significance as an aphid vector.

Virus yellows is an aphid-transmitted virus 'complex' of three different viruses that includes the poleroviruses Beet mild yellowing virus (BMYV) and Beet chlorosis virus (BChV), and the closterovirus Beet yellows virus (BYV). Peach potato aphids are regarded as the principle aphid vector, although the potato aphid *(Macrosiphum euphorbiae)* can transmit all three viruses to sugar beet, too; the viruses are transmitted via persistent (BMYV and BChV) or semi-persistent (BYV) transmission mechanisms by both aphid species. Therefore, once an aphid has acquired BMYV and BChV it remains infective for the rest of its life, although the adult cannot pass this virus directly onto its progeny. Aphis fabae (black-bean aphid) is generally thought to only transmit BYV and only tends to become an issue later in the season so is not regarded as a major virus vector in sugar beet. Aphids carrying BYV remain infective for up to three days.

Fig. 13. *Macrosiphum euphorbiae* (potato aphid)

Fig. 14. Winged and wingless green aphids. Threshold is for green wingless aphids

Fig. 15. Use the BBRO magnifier to assist in finding aphids in field.

What to do in 2020: YOUR ACTION PLAN

- If aphid numbers exceed the threshold for treatment of **one green wingless aphid per four plants up until 12 leaf-stage (or one green wingless aphid per plant after this growth stage)** then treatment is warranted.
- Repeat treatments could only be justified if the threshold is exceeded again at the appropriate growth stage.
- The BBRO will monitor aphids at 40 sites. This information provides an **early warning** of pest pressure to raise awareness to growers and agronomists to monitor crops for their own wingless aphid build-up.
- **Remember** that the threshold for treatment is based on **wingless** green aphid numbers and not winged aphid numbers.
- Tank mixing insecticides with other products (such as herbicides) may not be suitable as the timing and water volumes may not be the same and it is important not to compromise the efficacy of the insecticide.
- Growers and agronomists are encouraged to follow BBRO Advisory Bulletin for updates on aphid numbers and virus levels.

The Ugly

So, how do we keep this ugly chap feeding on aphids and ensure he grows into a cheery voracious adult?

We are often asked questions about the difference between the effects of different insecticides on beneficials and indeed, do we need to use insecticides at all if we have a good population of beneficials. Unfortunately, as we are trying to control virus transfer it is unlikely that beneficial control alone would work quickly and efficiently enough to reduce transfer sufficiently. However, we do know there are differences in the effect of insecticides on these important predators.

Jansen et al (2011) tested the side effects of Flonicamid and pymetrozine* in laboratory tests on five aphid natural enemy species including on the rove beetle *Aleochara bilineata* (Gyll.), the parasitic wasp *Aphidius rhopalosiphi* (DeStefani-Perez), the ladybird *Adalia bipunctata* (L.), the carabid beetle *Bembidion lampros* (Herbst), and the hoverfly *Episyrphus balteatus* (DeGeer). Deltamethrin and pirimicarb were also tested as toxic reference compounds.

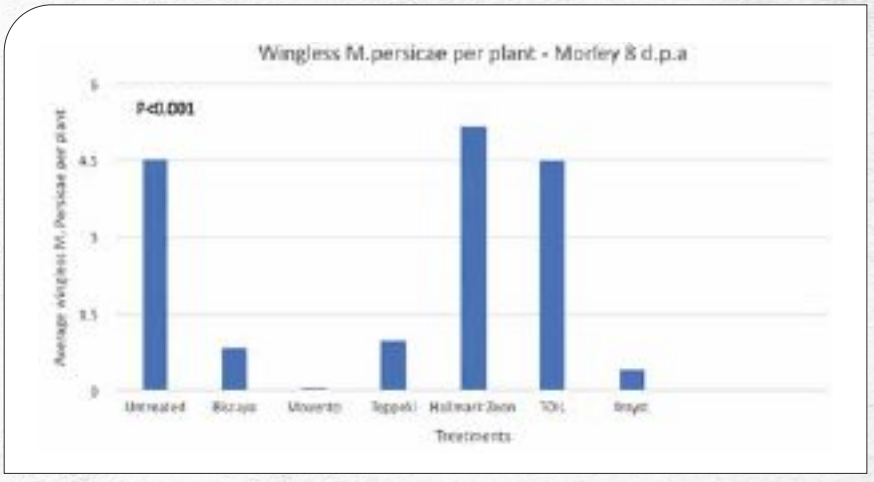
Flonicamid & pymetrozine were shown to be highly selective for aphids, only affecting the parasitic wasp (Aphidius) in the laboratory tests although no effects were observed on plants treated in the field.

*Remember, pymetrozine (Plenum) is not approved for use of aphid control.

In contrast, the pyrethroids were shown to affect all the species tested, a reminder of why we should not use these products on our crops.

This was reinforced by a BBRO aphicide trial in 2018 where there were higher numbers of aphids recorded after treatment with Hallmark Zeon than there were in the untreated controls!

Fig. 16. Don't judge a book by its cover! Ladybird larva are one of the good guys!



On April 2nd we gained emergency authorisation for the use of Biscaya on the 2020 crop. Comparing the EIS (Environmental Impact Sheets) for Teppeki and Biscaya there are indications that Teppeki may have slightly less impact on beneficial insects than Biscaya. The wording on the EID sheets is as follows:

Biscaya may have adverse effects on some non-target beneficial arthropods, in particular foliage dwelling-predators. However, no risk management is necessary. When Biscaya is used in accordance with the label instructions it is unlikely that non-target beneficial arthropods will be adversely affected.

Teppeki poses a low risk to a range of arthropod species commonly found in and around treated fields, including ground beetles, ladybirds and aphid parasitoids. No risk management is necessary.

At the time of writing we have also just gained Emergency Authorisation for Insyst, details of which will be available on our website.

Having some understanding of the numbers of beneficial insects you have in your crop is useful to decide on what insecticide to deploy and when. Watch out for latest advice from BBRO on this as the season progresses, as we will be keeping an eye on beneficial insect levels as well as aphids.

Don't upset the ugly bugs – they may repay you handsomely!