Improving integrated pest management in soft fruit crops – A summary of the first year's findings in AHDB Project SF 174

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Following the completion of AHDB's five-year projects to improve integrated pest and disease management in strawberry and cane fruit crops (SF 156, SF 157 and SF 158), Project SF 174 was set up to develop and further investigate some of the findings. Managed by Michelle Fountain at NIAB EMR with input from ADAS, NRI and Keele University, this new three-year project will undertake the following work:

1. Research and report on new and emerging pests which pose a future threat to UK soft fruit production, informing the industry ahead of potential pest outbreaks, allowing better preparation for prevention and control options.
2. Test the efficacy of the repellent successfully used in strawberry to control capsid in cane fruit and optimise the dispensing method for the repellent compound.
3. Investigate the ability of Orius to predate the capsid juvenile stages for use under warmer, summer, temperatures.
4. Determine whether early season aphids can be kept in check with a novel biocontrol strategy utilising mass releases of hoverflies with semiochemical attractants for retention in the crop.
5. Determine winter survival of parasitoids in aphids in strawberry crops and how insecticide use in the autumn and spring can be adjusted to protect these key natural enemies.
6. Gain scientific data on efficacy of floral margins on soft fruit crop protection and potential to harbour pest species to inform growers on sowings.
7. Pilot-test a 'push-pull' method to prevent non-western flower thrips entering strawberry crops and causing fruit damage.
8. Develop a culturing method for thrips so that cost effective experiments can be done to understand the biology, damage and control strategies for future use.
9. Field test a semiochemical push pull strategy for control of midges in cane fruit.

In the first year (2020), the focus of research was on Task 1 (New and emerging pests), Task 2 (Developing a repellent for capsid control), Task 6 (Efficacy of floral margins to support natural enemies), Task 7 (Test a 'push-pull' method of control for non WFT thrips) and Task 8 (Culturing thrips species other than WFT for future studies).

This report provides an abbreviated summary of the findings of the work on these tasks in 2020.

Identify and report new and emerging pests which pose a future threat to UK soft fruit production

The increasing movement of plant material and fresh produce around the world is resulting in a corresponding increase in movement of invasive pests and diseases to non-native countries, and when taken out of their natural habitats and environments, these have the potential to cause serious damage to soft fruit crops. The increasing use of integrated and biological control techniques and loss of plant protection products makes it increasingly complicated to gain control when such pests or diseases find their way to the UK. Spotted wing drosophila is a good example of just how serious a threat non-native pests or diseases can be in the soft and tree fruit industries in this country.

The team of scientists working on this project have attended national and international meetings to report back potential new and invasive pests of soft fruit crops. There has been liaison with AHDB, Fera, Defra's Animal and Plant Health Agency (APHA) and the Royal Horticultural Society (RHS). EPPO and CABI databases have also been searched to identify and alert growers and agronomists to potential new pest problems.

Future potential pest threats to the UK soft fruit industry have been summarised in the report, but current threats include:

- two species of thrips; Japanese flower thrips and flower thrips
- a true bug; Brown Marmorated Stink Bug
- a whitefly; honeysuckle whitefly
- a scale insect; white peach scale
- two beetles; Japanese flower beetle and whitefringed weevil
- several tortrix moths; strawberry tortrix, Blastobasis, lesser apple leaf-folder, *Acleris nishidai*, *Acleris fimbriana*, yellow tortrix moth and snowy-shouldered acleris moth

In addition, a spider mite threatens to cause damage in glasshouse crops; *Tetranychus mexicanus*. Another beetle species has been raised as a potential concern, but little information has been found on this to date (*Anthonomus bisnignifer*).

Investigate the efficacy of the *Lygus rugulipennis* repellent compound for control of capsids in cane fruit and refine the dose and method of deployment in strawberry and cane fruit

In AHDB Project SF 156, a 'push-pull' approach was investigated for controlling capsids in strawberry crops. A semiochemical 'push' using hexyl butyrate was deployed in the crop in combination with a semiochemical 'pull' in green cross vane funnel traps at regular intervals around the crop perimeter. The approach significantly reduced numbers of *L. rugulipennis* (adults and nymphs) in the crop and reduced fruit damage by up to 90% in organic strawberry. Cane fruits are also damaged by *L. rugulipennis*, along with the common green capsid, *Lygocoris pabulinus* so it was decided in 2020 to assess if the 'push' component (hexyl butyrate) could reduce capsid numbers and damage to fruit in cane fruit crops. Two treatments were tested, one using repellent sachets at a height of 1m in the crop row and one using repellent sachets at 0.5m, 1.0m and 1.5m height within the row.

Both push treatments significantly reduced numbers of capsids in the crop as well as damage to fruit and young leaves. Treatments had no clear adverse effect on numbers of beneficials counted in the crop, due to low numbers sampled, so this may need further investigation. However, previously in strawberry, push-pull treatments had no adverse effect on numbers of beneficials counted in the crop. The repellent did not cause any detectable phytotoxic effects to the raspberry plants.

Work is also being done to develop commercial formulations of the capsid repellent and to evaluate it in the field. As well as formulations of hexyl butyrate alone, blends with methyl salicylate (a pest repellent and an attractant to beneficial insects) are also being evaluated. Formulations have been optimised through laboratory release rate measurements during 2020. Scientists from NRI worked with Russell IPM to successfully refine the dose of hexyl butyrate and they found that the Russell IPM blister packs provide a convenient formulation of hexyl butyrate for use in control of capsids by a push-pull approach. Work will continue in 2021 to evaluate these and develop a product that is available to commercial growers.

Guidance for growers resulting from this work so far:

- Monitor for capsids around the crop from spring:
  - For *L. rugulipennis* use a standard green bucket trap (Unitrap) with green cross-vanes (no bee excluder grid) baited with synthetic attractants and water, with a drop of detergent as a drowning solution.
  - For *L. pabulinus* use a blue sticky trap baited with synthetic attractants.
- *L. rugulipennis* overwinter as adults in weeds surrounding soft fruit crops, breeding in spring and then adult offspring migrate into crops late June/early July.
- *L. pabulinus* overwinter as eggs in young shoots of various shrubs and trees. Nymphs of the first generation emerge in April or May.
- Management of weeds that host capsids in and around the crop is recommended. Weed hosts include groundsel, mayweed, fat-hen, nettle, dock and common mugwort.
- Weedy areas could be replaced with perennial wildflowers which host a range of natural enemies and pollinators important to fruit crops as these can outcompete undesirable weeds (see below).

Test the ability of floral margins to support natural enemies and pests in proximity to soft fruit crops

It has long been thought that the use of wildflower mixes around the margins or within crops can have a beneficial effect on fruit crops, by attracting pollinating and other beneficial insects, such as predators for pest control. Some growers already use such mixes, but there is very little knowledge of the species or phenology of natural enemies in the crop or which flora might be attractive to crop pests.

Crops themselves do not provide the diversity that most natural enemies need to establish a stable and growing population throughout the year. A properly managed floral resource could provide a food source for natural enemies in the form of alternative prey, pollen and nectar, and as a shelter and overwintering habitat.

In the first year of this study, we aimed to;

1. Compare three floral treatments to an unsown control.
2. Monitor the establishment and floral resource in the margins.
3. Identify key natural enemies utilising floral margins.

4. Identify pest species inhabiting specific flora.
5. Establishing floral margins in commercial farms in the vicinity of soft fruit crops for 2021 trial.

In the first year the replicated plots (unsown, sainfoin, chicory, perennial meadow mix (EM1)) that had established around the WET Centre (strawberry crop) at NIAB EMR in 2019, were surveyed for soft fruit natural enemies and pest species in May, June, July, and August of 2020.

Findings from the first year:

- Single species plots like sainfoin and chicory had shorter flowering periods than unsown and EM1 plots. Longer flowering periods provided a better food and habitat resource for natural enemies and pollinators.
- There was a higher abundance of beneficial arthropods in the floral margins of the strawberry crop in May and June.
- Most arthropod herbivores or potential soft fruit pests found during this trial were capsids and aphids. No strawberry pest aphids were found in the floral resources. Common green capsid was found in high numbers in all treatments except in chicory.
- Numbers of herbivores declined in July. No aphids or capsid nymphs were found in July and August.
- Unsown species like dandelion, bindweed, hawkbit, white clover and yarrow had, on-average, greater numbers of thrips (two per flower head) than sown species. Other unsown plant species had fewer than two thrips per flower or had thrips species not found on soft fruit. In sown plots chicory, sainfoin, oxeye daisy, common knapweed and wild carrot were the flowering species with more than two thrips per flower on at least one sampling occasion. Overall thrips numbers declined in August.
- Predatory thrips (*Aeolothrips*), parasitoids, ground beetles and *Orius* nymphs and adults were present in flower heads. No significant numbers were recorded on any plant species. There was a more diverse and abundant community of pollinators in May than September, probably a reflection of floral resource.

In 2020, floral margins were successfully established in two commercial farms. A third farm was sourced from a previous project where floral margins were implemented in 2017. All sites will be monitored for beneficials and pests in 2021.

Controlling thrips species other than WFT in strawberry crops

Most strawberry growers now rely on the use of the predatory mites, *Neoseiulus cucumeris*, predatory bugs, *Orius laevigatus* and on some farms, ‘mass monitoring’ with blue roller traps to control western flower thrips, but these strategies are not always effective against several other species of thrips which fly in as adults and can damage fruit. The biology and behaviour of these species is not well understood.

This study is testing the ‘push-pull’ approach to thrips control, using Magipal™ as the ‘push’ component and LUREM-TR as the ‘pull’. Magipal™ is currently marketed as an attractant for natural enemies but has also been found to be a general pest repellent. LUREM-TR is a non-pheromone lure containing methyl isonicotinate (MI), which has been found to increase

catches of 12 different species of thrips, including some that occur on strawberry i.e. WFT, the rubus thrips (*Thrips major*) and the onion thrips (*Thrips tabaci).*

The objectives of the study are to:

1. Test the 'push' (repellent activity) of Magipal^{TM} on thrips adults from strawberry flowers and its attraction of thrips predators.
2. Test the 'pull' (attraction) of LUREM-TR to thrips adults on blue sticky traps and check numbers of beneficial insects caught on the traps.
3. Test the combined 'push' and 'pull' components when used together.

Findings from the first year:

- Despite best-efforts with site selection, thrips numbers per flower were low overall in the untreated and treated plots at both sites used on the three assessment dates, and there were no significant differences between treatments.
- Thrips adults found on both sites were predominantly rose thrips (*Thrips fuscipennis*) but particularly at Site 2.
- Rubus thrips (*Thrips major*) was the second most common species of thrips adult, especially at Site 1.
- No WFT were seen at either site with only small numbers of flower thrips (*Frankliniella intonsa*).
- Overall thrips numbers were too low to determine whether the strategy led to lower numbers of thrips in flowers.

Culturing non-WFT thrips species for future biological and control studies

Despite some growers effectively controlling western flower thrips (WFT) in commercial strawberry plantations, in recent years bronzing and fruit damage has still occurred. Recent AHDB funded research has demonstrated that other thrips species that fly into the crop may be causing this damage. To allow the scientists the opportunity to do further research on individual thrips species, better understand their behaviour and develop potential control strategies, a pure species culture of individual thrips like rose thrips (*Thrips fuscipennis*), needs to be produced.

A system of rearing a pure species culture needs to be developed. In this work, the scientists tried to rear a culture of thrips using a method successfully employed for WFT using French beans. Although larvae of a single species were successfully reared on bean pods, they did not survive the pupal stage to produce the next generation of adults. Further work would be needed to establish a successful laboratory rearing system for a thrips species such as *T. fuscipennis*.