HDC

A grower guide

Soft Fruit

Biocontrol in soft fruit

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Crop hygiene

Vine weevil movement is fairly predictable on farms. It will migrate from infested areas to adjacent plants or crops. It cannot fly so tends to work in from the edges.

Adult vine weevils are readily carried by pickers who can transport them on their clothes, shoes, punnets or picking trays, sledges etc. This can lead to unexpected areas of damage appearing in remote or isolated parts of a previously clean plantation.

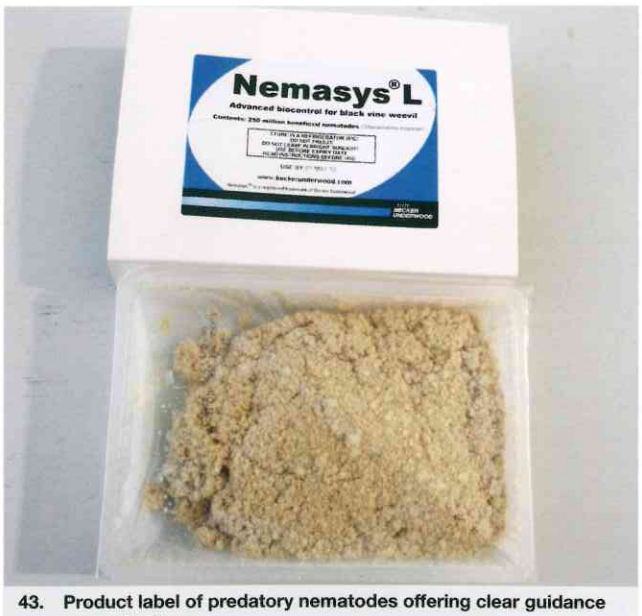
Aim to control populations in older crops, before the younger neighbouring plantations become infested.

How to treat with insect-pathogenic nematodes

Although most growers try to control adult vine weevils in the summer months using insecticide sprays, complete control is rarely gained and some degree of egg laying takes place. There are currently no recommended biocontrol agents available for controlling adult vine weevil, so biocontrol of the larvae is essential if the pest is to be controlled effectively.

Nematode drenches are very effective, if targeted in August and early September when optimum soil and compost temperatures prevail. The correct temperature is all important if good control is to be achieved. At least a month of the minimum temperature provides an acceptable period of time for nematodes to gain effective control. Complete control is unlikely with a single treatment as some larvae will be protected inside the crown and roots, or located outside the treatment area. For best results start treating with nematodes early to provide as big a window of control as possible. Do not wait until late September unless you are using the comparatively cold tolerant species *Steinernema kraussei.*

The product labels (Figure 43) give very important and clear guidance regarding application methods including the constant agitation of the solution to prevent nematodes settling out, removal of inline filters to prevent nematodes clogging them and assessing irrigation line flow times in order to reach the entire crop. It is important to locate the drench as close to the root zone as possible. Soil beds must be well wetted up beforehand to increase the potential for nematode migration. The small root zones of container or bag grown crops, and their comparatively damp root zone are perfect for nematodes.



43. Product label of predatory nematodes offering clear guidance on application

Autumn applied drenches of chlorpyrifos to soil grown crops (up to November according to label directions) are temperature insensitive and can complement the use of earlier applied nematodes if required.

Spring re-planted soil beds cannot be treated with chlorpyrifos, but are very effectively protected with a planting hole drench of colder tolerant *Steinernema kraussei* in March to April. A 100% plant survival rate is commonly possible for soil and compost re-plants.

Further reading

Further information on vine weevil in soft fruit is provided in HDC Factsheet 01/03 (*Vine weevil control in soft fruit crops*) by Scott Raffle, formerly of ADAS UK Ltd.

Aphids

Aphids – key facts

A large number of aphid species infest soft fruit crops. The most commonly found in strawberry include strawberry aphid (*Chaetosiphon fragaefolii* - Figure 44), shallot aphid (*Myzus ascalonicus*), melon and cotton aphid (*Aphis gossypii*), potato aphid (*Macrosiphum euphorbiae*) and glasshouse and potato aphid (*Aulacorthum solani*).

44. Strawberry aphid

Most commonly found in cane fruit are the large raspberry aphid (*Amphorophora idaei* – Figure 45), small raspberry aphid (*Aphis idaei*), potato aphid (*Macrosiphum euphorbiae*), peach-potato aphid (*Myzus persicae*), the melon and cotton aphid (*Aphis gossypii*) and two species confined to blackberry, the blackberry-cereal aphid (*Sitobium fragariae*) and the rubus aphid (*Amphorophora rubi*).

45. Large raspberry aphids

The life cycles of all of these aphids differ, but it is outside the scope of this guide to provide full details of each. Further information can be found in two HDC Factsheets (see Further information section at the back of this guide).

Good end of season hygiene using aphicides delivers a significant reduction of spring aphid levels.

Damage symptoms

It is important to know that the different aphid species cause varying amounts of damage to strawberry and cane fruit crops.

All species debilitate the plant by sucking sap and excreting honeydew that contaminates the foliage, flowers and fruits. Sooty moulds grow on the honeydew which gives rise to blackening. In addition, fruits and/or the calyx may be contaminated by aphids themselves, their dead bodies or their cast skins.

The strawberry aphid does not cause any leaf distortion in strawberry, but it is an important virus vector in strawberry and is capable of transmitting strawberry crinkle virus, strawberry mottle virus, strawberry vein banding virus and strawberry mild yellow edge disease.

The melon and cotton aphid (Figure 46) infests strawberry foliage and flowers forming dense colonies in patches that produce copious secretions of honeydew, which rapidly become blackened by sooty mould. It also acts as a vector of strawberry mottle virus.

46. Melon and cotton aphids

The potato aphid (Figure 47) is very common, especially in spring. Heavy infestations can weaken the young plants and flower trusses, causing distorted trusses and berries.

47. Potato aphid

The shallot aphid causes serious feeding damage to strawberry plants. It feeds during winter and early spring, mainly in the growing points and young leaves, causing strong plant distortion symptoms. Infested plants become severely stunted when growth commences in spring, the petioles being shortened and the leaves curled and twisted. Blossom trusses on infested plants are similarly affected. Cropping is much reduced and the fruits are small and of poor quality.

In cane fruit, the large raspberry aphid acts as a vector for black raspberry necrosis virus, rubus yellow net virus, raspberry leaf mottle virus and raspberry leaf spot virus.

The small raspberry aphid, if present in large numbers, can cause extensive leaf curling on primocanes (Figure 48) and developing fruiting laterals. Ants may be found associated with colonies of any aphid species, but they are particularly common on this species, feeding on the copious honeydew the aphids produce and defending the colony from attack by predators and parasitoids. The small raspberry aphid also transmits raspberry vein chlorosis virus.

48. Leaf curling damage on raspberry caused by the small raspberry aphid

Potato aphid can also give rise to serious leaf and fruit contamination by honeydew and sooty mould on raspberry, but is not considered to be a virus vector.

On raspberry, the melon and cotton aphid is increasingly found on protected crops. Although this species is a very efficient virus vector in many crops, its status as a virus vector on cane fruit is not well documented.

Parasitoids and predators – key facts about the primary biocontrol agents

- Both parasitic wasps (parasitoids) and predatory midges have been successfully used to control aphids in commercial soft fruit crops under protection, although they can be a more expensive option than a traditional aphicide.

Parasitoids

- Aphid parasitoids should be the first line of defence. They are very specific to certain aphid species, so until recently, correct aphid identification (or ideally, knowing which aphid species to expect, to allow preventive parasitoid releases) has been essential before deciding which parasitoid to choose. However, a mix of six parasitoid species is now available for use in soft fruit crops (Table 4 - overleaf). This extends the range of aphid species attacked, and as it is designed to be used preventively, it can be used without the need for aphid identification.

- Parasitoids lay their eggs inside the aphid's body, which turns into a parasitised mummy (Figure 49). Adult parasitoids emerge from the mummified aphid and search for living aphids in which to lay further eggs.
- Most parasitoid species (except for *Aphelinus abdominalis*) are very mobile. Release points every 200m² should be sufficient for good distribution as the adult parasitoids will fly to find aphids.

49. Parasitised aphid mummy

Table 4. Guide to aphids controlled by parasitoids (single: available as single species, mix: available in mix of 6 species)

Aphid species	Parasitoids					
	Aphidius colemani (single & mix)	*Aphidius ervi* (single & mix)	*Aphidius matricariae* (single & mix)	*Aphelinus abdominalis* (single & mix)	*Ephedrus cerasicola* (mix)	*Praon volucre* (mix)
Peach-potato aphid (*Myzus persicae*)	Yes		Yes	Yes	Yes	Yes
Shallot aphid (*Myzus ascalonicus*)			Yes		Yes	Yes
Melon and cotton aphid (*Aphis gossypii*)	Yes		Yes		Yes	Yes
Small raspberry aphid (*Aphis idaei*)	Yes		Yes			
Glasshouse and potato aphid (*Aulacorthum solani*)		Yes	Yes	Yes	Yes	Yes
Potato aphid (*Macrosiphum euphorbiae*)		Yes		Yes		Yes
Strawberry aphid (*Chaetosiphon fragaefolii*)					Yes	Yes
Large raspberry aphid (*Amphorophora idaei*)		Yes				Yes

Predators

- The aphid predatory midge *Aphidoletes aphidimyza* is the principal predator used in soft fruit and can be used to supplement the control achieved by parasitoids. It feeds on all aphid species.
- It only establishes where aphid colonies are present so should not be used as a preventive measure. Adult midges are mainly active at night. Females search for aphid colonies in which to lay their eggs. The number of eggs laid depends on the density of the infestation.
- The midge larva that hatches is bright orange and immediately attacks the aphids (Figure 50). The larvae inject a poison into an aphid to paralyse it, making it easier for the larva to consume. When many aphids are available, the midge larvae kill more aphids than they can consume, making the midge an effective and reliable predator.
- Temperature has a marked effect on the activity of *Aphidoletes aphidimyza*. A minimum dusk and night temperature of approximately 15°C is required, which limits the use of *Aphidoletes* until about mid-May at the earliest under polythene tunnels. The midge needs high humidity conditions for adult survival.
- *Aphidoletes aphidimyza* needs 15 hours of daylight per day to allow it to complete its development, which also limits its use to between May and September.

50. *Aphidoletes aphidimyza* larvae feeding on aphids

Assessing crops for aphid presence and damage

Check all plantations weekly or at least fortnightly from the resumption of growth in strawberries and from bud burst in cane fruit.

Strawberry

In strawberry, monitoring should take place throughout the growing season and should continue through the winter, when shallot aphid becomes active. Examine the whole area of crop, looking for patches of stunted growth or abnormal colouring. Any such patches should be closely examined and the cause diagnosed. Although aphids could be the cause of such damage, other pests or diseases may be implicated.

Examine the undersides of the youngest emerging leaves and the undersides of the older leaves. Shallot aphid may occur singly or in small numbers between the folds of very young, unfurling leaves, which are usually characteristically distorted (Figure 51). Melon and cotton aphid may occur in the flowers. Leaves, flowers and fruits, including stalks, should be examined for other tell tale signs of aphid infestation such as glistening or stickiness of honeydew or the presence of cast skins. Blackening by sooty mould usually indicates the infestation has been present for some time.

51. Strawberry leaves distorted by shallot aphid feeding

Cane fruit

In cane fruit, monitoring should continue from bud burst until early autumn, looking initially in the unfolding leaves in the tips of fruiting canes and primocanes and later under all the foliar canopy when the aphids should be on the underside of fully and expanding foliage.

Damage thresholds

To date, for the majority of aphid species in strawberry and cane fruit, no economic damage thresholds have been developed. Simple thresholds that do not take into account time of season, growth stage, crop age, growing conditions and crop value are likely to be misleading.

There are exceptions however for the more damaging species. In strawberry, only very low populations (<5% plants infested) of damaging aphid species such as strawberry aphid or melon and cotton aphid can be tolerated early in the season. When low levels of these species are found, more frequent (twice weekly) and careful monitoring should be applied. There is a zero tolerance for shallot aphid, due to the damage it causes.

In raspberry, for the large raspberry aphid, the current suggested threshold for control in non-A_{10} resistant raspberry varieties is one aphid per young or mature leaf on fruiting canes or primocanes. A similar approach could be taken with the small raspberry aphid. For potato and peach-potato aphid, an estimation of the insect's population and its potential to cause crop contamination should be used to determine whether or not specific control measures are needed.

Crop hygiene

Aphids are ubiquitous pests so it is impossible to eradicate them from soft fruit plantations. However recent research in Defra Horticulture LINK projects to develop novel pest control technologies and ways of minimising pesticide residues in strawberry and raspberry (Projects HL 0191 – SF 94 and HL0175 – SF 74), has demonstrated that by completely eradicating aphids from strawberry and raspberry crops in the autumn, a significant reduction in pest populations will occur the following spring. Where this is achieved post harvest using aphicides, more reliance on biocontrol agents can be made the following spring when aphid numbers are low.

How to treat with parasitoids and predators

Specific parasitoids are supplied as parasitised mummies in a carrier (e.g. buckwheat), for gentle application to the crop canopy or release boxes (available from the biocontrol suppliers). The mixture of six species are supplied in cardboard tubes that need to be opened to allow the adults to emerge and feed on the drop of honey inside the cap, then placed horizontally in a sheltered position in the crop canopy to avoid direct sunlight and water (Figure 52).

52. Parasitoid mix being released through a cardboard tube

For preventive treatment, introduce single species parasitoids at a rate of 0.25 per m^2 per week, as soon as the crop begins to grow in late March. Parasitised 'mummies' should be visible on the plants within two weeks of starting introductions. For curative treatment of low populations, introduce 0.5-1.0 per m^2 per week. The mix of six parasitoid species is recommended to be released preventively, at the rate of one tube every 200m^2, on three occasions.

The predator *Aphidoletes aphidimyza* is supplied as cocoons within a carrier, in bottles or pots. The bottle or pot should be opened and left in a shaded area where aphids are present. The adult midges will emerge from the cocoons in the carrier and fly off to find the aphids. Look for the orange midge larvae in aphid colonies one week after introduction.

For curative treatment of low populations of aphids, introduce *Aphidoletes* at a rate of 0.5-1.0 per m^2 per week. For curative treatment of higher populations, introduce at 1-2 per m^2 per week. For treatment of aphid hot spots, introduce at 5-10 per m^2 per week for the first introduction.

Whitefly

Whitefly – key facts

The principal whitefly species that affects soft fruit crops is the glasshouse whitefly (*Trialeurodes vaporariorum*). It feeds on plant sap, causing the plants to lose vigour. The waste product, honeydew, builds up on the leaves and allows sooty mould to grow, which is very disfiguring.

There are four stages in the life cycle of whitefly; eggs, nymphs/scales, pupae and adults (Figure 53).

53. Adult whitefly

Eggs are laid by the female whitefly on the undersides of leaves. They are an elongated oval shape and stuck onto the leaf. Eggs are normally laid on the youngest leaves towards the shoot tips. Glasshouse whitefly often lays them in a semi-circle in the case of heavy infestations, but otherwise eggs are scattered randomly. The eggs are white when first laid and turn black just before hatching into 'crawlers' or first stage nymphs.

The crawlers move around the underside of the leaf before they settle and attach themselves with their mouthparts. From this phase onwards they remain immobile, feeding on plant sap, and pass through four nymphal stages before reaching the pupal stage. Scales of glasshouse whitefly are translucent when young and pale cream in colour when older.

Older scales and pupae are found more often on lower leaves. The adult emerges from the pupa through a T-shaped slit in the upper surface. A hand lens is essential to check whether the adult has emerged otherwise the remains of pupae can be mistaken for living whitefly scales. This can lead to false conclusions about the effectiveness of control measures. Pupae are creamy white in colour, oval in shape and when viewed from the side, have a 'mattress' effect in that the depth can be seen.

Adults are 1mm long and appear pure white in colour. The adults have a 'lazy' flight compared to leafhoppers and tend to only fly when disturbed. They mainly occur on the leaves and very young shoots. Whitefly populations are generally low in the winter, but increase rapidly through the summer before decreasing again in late autumn.

Whiteflies require temperatures of 5-30°C to develop with an optimum of 20-25°C, when the time from egg to adult is around 32 days. Optimum humidity is 75-80% RH, so is almost exclusively a pest of protected crops.

Damage symptoms

No leaf or shoot distortion is caused by whitefly feeding, but both adults and larvae produce copious amounts of honeydew. When whitefly populations are high, the honeydew contaminates both leaves and fruit reducing crop vigour and making fruit unmarketable. On the foliage the honeydew eventually becomes infected with the sooty mould fungus and turns black (Figure 54).

54. Sooty mould growth on honeydew

Encarsia formosa – key facts about the primary parasitoid

- The main biocontrol agent used for whitefly control is the tiny parasitic wasp *Encarsia formosa.*
- It needs higher temperatures than the whitefly i.e. a few hours above 18°C each day.
- The adult wasp lays eggs in the whitefly scales. The whitefly scale is killed and the parasitised scale turns black before the new wasp emerges (Figure 55).