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Strawberry blossom weevil

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This factsheet describes the damage caused to strawberry by strawberry blossom weevil, and how its presence should be monitored. It also offers guidance on how and when to control the pest.

Background

Strawberry blossom weevil (*Anthonomus rubi*) is a major pest of strawberry and has the potential to cause very significant economical damage. The adults can sever flower buds from their stalks, leading to a direct loss of crop. Most strawberry varieties can withstand small populations, but when large populations attack a plantation during the early flowering period, a complete removal of flowers and crop loss can occur.

Pest identification

Adults

Adults are black, 2 – 4 mm in length, with a scattered greyish pubescence and a long snout about 40% of the length of the body (Figure 1). If the individuals are disturbed, the snout and legs may be folded under the body. The antennae are inserted about two thirds of the distance down the snout from the base and are elbowed at the first segment. This first segment is longer than the total length of the remaining segments.

Eggs

Eggs are 0.5 x 0.4 mm in size, oval, white and translucent. They are found inside flower buds (see 'Life cycle' section).

Larvae

Larvae are 3.5 mm long, dirty creamish white, legless, with a brown head. The body has a noticeable C shape and is wrinkled. It is found inside severed, withered flower buds.

1 Adult strawberry blossom weevil. Note the characteristic long snout

Host plants

Strawberry is a favoured host but cultivated raspberry and blackberry are also attacked later in the season. Wild hosts include wild strawberry, bramble, rose and other rosaceae.

Crop damage

Flower bud severing damage

In spring and summer, flower buds are (partially) severed by egg-laying females (Figure 2). After mating, the female deposits eggs singly in unopened flower buds. As soon as the egg is laid, the female crawls a short distance along the flower stalk (peduncle) which she then girdles with several small punctures with her rostrum. The injured buds cease to develop and consequently wither. They either fall to the ground or remain dangling from partially severed stalks. Damage starts shortly after flower stem extension and continues until all flower buds have opened.

The open flowers are not attacked in this way. Fortunately, the weevil often preferentially severs smaller secondary, and lower order flower buds which have thinner flower stalks, rather than the primary blossoms. However, the first primary flower buds are prone to attack.

Severing damage is usually patchy and most intense at the margins of fields close to the weevil's overwintering sites or close to earlier flowering crops from which the invading adults have migrated. Severing damage to strawberry can cause yield loss. However this depends on the number of flower buds severed in relation to the capacity for yield compensation of the plant.

A series of studies were conducted by East Malling Research and Efford Experimental Horticulture Station. Yield losses were investigated on the Junebearer Elsanta and on everbearer varieties, by mechanically severing different numbers of flower buds from plants with different yield potentials.

Elsanta

The work on Elsanta was revealing. It was found that after flower buds had been severed from the plant, those flowers and buds remaining were unable to produce a mean berry weight of more than 15 g to acheive the full yield potential of the plant and yield loss occurred. This finding can be applied to a commercial Elsanta crop to assess the likelihood of yield loss occurring following blossom weevil attack:

- In a first main crop of Elsanta, a typical expected yield may be 1000 g per plant.

- If, following blossom weevil attack, there were 50 flowers and/or buds remaining on the plant, then the following calculation can be made:

$$\frac{\text{1000 g (Yield potential)}}{\text{50 (Remaining flowers and/or buds)}} = \text{20 g}$$

- This indicates that to maintain the expected yield potential, the flowers and buds remaining after attack would need to produce an average berry weight of 20 g. With Elsanta, this is unlikely to happen, so yield loss would occur.

- As a rule of thumb, the work has demonstrated that if the above calculation is made and the resulting berry weight of Elsanta is **15 g or more**, then yield loss is likely to occur.

On Elsanta plants with an excess of flowers (eg older plants), it was found that severing damage was beneficial because it slightly increased the mean berry weight. However, severing of the first primary flowers could cause a delay in the onset of harvest by a day or two.

As a result of this research work, the predicted yields from Elsanta plants with varying yield potentials have been calculated based on differing levels of flower severing. These yields are set out in the look-up table (Table 1).

It should be noted that 60-day Elsanta crops can be at risk of damage as well as mainseason crops. Those 60-day crops that are planted early in the season (April) are at greatest risk, as flowering coincides with emergence of high numbers of adults (see 'Life cycle' section). However, later planted crops can still be at risk and growers should monitor their crops carefully for presence of the pest.

Everbearers

In contrast to Elsanta, on everbearer strawberries, it was found that significant levels of severing damage had no effect on total yield for the season. This is largely due to the timing of crop flowering in everbearers. Much of the feeding damage occurs in April and May (see 'Life cycle' section). As the early flowers produced in spring on everbearers are not usually retained or used for harvest, the level of damage is less significant. However, growers wishing to retain early produced flowers on everbearers for early summer cropping should still be aware of the threat posed by blossom weevil.

Adult feeding damage

Adult feeding on flower petals and between folded young leaves results in small irregular round holes, sometimes in groups. Adults which emerge in the summer (whilst in reproductive diapause phase), feed for a few weeks on strawberry, mainly between the folded lamellae of young leaves. However, this generation does not reproduce or cause flower bud severing damage (see 'Life cycle' section).

2 Flower bud severing damage to strawberry

Table 1 Look up table setting out the predicted yields (g/plant) that are likely to be achieved from Elsanta plants following varying levels of flower and/or bud severing. Note that the starting number of flowers and buds in column 1 includes all flower buds on the plant, including weak secondary ones.

Starting number of flowers and/or buds per plant before severing	Numbers of flowers and/or buds remaining after severing	Predicted yield – based on number of flowers remaining after severing * Initial yield potential of plant crown before severing (g/plant)				
		200*	**400***	**600***	**800***	**1000***
10	10	150	150	150	150	150
	9	135	135	135	135	135
	7	105	105	105	105	105
	0	0	0	0	0	0
20	20	200	300	300	300	300
	19	200	285	285	285	285
	17	200	255	255	255	255
	10	150	150	150	150	150
30	30	200	400	450	450	450
	29	200	400	435	435	435
	27	200	400	405	405	405
	20	200	300	300	300	300
	0	0	0	0	0	0
40	40	200	400	600	600	600
	39	200	400	585	585	585
	37	200	400	555	555	555
	30	200	400	450	450	450
	10	150	150	150	150	150
60	60	200	400	600	800	900
	59	200	400	600	800	885
	57	200	400	600	800	855
	50	200	400	600	600	600
	30	200	400	450	450	450
100	100	200	400	600	800	1000
	90	200	400	600	800	1000
	70	200	400	600	800	1000
	40	200	400	600	600	600

Life cycle

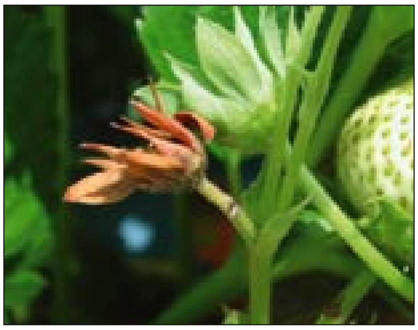
Strawberry blossom weevil has one generation per year. Adults emerge from debris in hedge bottoms on warm sunny days from April onwards, reaching a peak in number by mid-May and invade strawberry plantations. After a short period of feeding, mating occurs and the females insert eggs, usually singly, into the flower buds of the host plant (Figure 3). These are not usually visible due to their size and the fact that they are hidden within the flower bud.

After oviposition, the female punctures the stalk just below the bud with her rostrum (Figure 4), partially severing it and causing it to wither (Figure 5). Eggs hatch in 5 – 6 days and each larva feeds on the shrivelled receptacle and other floral parts beneath the canopy of withered petals and sepals. Larvae develop rapidly and are fully fed in about 2 weeks. Pupation occurs in situ and the new adults emerge about 2 weeks later.

The overwintered adults continue to reproduce and cause damage into late summer, moving to new crops or wild hosts such as wild rose or bramble that provide flower buds for oviposition. However, the new adults that emerge from the withered buds are not reproductively active and do not cause severing damage. They feed for a few weeks on young strawberry leaves (Figure 6) but do not reproduce. They migrate to overwintering sites in August.

3 Blossom weevil egg within a flower bud – these are not usually seen as they are hidden under the unopened sepals and petals

4 The adult female punctures the stalk just below the bud with her rostrum



5 After being severed by the adult female, the bud withers and dies

6 Typical damage caused to leaves by new adults feeding

Pest and crop monitoring

Strawberry blossom weevil is a common and important pest of strawberry. Growers should familiarise themselves with the pest and the damage it causes, and have a good understanding of the timing and distribution of damage. Crops must be monitored carefully and regularly for infestation and damage, as part of the routine crop-monitoring programme. A number of methods have been developed for monitoring blossom weevil activity.

Visual inspection

- Crops should be inspected at least fortnightly, and preferably weekly during the growing season for all pests and diseases .
- Particular attention should be paid to strawberry blossom weevil before flowering and during the early part of the flowering period. Monitoring should begin during the start of flower stem extension in spring.
- Initially, the margins of fields bordering overwintering sites, such as hedges or woodland, should be inspected for signs of infestation or damage. Later in the season, inspect margins of plantations adjacent to earlier infested crops.
- At each inspection point, several plants in a 5 metre radius should be overviewed for early signs of damage such as severed flower buds or feeding damage on leaves. Both the adult weevils and resulting small holes in flower petals brought about by their feeding, may readily be seen in the first open flowers. Count the numbers of severed flower buds and/or adult weevils.
- A zig-zag transect should be made across the field stopping at a minimum of 10 points per ha.
- The assessment should result in a quantification of the following:
  1. The average numbers of flower buds present per plant
  2. The average and maximum numbers of flower buds severed per plant
  3. The numbers of weevil adults present per plant

The assessment should also give a clear indication of how the damage is distributed across the field.

- If the yield potential of the plant is known, the likely yield loss that will result form the damage that has occurred already can be determined (see ‘Crop damage’ section). If economic damage has occurred already before flowering, and especially at the early stages of flower stem extension, application of an insecticide spray to control adults will certainly be justified.

Plant hand brushing

Visual inspection for the incidence of flower bud severing on its own is not adequate because it only quantifies the damage after it has occurred. An early assessment of numbers of adult blossom weevils is much more valuable and reliable. However, adult weevils are difficult to see by unaided inspection of strawberry pants, especially before flowering when they are hidden amongst foliage.

The plant hand brushing method is a much more effective and sensitive method of quantifying adult weevil populations early so that preventive insecticide application can be made in a timely manner.

The plant is brushed or swept by hand over a white or light coloured washing up bowl with one side cut away (Figure 7). The bowl acts as a collecting tray for weevils that are dislodged from a number of individual plants sampled, one at a time. The cut side of the bowl is placed on the surface of the ground held against the base of the plant. The plant is then brushed or swept with the hand towards the bowl causing any weevils present to fall into the bowl where they can be counted.

Ideally, at least 50 plants, 5 in each of 10 places across the field, should be brushed. The average number of weevils collected per plant should be recorded. It is important to note that one weevil can sever up to 50 flowers. Based on this, the effects of the pest on yield can be determined (see 'Crop damage' section).

Aggregation pheromone trap

Male strawberry blossom weevils produce a sex aggregation pheromone, which attracts both males and females for the purposes of mating. The pheromone has three chemical components, Grandlure I, Grandlure II and Lavandulol in a 1:4:1 ratio. The pheromone can be used in pheromone traps for monitoring strawberry blossom weevil populations as an aid to timing of sprays.

The pheromone is dispensed from a polythene sachet lure containing 1/10th of a millilitre (ml) of the pheromone blend. The sachet contains a cigarette filter to hold and distribute the pheromone evenly in the sachet. **Do not tear** the sachet open and use the cigarette filter as the lure. This will result in very rapid loss of the pheromone! The sachet lures have a life of over 8 weeks. The pheromone was initially used in conjunction with a sticky stake trap but recent work in Norway has shown that a green funnel trap fitted with white cross veins (Figure 8 overleaf) is far superior.

The strawberry blossom weevil adults are not only attracted by the sex aggregation pheromone lure (held in the basket in the top of the trap) but are also strongly attracted by the non-UV reflective white cross veins which mimic strawberry flowers. The funnel trap below, into which the weevils fall, can contain a few cm of 50:50 antifreeze plus water with a small amount of washing up liquid soap to break the surface tension in which the weevils drown. The antifreeze is used so that the traps do not dry out in prolonged periods of hot/dry weather. A sieve can be supplied as a trap accessory to aid removal of the insects from the trap.

Perhaps a more convenient alternative to using antifreeze plus water in the trap is to puff diatomaceous earth into the bottom of it and to swirl it round the sides and base. This has proved effective for killing other beetle and moth pests but has not as yet been tried with strawberry blossom weevil. The suppliers of the trap, Agralan Ltd (see 'Further information' section) can supply diatomaceous earth puffers.

This funnel trap is not only more efficient than the sticky stake design, but is much easier to use. However it has not been calibrated, so there is no information on how to interpret trap catches.

When to set the traps:

- For Junebearer strawberry crops, the traps should be set out in early spring (March in outdoor crops in a typical season, earlier under protection) as soon as growth commences and well before flower stem extension has started.

- For everbearer crops, traps may be set at the same time as for Junebearers to gain the maximum information. However, where flowering is to be delayed (eg because of de-blossoming), the setting of traps can be delayed until just before the start of flower stem extension.

Where to set the traps:

- The traps may be used in protected or non-protected strawberry crops. Both crops may be severely attacked by blossom weevil. The

7 Hand brushing strawberry over a washing up bowl with side cut away to determine infestations of strawberry blossom weevil and other pests

trap base should be partially buried in the soil so that the trap is firmly held (Figure 8). Do not bury it too deeply as this can result in larger numbers of ground beetles entering the trap inadvertently. Make sure that the top of the trap is below the boom height of the sprayer.

- Ideally, two or more traps should be set in each strawberry field. They should be sited in places where adults are likely to migrate into the crop in spring. The crop margin next to the hedgerows or woodland where the adults may have overwintered in hedge bottoms is a good position, or else where adults may migrate from neighbouring crops which have flowered earlier.

- For protected crops, traps should be set at the ends of tunnels near the entrance where weevils are likely to enter from hedgerows, headlands or adjacent infested crops.

Trap inspection:

- The traps should be inspected at weekly intervals, or more frequently if possible.

- The cumulative number of strawberry blossom weevil adults captured should be recorded. Weevils captured may be removed on each sampling occasion which makes counting new arrivals easier, but this is not strictly necessary.

- Care should be taken that the strawberry blossom weevil is correctly identified (see ‘Pest identification’ section and Figure 1).

Trap maintenance:

- The water/antifreeze should last many weeks. Each time the weekly records of the numbers of blossom weevil captured are taken, non-target insects (eg flies, bees, etc) should be removed using a strainer for instance. The lures should last at least 8 weeks.

Interpretation of trap catches:

- The trap catches provide an early warning of the arrival of weevils and the onset of flower bud severing damage by females. Experience indicates that for Junebearer crops in spring, the first weevils are often caught a week before the first damage is visible.

- A record of the cumulative trap catches should be kept. Trap calibration experiments by East Malling Research in 2000 – 2003 were conducted with the sticky stake traps. The average number of flower buds severed per plant was generally in the range 0.5 to 2 buds severed per adult weevil caught, though in one instance considerably more severe damage occurred. The green funnel traps with white cross veins are more efficient at catching weevils, so it could be interpreted that less damage is likely to occur per weevil captured. However, as the estimate is only approximate the same interpretation should be used until better evidence is obtained.

- An approved insecticide to kill adults should be applied as soon as a damaging catch is recorded.

Economically damaging pest thresholds:

- Economically damaging thresholds have not yet been developed by scientists for the new trap design. However, work is being undertaken by East Malling Research to test and calibrate the trap in 2008.

Can the pheromone traps be used for control of blossom weevil? :

- Initial attempts to control strawberry blossom weevil by perimeter trapping, mass trapping and lure and kill strategies were made in 2002, but were not successful. However, work is in progress to greatly enhance the activity of the pheromone lure by adding flower specific host plant volatiles and it is hoped that it will then be possible to control the weevil by mass trapping.

Storage of lures:

- The lures come in packs of 10 and can be stored for long periods (several years) in a freezer (at about -20°C) if the pack is sealed. Lures can also be stored in a fridge at higher temperatures (eg 4°C) for periods of up to 1 year. Although the pheromone is not harmful to humans, lures should not be kept in a freezer or fridge where food is stored.

8 Sex pheromone funnel trap with non-UV reflective white cross veins for monitoring strawberry blossom weevil

Natural enemies

Predators

There is little information about predators of strawberry blossom weevil but birds including tits, sparrows, chaffinches and goldfinches, have been recorded as predators of apple blossom weevil. It is probable that general predators such as spiders and ladybirds predate strawberry blossom weevil adults, but eggs and larvae are protected inside the flower buds from non-specialised natural enemies.

Parasites

There has been little work to investigate the natural enemies of strawberry blossom weevil. Five species of parasitic wasp are reported as parasitizing strawberry blossom weevil larvae. There are no records of parasitic wasps that attack eggs or adults.

In Italy, there are records of parasitoids such as the braconids and pteromalids, emerging from strawberry blossom weevil larvae in raspberry and bramble. However, there is little information about species or parasitism rates or the impact these have on populations in the UK.

Chemical control

Strawberry blossom weevil is best controlled by one or more applications of a suitable insecticide applied to control the adults. Applications should be made when the adults have invaded strawberry crops before flowering, but before significant damage is done. Timing of spraying is crucial. Once severing damage has occurred and the crop is in full flower with no more developing flower buds present, then the applcation of insecticides will have no benefit. Maximum benefit will occur if sprays coincide with a time when maximum numbers of weevils have migrated into the crop but when severing damage has only just begun.

Several insecticide products approved for use on strawberry will give some control of strawberry blossom weevil but none are specifically recommended for control of the pest (Table 2 overleaf). The merits and disadvantages of the different insecicides are discussed below.

Bifenthrin (various products)

This is a broad-spectrum synthetic pyrethroid insecticide with acaricidal properties which is approved for control of two-spotted spider mite on strawberry. However, it is also effective against strawberry blossom weevil adults. It is very harmful to many biocontrol agents and has very persistent disruptive effects to IPM programmes.

Chlorpyrifos (Equity, Lorsban)

This broad-spectrum organophosphorus (OP) insecticide has been very widely used for strawberry blossom weevil in the UK for many years. It is fairly effective. Though inexpensive, it has a number of drawbacks:

- It is harmful to bees and should not be used during flowering.
- Applications near flowering can lead to detectable residues in fruits at harvest. Such residues, and especially of OPs, are not favoured by multiple retailers, though residues should not exceed Maximum Residue Levels if instructions for use are adhered to.
- It is harmful to many natural enemies and biological control agents and has persistent disrputive effects to IPM programmes.

Pyrethrins (Pyrethrum, Spruzit)

This is a broad-spectrum, short persistence contact acting insecticide derived from the pyrethrum plant. It will control strawberry blossom weevil adults by direct interception. The Spruzit formulation contains a naturally derived oil which is claimed to enhance efficacy. Good spray cover is needed to get worthwhile results. Although pyrethrins is a broad-spectrum insecticide which is very harmful to many natural enemies and biological control agents, it is of short persistence allowing re-introduction of natural enemies shortly after treatment.

Thiacloprid (Calypso)

Calypso has two SOLAs for controlling capsid bugs in strawberries. The first (0333/06) is for use on outdoor strawberry, the second (0334/06) for use on protected strawberry. Both expire on 31st December 2014. Calypso also has very useful activity against strawberry blossom weevil and several other important strawberry pests. It is a chloronicotinyl insecticide with systemic and translaminar properties. It is considered to control adults directly as well as larvae developing inside severed flower buds. It is now the preferred insecticide for control of strawberry blossom weevil. It is moderately harmful to some biocontrol agents (Table 2 overleaf).

Action points for growers

- Growers should ensure their relevant members of staff are acquainted with the appearance and damage caused by strawberry blossom weevil.
- Ensure members of staff know how to monitor the crop for the pest using visual inspection and hand brushing techniques.
- Consider using the aggregation pheromone trap to help to monitor the crop and aid in the early detection of the pest.
- Where appropriate, employ chemical control measures early, before the majority of flower buds open.

Further information

Suppliers of lure and trap:
Agralan Ltd
The Old Brickyard, Ashton Keynes
Swindon, Wiltshire SN6 6QR
Tel. (01285) 860015
Fax. (01285) 860056
Email. **sales@agralan.co.uk**

Table 2 Insecticides approved for control of pests on strawberry that are likely to be effective or partially effective for control of strawberry blossom weevil

Choice of insecticides – Efficacy factors

Active ingredient	Trade name (examples)	Class	Persistence	Recommended for control of	Safety to biocontrol agents			
					Phytoseiulus	Amblyseius	Orius	Steinernema
bifenthrin	Talstar 80 Flo, Gyro	pyrethroid	long	Two-spotted spider mite	harmful 8–12 wks	harmful 8–12 wks	harmful 8–12 wks	safe
chlorpyrifos	Various products	organo-phosphate (OP)	long	Aphids, spider mites, blossom weevil, vine weevil, tortrix caterpillar	moderately harmful 0.5 wk	harmful 6–8 wks	harmful 5–6 wks	moderately harmful 2 wks
pyrethrins	Pyrethrum, Spruzit	botanical	short	Aphids, caterpillars	very harmful 0 days	very harmful 1 day	very harmful	safe
thiacloprid	Calypso	chloronicotinyl	long	Capsids outdoors (SOLA0333/06) and capsids under protection (SOLA 0334/06)	moderately harmful >2 wks	Unknown	very harmful 2 wks	Unknown

Choice of insecticides – Safety factors

Active ingredient	Hazards				Harvest interval (days)	Max. no. sprays	LERAP category
	Anticholin-esterase yes/no	Humans	Fish & aquatic life	Bees			
bifenthrin	no	harmful, irritant	extremely dangerous	high risk	0	2	A
chlorpyrifos	yes	harmful, irritant	very toxic	dangerous	7	3	A
pyrethrins	no	harmful, irritant	very toxic	high risk	0	unspecified	None specified
thiacloprid	no	unspecified	harmful	uncategorised	3	unspecified	B

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