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Project leader:	John Buxton & Mike Lole, ADAS
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Location of project:	Bransford Webbs Plant Company, Worcester, WR6 5JB
Project coordinator:	John Richards, John Richards Nurseries, Colwall, Worcester WR14 4BZ
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Key words:	*Fagus sylvatica*, Beech, *Phyllaphis fagi*, Beech aphid, winter washes.

The results and conclusions in this report are based on a series of experiments conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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Grower Summary

Headline

- 'Certis Spraying Oil' and 'Savona' are effective winter treatments for controlling beech aphid (*Phyllaphis fagi*).

Background and expected deliverables

- The beech aphid (*Phyllaphis fagi)* is a common and serious pest of container-grown beech used for hedging and amenity purposes. It produces copious wax which makes spray penetration and control, very difficult during the summer season. Moreover, the wax protects the aphid from many predators and parasites, with the result that natural control agents exert only minimal effect on beech aphid populations.
- This pest overwinters as dormant eggs, which are laid in exposed clusters around shoot tips and buds. If these eggs could be controlled by a treatment applied to the plants during the winter period then subsequent infestations the following spring would be significantly reduced.
- The main aim of the project was to evaluate a range of physically-acting insecticidal products against winter eggs of beech aphid in the 2007/08 winter to determine if they reduced the level of aphid infestation that developed the following spring. The main deliverable of the project was therefore to identify suitable winter-applied treatments for the control of beech aphid.

Summary of the project and main conclusions

- A severe, evenly-distributed infestation of beech aphid was established on the experimental plants during summer 2007, which resulted in a significant population of eggs on the test plants in autumn 2007.
- Winter washes, using only physically acting products, all of which were exempt from PSD regulations, were applied in February 2008 to the dormant plants.
- Assessments of subsequent beech aphid numbers showed that all treatments appeared to reduce the percentage of leaves infested compared to untreated plants, but the most effective treatments were i) a two-spray programme of 'Certis Spraying Oil' at 1% and ii) one application of 'Savona' at 1% concentration. Both these treatments significantly reduced beech aphid numbers in comparison with aphid populations on untreated plants.

- The conclusion from this work is that growers can now target this difficult pest during the winter or early spring period and obtain good control of the winter eggs, thus reducing the need for intensive sprays of broad-spectrum insecticides during the summer months.

Financial benefits

- Although the precise monetary value is difficult to assess, effective winter washes for beech aphid will save growers money through reduced plant losses during the summer.

- Although the winter wash treatment will be an additional cost, this is likely to be more than offset by a reduction in the likely number of foliar treatments required during the spring and summer.

- A reduction in the number of summer treatments will also help reduce labour costs associated with beech production.

Action points for growers

- Inspect beech plants during the winter using a hand lens. Beech aphid eggs are small, oval black or dark brown objects clustered around dormant buds and shoots.
- If eggs are found, growers should consider one or more applications of 'Certis Spraying Oil' or 'Savona' in the January/February period when beech plants are dormant. Thorough spray coverage of the plants will be necessary to achieve good results.
- Applications should be made before bud break, which usually occurs in early April under protection, to ensure that egg hatch has not occurred and to reduce the risk of phytotoxic effects.
- Winter treatment should lead to a significant reduction in the number of eggs that hatch and thus a reduction in beech aphid levels in the spring. However, further control measures may be needed during the summer period, especially for plants grown under protection.

Science Section

Introduction

The beech aphid, *Phyllaphis fagi*, is a specific pest of *Fagus* spp. and colonises only beech (*Fagus sylvatica*) in Britain. Severity of attacks by beech aphid outdoors vary from year to year, but under protection very high populations invariably build up during the summer, causing leaf curl, loss of quality and a reduction in plant growth if left uncontrolled. Plants grown outdoors can also suffer serious infestations. Up to 10 generations of this pest can occur during one growing season (Iversen & Harding, 2007). This aphid secretes copious quantities of white wax which cover the aphid colonies and make spray penetration, and therefore control, very difficult. The wax also reduces the effectiveness of predators and parasites. The only predator noted feeding on beech aphid over three years of observations in the field (J. Buxton pers. comm.) has been syrphid (hoverfly) larvae, and then only at low densities.

Growers currently attempt to obtain control using very high volume insecticide treatments to ensure thorough coverage and spray penetration into the plant canopy. Products such as 'Calypso' (thiacloprid), 'Gazelle' (acetamiprid), 'Stalwart' (nicotine) or 'Aphox' (pirimicarb) are often used, usually with added wetting agent. However, control is often poor and repeat applications are needed, which is costly in terms of labour and pesticide product.

Beech aphid overwinters as the dormant egg stage, rather than as adults or nymphs. These eggs are laid during autumn on the bark of shoots and on bud scales and can be seen as black, oval bodies, often in clusters. The main aim of the project was to evaluate a range of physically-acting insecticidal products against winter eggs of beech aphid to determine if they reduced the level of aphid infestation that developed the following spring. The main deliverable of the project was therefore to identify suitable winter-applied treatments for the control of beech aphid.

Materials and Methods

Site location & plant material

The work was done at Bransford Webbs Plant Company, Worcester, where problems with beech aphid have occurred regularly in the past. Beech plants approx. 60 cm high, grown individually in 3 litre pots, were sourced from a commercial supplier in September 2007. Plants were chosen that already had an obvious infestation of beech aphid. They were placed in a polythene tunnel on a gravel standing-out bed.

Aphid numbers were allowed to build up during October; by November the leaves had turned brown and the first winter eggs were laid. Egg-laying continued throughout November, although the population of summer aphid stages steadily declined as the plants became dormant and leaves turned brown.

Experiment design

Plants were arranged in a randomized complete block design using 12 replicates (each pot was a replicate) of six treatments. Treatments are given in Table 1.

Table 1. Experimental treatments applied to potted beech trees

Product	**Active ingredient**	**Application rate**	**Approval status**
Control (water only)	-	-	-
'Certis Spraying Oil'	Refined petroleum oil	1%	Label approval
'Certis Spraying Oil'	Refined petroleum oil	1% applied twice, two weeks apart	Label approval
'Majestik'	Natural plant extracts and polymers	2.5%	Label approval
'Savona'	Potassium salts of fatty acids	1%	Label approval
'SB Plant invigorator'	Surfactants and wetters	1.0%	Label approval

All treatments were applied to the dormant plants on 20 February 2008 using a CO_2 pressurized sprayer and flat fan nozzle at 3 bar pressure. Plants were sprayed to run-off using a water volume equivalent to 1,500 L ha^{-1}. A shield was used to prevent spray drift between treatments.

Assessments

1. A pre-treatment count of winter eggs of the beech aphid was made on 29 January 2008. The total number of buds per plant was counted on 10 plants taken at random from within the experiment. The total number of beech aphid eggs was counted with the aid of a hand lens on five randomly selected buds per plant.

2. An assessment of the aphid population in the spring was done on 14 May 2008 when plants were actively growing away and new leaves had just expanded.

   At this time, beech aphids had moved onto the leaves, were colonizing rapidly and forming copious wax. Each plant was examined individually. A bottom, middle and top shoot were chosen at random and the number of leaves per shoot was counted,

followed by the number of leaves actually infested by aphids. Finally, the largest aphid colony on each chosen shoot was scored using the following system:

Index	Description
0	No aphids
1	1 aphid
2	2 to 5 aphids
3	6 to 10 aphids
4	11 to 25 aphids
5	26 to 50 aphids
6	>50 aphids

A mean score was then calculated for lower, middle and top shoots.

3. All plants were assessed for potential phytotoxicity of the treatments.
4. The data for percentage leaves infested with beech aphids, and the scores of aphid numbers on chosen shoots were analysed by using a Generalised Linear Model (GLM) method. This method of analysis carries out a transformation of the data so that it conforms to a Normal distribution. Before analysis, aphid scores were replaced by the midpoint of the scoring scale used, whereby Index 0=0 aphids, 1=1 aphid, 2= 3.5 aphids, 3=8 aphids, 4=18 aphids, 5=38 aphids, 6=75 aphids. This was necessary because scores themselves are unsuitable for statistical analysis.

Results and Discussion

Aphid assessments

The results of the pre-treatment assessment of egg infestation levels are given in Table 2.

The data indicate that infestation levels were variable across the experiment, with some plants having over 6 eggs per bud and others less than one. However, all plants were infested. Given that the mean number of buds per plant was 93.7, and the mean number of eggs per bud was 4.2, on average there were *c*. 392 beech aphid eggs per plant in the experiment prior to treatment.

Table 2. Counts of beech aphid eggs made in January 2008 on 10 randomly selected plants

Plant	Total buds per plant	Total number of aphid eggs per 5 buds	Mean eggs per bud
1	77.0	24.0	4.8
2	121.0	4.0	1.6
3	156.0	17.0	3.4
4	88.0	29.0	5.8
5	74.0	12.0	2.4
6	98.0	14.0	2.8
7	68.0	31.0	6.2
8	62.0	4.0	0.8
9	78.0	32.0	6.4
10	115.0	38.0	7.6
Mean	93.7	20.5	4.2

The results of the spring (May) assessments of beech aphid infestation are given in Table 3 and Table 4.

These assessments were done approximately 11 weeks after treatment. The results showed that the most consistently-effective treatments were i) 'Savona' and ii) two applications of 'Certis Spraying Oil', both of which significantly reduced the percentage leaves infested on bottom shoots and overall in comparison to untreated (water only) plants. 'Majestik' and 'SB Plant Invigorator' also significantly reduced the percentage of leaves infested on the bottom shoots only. All treatments tended to be less effective on the upper shoots, where no significant differences between treatments were found.

Table 3. Effect of treatment on percent leaves infested by beech aphids in May 2008 (ns = not significant; SEM= Standard error of the mean.)

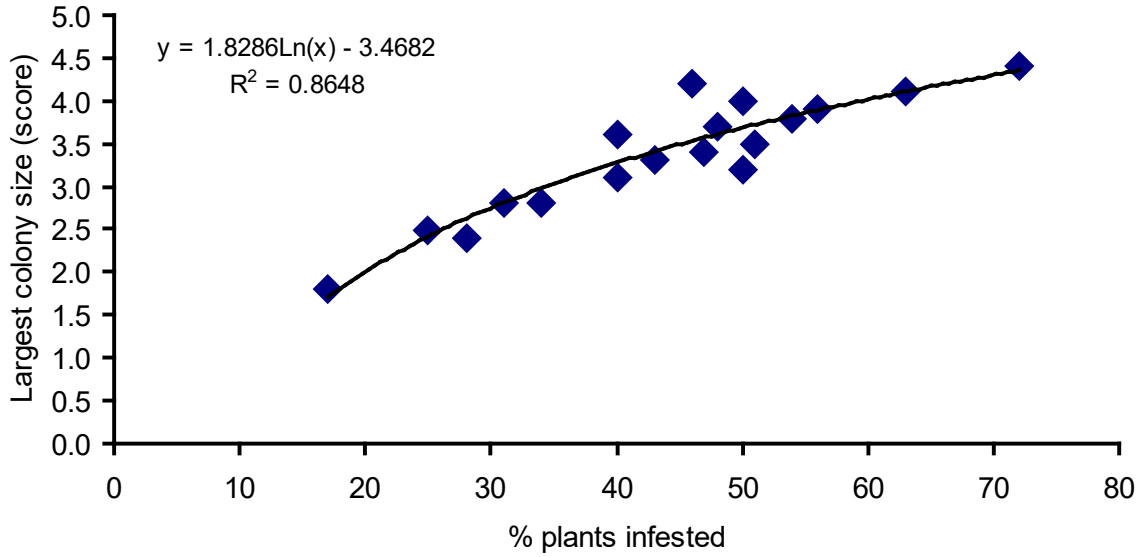
	Bottom shoots		Middle shoots		Top shoots		All shoots
Treatment	**% leaves infested**	**SEM (95% confidence limits)**	**% leaves infested**	**SEM (95% confidence limits)**	**% leaves infested**	**SEM (95% confidence limits)**	**Mean % plant leaves infested**
Untreated	66	9.3 (47,85)	64	8.8 (46,82)	47	11.6 (24,70)	60
'Certis Spraying Oil' x 1	41	8.3 (24,58)	51	9.3 (32,70)	44	10.7 (23,65)	46
'Certis Spraying Oil' x 2	33	9.3 (14,52)	35	8.5 (18,52)	38	10.6 (17,59)	36
'Majestik'	37	8.5 (6,36)	48	9.1 (30,66)	31	9.2 (13,49)	36
'Savona'	21	7.7 (6,36)	17	6.6 (4,30)	25	9.9 (5,45)	21
'SB Invigorator'	39	9.5 (20,58)	47	9.2 (29,65)	33	10.0 (13,53)	40
F ratio	2.52		3.49		0.58		2.23
Error df	55		55		55		55
P	0.004		0.008		ns		0.06

Table 4. Effect of treatment on mean numbers of beech aphids per shoot, May 2008 (ns= not significant; SEM= standard error of the mean)

	Bottom shoots		Middle shoots		Top shoots	
Treatment	**Mean aphid number**	**SEM (95% confidence limits)**	**Mean aphid number**	**SEM (95% confidence limits)**	**Mean aphid number**	**SEM (95% confidence limits)**
Untreated	36	6.3 (24,48)	30	5.9 (18,42)	30	7.1(16,44)
'Certis Spraying Oil' x 1	17	4.3 (9,25)	18	4.5 (9,27)	21	6.0 (9,33)
'Certis Spraying Oil' x 2	15	4.1 (7,23)	15	4.2 (7,23)	31	7.2 (17,45)
'Majestik'	18	4.5 (9,27)	27	5.6 (16,38)	22	6.2 (10,34)
'Savona'	11	3.4 (4,18)	5	2.4 (0,10)	19	5.6 (8,30)
'SB Invigorator'	12	3.7 (5,19)	15	4.1 (7,23)	12	4.5 (3,21)
F ratio	3.51		4.39		1.4	
Error df	55		55		55	
P	0.08		0.002		ns	

There was a close relationship between the percentage leaves infested and the largest aphid colony size (Figure 1), indicating that plants with fewer leaves infested tended to have lower aphid populations.

Figure 1. Relationship between percentage leaves infested and aphid colony size



The products used in this experiment act by physical means, either by coating the target with oil or removing surface wax by detergent action. Since beech aphid eggs become dormant in order to survive the winter period, insecticides that act by chemical means, such as targeting specific enzyme systems, are likely to have been ineffective and were not included in the treatments.

'Savona' is thought to remove surface waxy layers via its strong detergent action, and this may be why it was effective against beech aphid eggs. Only one application was made in this experiment, and it is possible that repeated applications would be more effective. Accurate prediction of the time of egg hatching of beech aphid is not possible, but an application of Savona just before egg hatch might be very effective.

Phytotoxicity

There was no evidence that any of the treatments caused phytotoxicity or resulted in differences between treatments in terms of plant vigor. Untreated plants had the highest number of aphids and within this group, some plants showed leaf paleness and curling due to aphid feeding.

Conclusions

- One application of ‘Savona’ or two applications of ‘Certis Spraying Oil’, applied to containerised beech hedging plants during the dormant period in February 2008, gave a significant reduction in subsequent levels of beech aphid in May 2008. This was achieved by controlling the overwintering egg stage.
- It is possible that repeated applications of ‘Savona’ during this period would improve control of the winter eggs still further, but this was not tested in this experiment.
- Application technique must be adapted to achieve good coverage of all parts of the plant, in order to gain full benefits from the winter treatment.

Technology transfer

An article for HDC News was prepared for publication in Autumn 2008 to enable growers to take advantage of these findings and enable them to plan a winter spray programme against beech aphid (published October 2008, HDC News no. 147).

References

Iversen, T & Harding, S (2007). Life table parameters affecting the population of the woolly beech aphid *Phyllaphis fagi*. *Entomologia experimentalis et applicata* **123**, 1-8.

Acknowledgements

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Appendices

Appendix 1. Raw data from the aphid assessments in May 2008.

1. **Aphid counts on bottom shoots.**

Replicate/ Treatment	No. leaves per shoot	No. infested leaves	Score for largest aphid colony
Untreated			
1	22	9	4
2	4	2	2
3	18	10	5
4	7	7	5
5	18	16	6
6	10	5	4
7	22	17	3
8	13	11	5
9	8	8	6
10	6	6	6
11	8	7	5
12	20	5	2
'Spraying oil'			
1	19	0	0
2	17	0	0
3	21	19	6
4	8	8	3
5	25	2	4
6	10	7	4
7	5	4	3
8	13	4	2
9	23	20	4
10	33	7	4
11	31	8	4
12	10	9	4
'Spraying oil' X2			
1	12	0	0
2	8	0	0
3	15	3	2

Replicate/ Treatment	No. leaves per shoot	No. infested leaves	Score for largest aphid colony
4	15	5	2
5	16	4	5
6	8	4	4
7	9	3	3
8	16	1	2
9	4	1	3
10	19	7	4
11	13	6	3
12	18	18	6
‘Majestik’			
1	31	6	5
2	13	11	3
3	23	16	5
4	8	4	4
5	11	9	5
6	17	4	4
7	21	4	3
8	17	0	0
9	13	1	3
10	19	3	3
11	12	6	4
12	11	6	4
‘Savona’			
1	21	2	1
2	7	3	3
3	21	2	2
4	9	4	4
5	10	0	0
6	15	2	2
7	15	0	0
8	16	4	3
9	13	2	2
10	19	5	5
11	9	9	5
12	13	2	3

Replicate/ Treatment	No. leaves per shoot	No. infested leaves	Score for largest aphid colony
'Agri 50'			
1	14	7	4
2	6	4	3
3	15	13	5
4	10	1	2
5	29	6	3
6	7	4	3
7	20	7	3
8	4	1	2
9	5	3	4
10	10	5	3
11	17	1	3
12	21	11	4

2. Aphid counts on middle shoots

Treatment/ replicate	Number leaves Per shoot	No. infested leaves	Score for largest Aphid colony
Untreated			
1	21	4	2
2	6	0	0
3	29	7	5
4	13	11	4
5	13	13	5
6	8	7	4
7	16	10	4
8	19	15	5
9	19	16	6
10	14	14	6
11	21	19	5
12	12	3	3
'Spraying oil'			
1	17	0	0
2	29	2	2
3	10	6	5
4	16	16	4

Treatment/ replicate	Number leaves Per shoot	No. infested leaves	Score for largest Aphid colony
5	21	18	5
6	13	8	4
7	19	8	4
8	17	12	3
9	17	3	4
10	16	7	5
11	13	7	3
12	13	7	3
‘Spraying oil’ X2			
1	15	0	0
2	14	0	0
3	13	4	4
4	16	4	3
5	18	8	5
6	12	4	3
7	17	3	3
8	18	0	0
9	15	9	2
10	19	9	4
11	15	7	3
12	22	22	6
‘Majestik’			
1	14	7	5
2	15	12	5
3	15	9	4
4	27	8	5
5	14	12	5
6	17	16	6
7	14	3	2
8	13	0	0
9	18	3	3
10	15	3	4
11	14	14	4
12	13	5	5
‘Savona’			

Treatment/ replicate	Number leaves Per shoot	No. infested leaves	Score for largest Aphid colony
1	27	0	0
2	12	4	3
3	31	3	2
4	27	3	3
5	20	1	2
6	10	0	0
7	16	1	1
8	20	6	2
9	11	0	0
10	21	6	4
11	16	13	4
12	12	0	0
‘Agri 50’			
1	26	12	4
2	13	7	4
3	16	6	4
4	9	3	4
5	11	3	3
6	10	4	4
7	17	16	4
8	22	3	2
9	16	2	3
10	10	10	4
11	24	12	4
12	18	11	4

3. **Aphid counts on top shoots**

Treatment/ Replicate	Number of leaves per shoot	No. infested leaves	Largest aphid colony score
Untreated			
1	**9**	**9**	**4**
2	**9**	**0**	**0**
3	**12**	**8**	**4**
4	**7**	**5**	**5**
5	**12**	**8**	**6**
6	**18**	**3**	**2**
7	**17**	**6**	**3**
8	**13**	**9**	**4**
9	**12**	**12**	**6**
10	**8**	**8**	**6**
11	**11**	**3**	**3**
12	**16**	**2**	**4**
'Spraying oil'			
1	**19**	**0**	**0**
2	**15**	**2**	**2**
3	**10**	**8**	**5**
4	**16**	**11**	**4**
5	**12**	**10**	**5**
6	**11**	**2**	**4**
7	**22**	**10**	**4**
8	**10**	**7**	**4**
9	**11**	**9**	**5**
10	**15**	**8**	**3**
11	**11**	**10**	**4**
12	**18**	**7**	**5**
'Spraying oil' X2			
1	**9**	**5**	**4**
2	**24**	**0**	**0**
3	**24**	**12**	**5**
4	**9**	**3**	**3**
5	**13**	**4**	**5**
6	**7**	**3**	**5**

Treatment/ Replicate	Number of leaves per shoot	No. infested leaves	Largest aphid colony score
7	11	6	4
8	20	3	4
9	12	5	5
10	8	7	6
11	10	4	3
12	15	15	6
'Majestik'			
1	16	15	5
2	15	9	4
3	14	7	4
4	14	7	5
5	6	2	4
6	15	15	5
7	8	1	1
8	15	0	0
9	20	0	0
10	10	2	3
11	7	7	6
12	9	4	4
'Savona'			
1	13	1	2
2	8	6	5
3	11	0	0
4	17	5	3
5	9	0	0
6	16	1	3
7	12	2	4
8	6	0	0
9	13	0	0
10	9	9	6
11	18	18	6
12	8	0	0
'Agri 50'			
1	7	1	1
2	8	8	4

Treatment/ Replicate	Number of leaves per shoot	No. infested leaves	Largest aphid colony score
3	35	16	4
4	11	2	3
5	21	2	3
6	7	4	3
7	5	0	0
8	19	6	3
9	10	4	4
10	13	12	4
11	15	6	4
12	20	7	4