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Pesticide Usage in Scotland

A National Statistics Publication for Scotland

Soft Fruit Crops 2016

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Executive summary

This report presents information from a survey of pesticide use on soft fruit crops grown in Scotland in 2016. The crops surveyed included strawberries, raspberries, blackcurrants and other minor soft fruit crops.

The estimated area of soft fruit crops grown in Scotland in 2016 was 1,876 hectares. Sixty eight per cent of this area was grown under permanent or semi-permanent protection. Strawberries accounted for 53 per cent of the soft fruit area, raspberries 18 per cent, blackcurrants 16 per cent and other soft fruit crops 13 per cent. Data were collected from a total of 47 holdings, representing 21 per cent of the total soft fruit crop area. Ratio raising was used to produce estimates of national pesticide usage from the sampled data.

The estimated total area of soft fruit crops treated with a pesticide formulation (area grown multiplied by no. of treatments) was ca. 26,000 hectares (± 10 per cent Relative Standard Error, RSE). The pesticides used had a combined weight of ca. 14,700 kilograms (± 19 per cent RSE). Overall, pesticides were applied to 94 per cent of the soft fruit crop area. Insecticides/acaricides were applied to 88 per cent, fungicides to 86 per cent, herbicides to 62 per cent, biologicals to 30 per cent, sulphur to 23 per cent and molluscicides to 12 per cent.

When pesticide application data are corrected for the area of crop grown, there were around 14 pesticide treated hectares for each hectare of crop grown in 2016. This represents a decrease of 32 per cent from the previous survey in 2014 and 33 per cent from 2011/12. The estimated quantity of pesticides applied per hectare of crop grown was approximately 8 kilograms in 2016. This represents a decrease of 42 per cent since 2014 and 38 per cent since 2011/12.

Overall pesticide application was lower in 2016 than reported in 2014. With the exception of the use of biological control agents which increased in use by 28 per cent between 2014 and 2016, there were reductions in the use of all other pesticide groups. This reduction in pesticide use may have been influenced by factors such as cooler climatic conditions and lower pest pressure in 2016 than in the previous survey. It may also have been influenced by changes in the size and distribution of the sample resulting from a low survey response rate.

In terms of area treated, the fungicide myclobutanil was the most commonly used active substance. Diquat, lambda-cyhalothrin and *Bacillus subtilis* were the most used herbicide, insecticide and biological active substances respectively. Sulphur was the most commonly used pesticide by weight.

Data collected from growers about their Integrated Pest Management (IPM) activities showed that the majority of growers were using a variety of IPM methods in relation to risk management, pest monitoring and pest control.

Introduction

The Scottish Government (SG) is required by legislation[1][2] to carry out post-approval surveillance of pesticide use. This is conducted by the Pesticide Survey Unit at Science and Advice for Scottish Agriculture (SASA), a division of the Scottish Government's Agriculture and Rural Economy Directorate.

This survey is part of a series of annual reports which are produced to detail pesticide usage in Scotland for arable, vegetable, soft fruit and protected edible crops on a biennial basis and for fodder and forage crops every four years. The Scottish survey data are incorporated with England, Wales and Northern Ireland data to provide estimates of annual UK-wide pesticide use. Information on all aspects of pesticide usage in the United Kingdom as a whole may be obtained from the Pesticide Usage Survey Team at Fera Science Ltd, Sand Hutton, York. Also available at:

https://secure.fera.defra.gov.uk/pusstats/surveys/index.cfm

The Scottish Pesticide Usage reports have been designated as Official Statistics since August 2012 and as National Statistics since October 2014. The Chief Statistician (Roger Halliday) acts as the statistics Head of Profession for the Scottish Government and has overall responsibility for the quality, format, content and timing of all Scottish Government national statistics publications, including the pesticide usage reports. As well as working closely with Scottish Government statisticians, SASA receive survey specific statistical support from Biomathematics and Statistics Scotland (BioSS).

All reports are produced according to a published timetable. For further information in relation to Pesticide Survey Unit publications and their compliance with the code of practice please refer to the pesticide usage survey section of the SASA website. The website also contains other useful documentation such as confidentiality and revision policies, user feedback and detailed background information on survey methodology.

Additional information regarding pesticide use can be supplied by the Pesticide Survey unit. Please email psu@sasa.gsi.gov.uk or visit the survey unit webpage:

http://www.sasa.gov.uk/pesticides/pesticide-usage

Structure of report and how to use these statistics

This report is intended to provide data in a useful format to a wide variety of data users. The general trends section provides commentary of recent changes in survey data and longer term trends. The 2016 pesticide usage section summarises the pesticide usage on all soft fruit crops in 2016 and also provides a breakdown for both non-protected and protected data for each crop. Appendix 1 presents all estimated pesticide usage in three formats (area of formulations and area and quantity of active substances). These different measures are provided to satisfy the needs of different data users (see Appendix 3 for examples). Appendix 2 summarises survey statistics including census and holding information, raising factors and survey response rates. Appendix 3 defines many of the terms used throughout the report. Appendix 4 describes the methods used during sampling, data collection and analysis as well as measures undertaken to avoid bias and reduce uncertainty. Any changes in method from previous survey years are also explained.

It is important to note that the figures presented in this report are produced from surveying a sample of holdings rather than a census of all the holdings in Scotland. Therefore the figures are estimates of the total pesticide use for Scotland and should not be interpreted as exact. To give an idea of the precision of estimates, the report includes relative standard errors. A full explanation of standard errors can be found in Appendix 5. Appendix 6 outlines the results of an additional survey which was conducted to collect details of the growers' Integrated Pest Management (IPM) activities (i.e. risk management, pest monitoring and non-chemical methods of control).

Data uses

The data presented here are used for a number of purposes including:

- Informing UK and Scottish Government Policy about the post-approval use of pesticides
- Aiding Government officials in their response to Scottish Parliamentary and Ministerial questions regarding the use of pesticides
- To inform and complement research projects conducted by agricultural research institutions
- To inform and prioritise monitoring strategies of environmental quality bodies
- To provide data to the pesticide industry to allow insight into the use patterns of pesticide products
- To provide information to interested or concerned environmental and wildlife groups and members of the public
- To provide an educational resource for teaching and student research projects

Case studies of how the Scottish dataset has been used are provided on the SASA webpage.

General trends

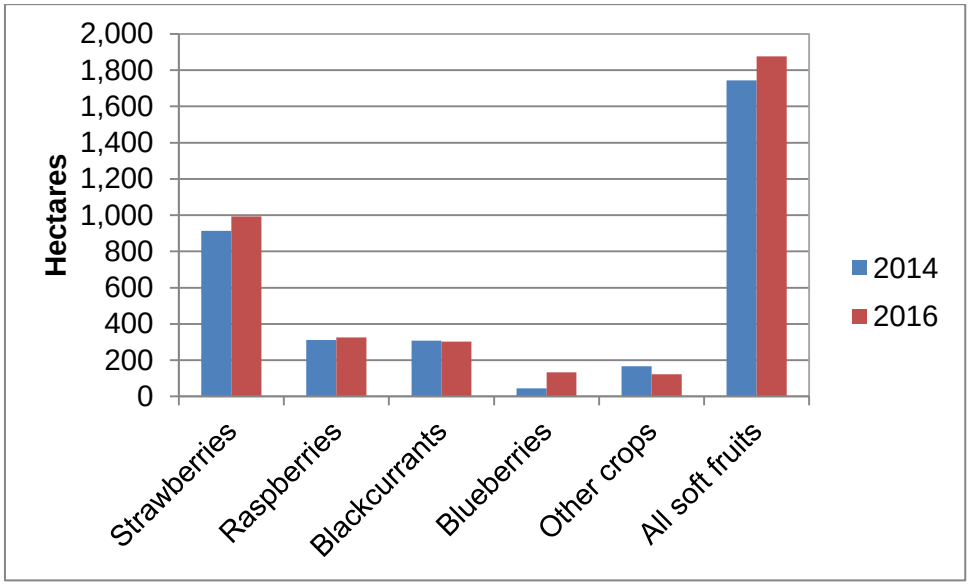
Trends relating to crop area and total pesticide use are discussed in this section. It should be noted the previous survey in 2014[3] was the first soft fruit report to contain data from both non-protected and protected soft fruit crops. To allow some longer-term comparisons, non-protected and semi-protected crop data from the 2012 Soft Fruit Crop survey[4] have been amalgamated with protected soft fruit crop data from the 2011 Protected Edible survey[5]. However, as the soft fruit crops in 2011 and 2012 will have experienced different pest pressure and climatic conditions, these trends should be treated with caution. Data users should also be aware that there have been differences in crop range, crop areas and methods used for estimating pesticide use between surveys (see Appendix 4 for details).

Crop area

The estimated area of soft fruit crops grown in 2016 was 1,876 hectares. This represents a four per cent increase from 2014 and a 13 per cent increase from 2011/12 (Table 36). No multi-cropping was encountered during the 2016 survey. Since the last survey the areas of blueberries, strawberries and raspberries increased (192, nine and five per cent respectively); while the areas of mixed/other soft fruit and blackcurrants decreased (27 and two per cent respectively, Figure 1).

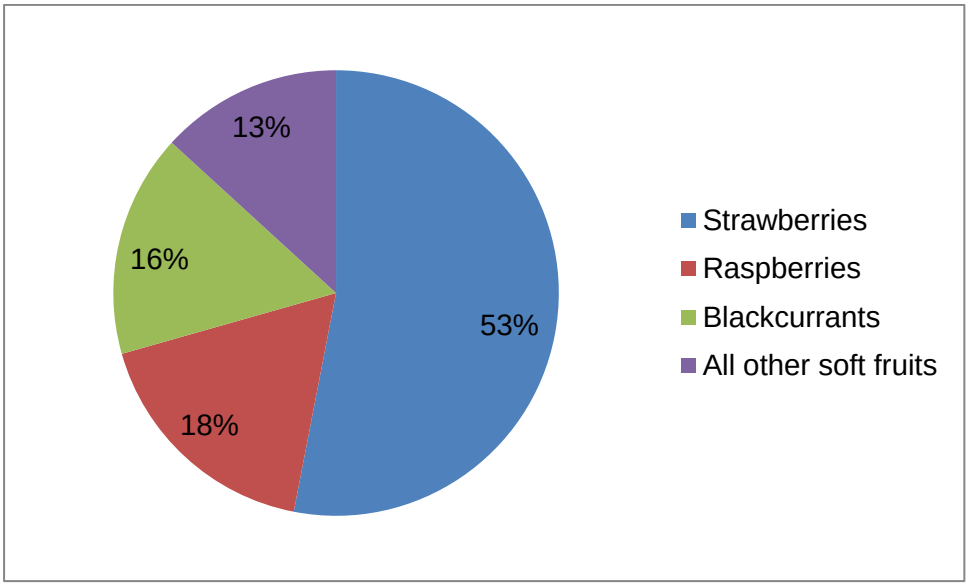
In the current survey, strawberries accounted for 53 per cent of the soft fruit area, raspberries 18 per cent, blackcurrants 16 per cent and other soft fruit crops (blueberries, blackberries, gooseberries, redcurrants and other minor crops) 13 per cent (Figure 2).

Figure 1 Census area of soft fruit crops grown in Scotland 2014-2016



Note: Areas include both non-protected and protected crops. Multi-cropping is not included.

Figure 2 Soft fruit areas 2016 (Percentage of total area)



Pesticide usage

The majority of soft fruit crops (94 per cent) received a pesticide treatment in 2016. Blackcurrants had the highest proportion of crop treated with a pesticide (Table 1, Figure 9) followed by strawberries, raspberries and other soft fruit crops (99, 96, 92 & 84 per cent respectively). In terms of average number of applications of pesticides, the treated area of soft fruit crops received on average 9.3 sprays. It should be noted this applies only to the treated proportion of the crop (94 per cent). Strawberries received the highest number of applications with an average 11.3 sprays. In contrast, the all other soft fruit category received the lowest number of sprays, 5.8 on average (Table 1, Figure 10).

It is estimated that the area of soft fruit crops treated with a pesticide formulation in 2016 was ca. 26,000 hectares compared with ca. 36,800 hectares in 2014 and ca. 34,500 hectares in 2011/12 (Table 35). This represents a decrease of 29 per cent since 2014 and 25 per cent since 2011/12. In terms of weight of pesticide applied 14.7 tonnes were applied in 2016, representing a decrease of 40 per cent from 2014 and 30 per cent from 2011/12

In order to make accurate comparisons between the 2016 data and the data collected in previous surveys, it is important to take into account differences in crop areas between the years. Therefore, the number of treated hectares per hectare of crop grown and the total weight of pesticide used per hectare of crop grown were calculated. Once the crop area has been taken into account there has been a decrease in the area and weight of pesticides applied (Figures 5 & 8). In 2016, for each hectare of crop grown, around 14 pesticide treated hectares were recorded (Figure 5). This represents a decrease of 32 per cent from 2014 and 33 per cent from 2011/12. The estimated quantity of pesticides applied per hectare of crop grown was approximately 8 kilograms (Figure 8). This represents a decrease of 42 per cent since 2014 and 38 per cent since 2011/12. This reduction in pesticide use may have been

influenced by factors such as cooler climatic conditions and lower pest pressure. However, it should be noted that it may also have been influenced by the size and distribution of the sample. In 2016 the response rate of growers participating in the survey (Table 47) was much lower than in previous surveys (53 and 68 per cent respectively). As a result, the sample in 2016 represented 21 per cent of the total crop area grown, compared with 33 per cent in the previous survey. In addition, in 2016 the proportion of holdings in the larger size groups, which tend to have more intensive pesticide use, was lower than in the previous survey. Despite these changes to the sample in 2016, the similar relative standard errors for total soft fruit reported between the last two surveys provides some reassurance that the statistical robustness of the data has not been compromised (Table 47).

Fungicides were the most frequently used pesticides, followed by insecticides/acaricides and then herbicides (Figure 3). This is the same pattern as was observed in the previous two surveys. In 2016, fungicides accounted for 53 per cent of the total pesticide treated area and 48 per cent of the total weight of active substance applied (Figure 6). When the changes in crop area are taken into account, the area treated with fungicide formulations decreased by 29 per cent from 2014 to 2016 and 36 per cent between 2011/12 and 2016 (Figure 5). From 2014 to 2016, the weight of fungicides applied per hectare of crop grown halved (Figure 8). From 2011/12 to 2016, there was a decrease of 56 per cent in the quantity of fungicides used per hectare of crop grown. The decreased use of fungicides in 2016 may partly be explained by the weather. The east Scotland experienced a slow cold spring, with much lower temperatures in the spring and summer and lower rainfall levels in the spring compared with 2014[6] which may have resulted in decreased use of disease control measures.

In 2016, sulphur accounted for three per cent of the total pesticide treated area and a quarter of the total weight of active substance applied (Figures 3 & 6). When crop area is taken into account the mean applications of sulphur were 2.0 kg/ha in 2016, 3.3 kg/ha in 2014 and 1.9 kg/ha in 2011/12. The rise in use of sulphur in 2014 was primarily due to the increased use of sulphur on blackcurrants for the control of big bud mite[3], which was not cited as a reason for pesticide use in 2016.

Insecticides and acaricides accounted for 22 per cent of the total pesticide treated area but only three per cent of the total weight of active substance applied (Figures 3 & 6). When changes in area of crop grown are taken into account, there is a 42 per cent decrease from 2014 to 2016 and a 34 per cent decrease from 2011/12 to 2016 in the area treated with insecticide/acaricide formulations (Figure 5). In terms of weight of active substance applied, when area of crop is taken into account, there was a decrease of 70 per cent from 2014 to 2016 and a similar decrease (69 per cent) from 2011/12 (Figure 8). Cooler temperatures in the east of Scotland during the spring and summer of 2016 compared with 2014[6] may have kept insect pest populations in check. In addition, a large reduction in the use of organophosphates which were applied at high dose rates, may partly explain why the weight of insecticides has declined more than the area treated. Previously, the principal

organophosphate used on soft fruit crops was chlorpyrifos. The Chemical Regulation Directorate (CRD) has withdrawn all commercial uses for all products containing chlorpyrifos in the UK, with the exception of gantry sprays on brassica plants. Therefore all products containing chlorpyrifos had to be used on soft fruit crops before the 31st of March 2016 and were not available for the majority of the growing season.

In 2016, herbicides accounted for 15 per cent of the total pesticide treated area and 23 per cent of the total weight of active substances applied (Figures 3 & 6). When changes in crop area are taken into account, there is a decrease in area treated with herbicide formulations of 11 per cent from 2014 to 2016 and an increase of six per cent from 2011/12 to 2016 (Figure 5). In terms of weight of active substance applied, when area of crop grown is taken into account, there was an increase of three per cent from 2014 to 2016 and an increase of 52 per cent from 2011/12 to 2016 (Figure 8). Herbicide use in the previous survey was higher than average due to mild weather conditions which increased weed pressure but also due to the number of table top grown crops encountered in the survey(3). Herbicides are frequently used in tunnels under table top grown strawberries. There was a reduction in the number of table top grown crops encountered in 2016 sample compared to 2014 (44 per cent of sampled strawberry area verses 60 per cent in 2014) which may have influenced the herbicide use estimate.

Biological control agents and biopesticides each accounted for three per cent of the total pesticide treated area (Figure 3). Thirty per cent of the total soft fruit crop was treated with a biological (either a biopesticide or a biological control agent – see appendix 3 for a definition). When changes in crop area are taken into account, the area treated with biological control agents increased by 28 per cent from 2014 to 2016 and by 29 per cent from 2011/12 to 2016. An increased awareness of integrated pest management techniques, and a decline in the number of active substances available to soft fruit growers, may have influenced the increased use of biological control agents. In contrast the area treated with biopesticides decreased by 54 per cent from 2014 and by 58 per cent from 2011/12 (Figure 5). Just over half (51 per cent) of the total soft fruit area treated with a biological was for the control of disease with the remainder for the control of invertebrate pests.

Molluscicides accounted for one per cent of the total pesticide treated area (Figure 3). When changes in crop area are taken into account, the area treated with molluscicide formulations decreased by almost a third (32 per cent) between 2014 and 2016 and by almost two thirds (65 per cent) between 2011/12 and 2016. The quantity of molluscicides applied per hectare of crop grown decreased by 40 per cent from 2014 to 2016 and by 69 per cent from 2011/12 to 2016.

As well as changes in overall trends in application of pesticide groups since the previous survey, there has been variation in the use of individual active substances. For example, the use of the fungicide myclobutanil, the most commonly used active substance, decreased by 16 per cent in terms of area treated and 18 per cent in terms of quantity of active substance applied (Tables 33 & 34). The fungicide potassium hydrogen carbonate, decreased

by 85 per cent in terms of area treated and by 79 per cent in terms of quantity applied. The fungicide cyflufenamid was recorded in this survey series for the first time. The biological control agents, *Aphidoletes aphidimyza* and *Neoseilus californicus* and the biopesticide *Beauveria bassiana GHA* were also recorded for the first time on soft fruit crops in 2016 (Table 35). The most commonly used herbicide, diquat, declined by 30 per cent in terms of area treated and by 33 per cent by quantity applied. In contrast, the herbicides isoxaben, napropamide and glyphosate increased by 319, 136 and 93 per cent respectively in terms of area treated and by 243, 115 and 115 per cent respectively by quantity of active substance applied.

For the first time in this series of reports, insecticides, fungicides and herbicides have been classified into groups according to their mode of action (Tables 30-32).

Figure 3 Use of pesticides on soft fruit crops (percentage of total area treated with formulations) - 2016

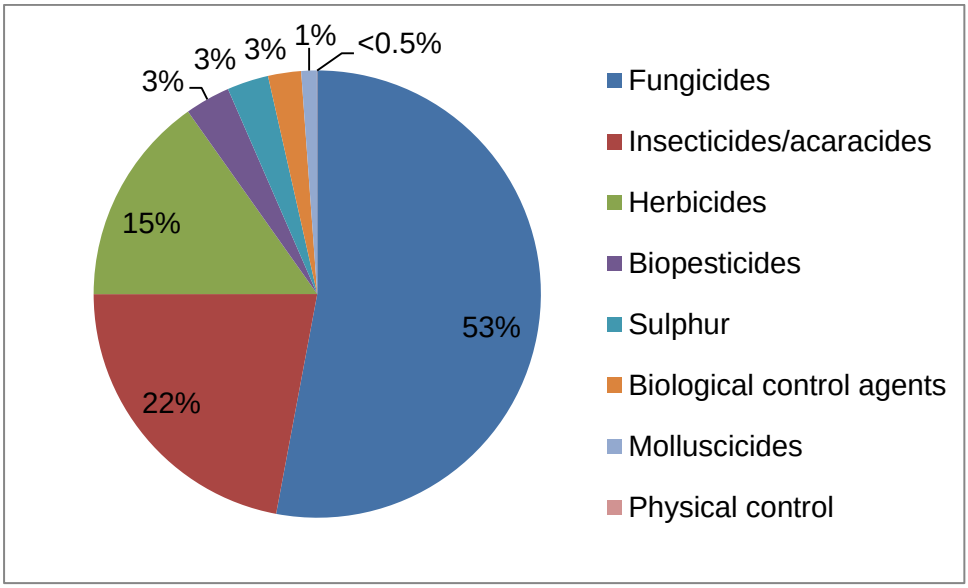
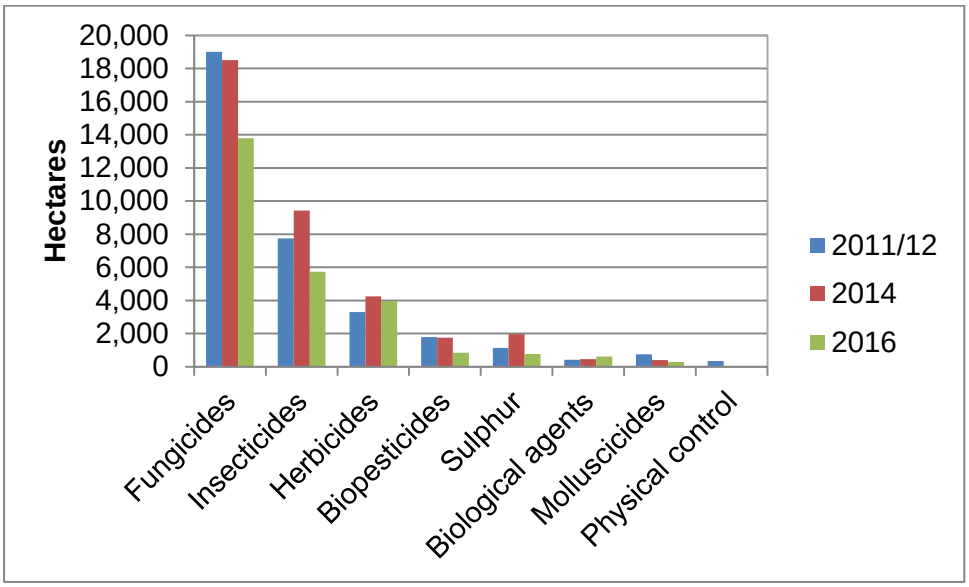
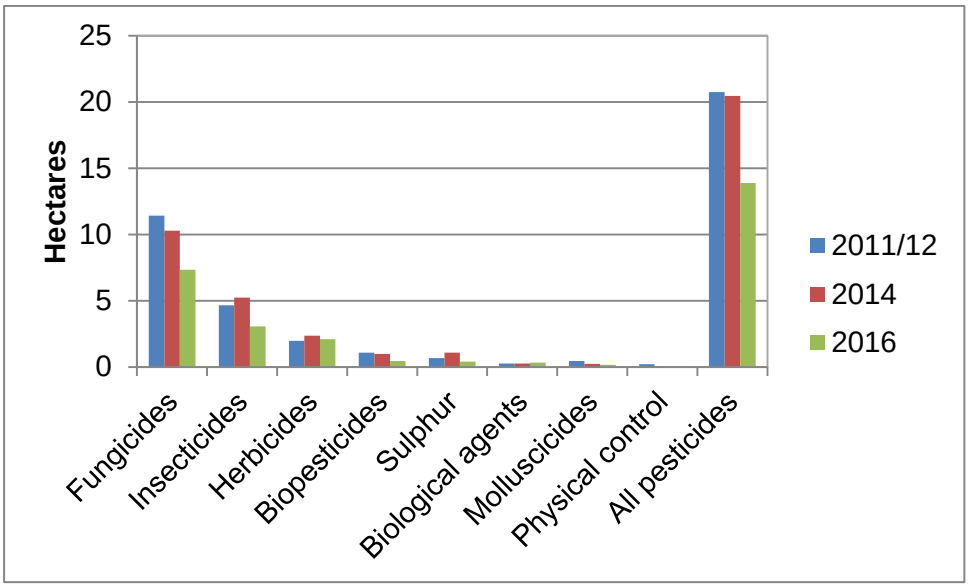


Figure 4 **Area of soft fruit crops treated with the major pesticide groups in Scotland 2011/12 - 2016**



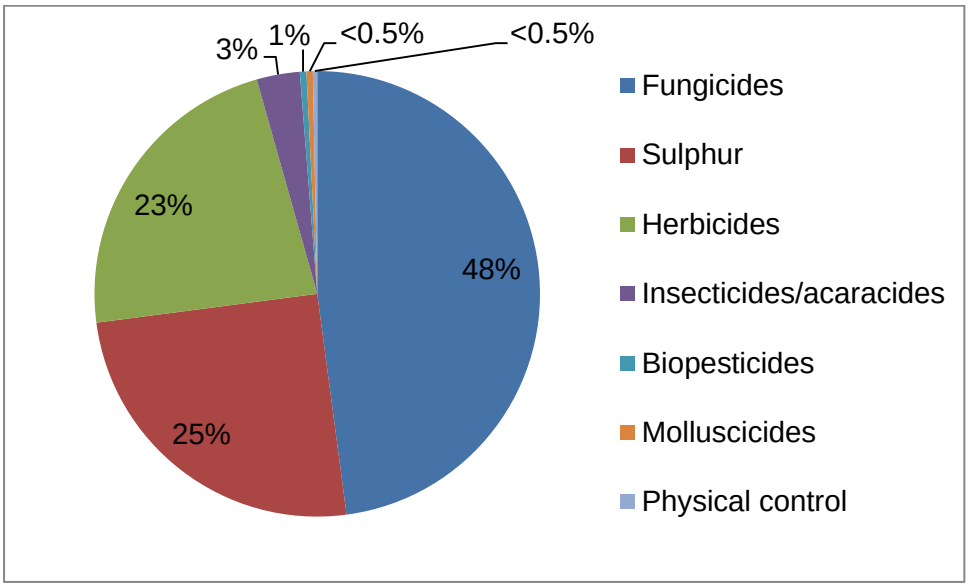
Note: Insecticides include acaricides

Figure 5 **Number of pesticide treated hectares (formulations) per each hectare of crop grown 2011/12-2016**



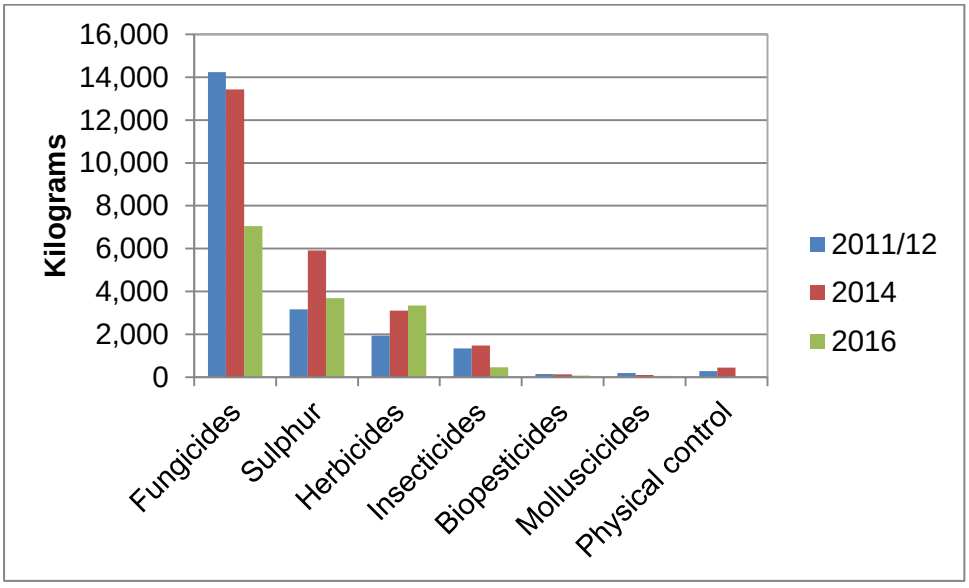
Note: Insecticides include acaricides

Figure 6 **Use of pesticides on soft fruit crops (percentage of total quantity of active substances applied) - 2016**



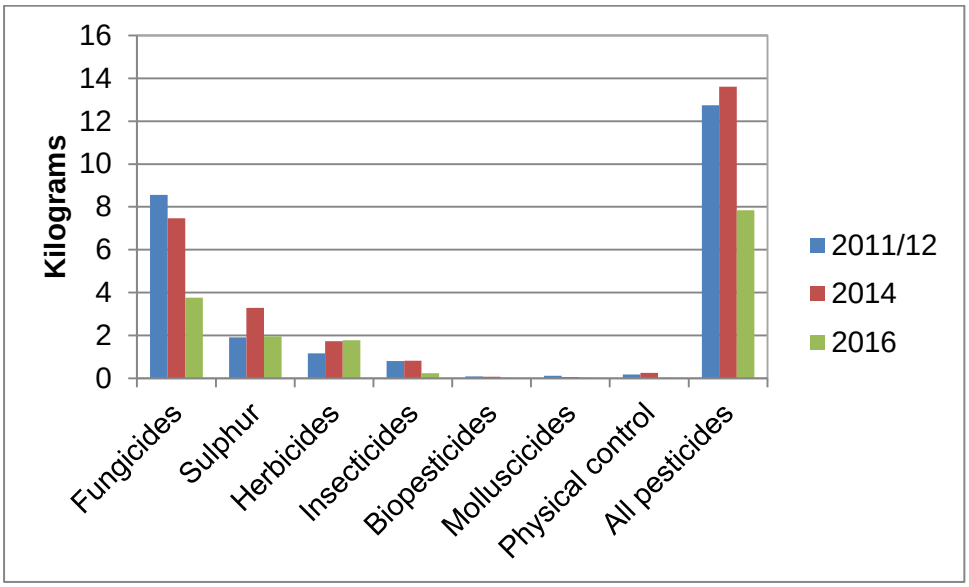
Note: invertebrate biological control agents are applied by number of organisms rather than weight therefore data are not presented

Figure 7 **Quantity of the major pesticide groups applied to soft fruit crops in Scotland 2011/12-2016**



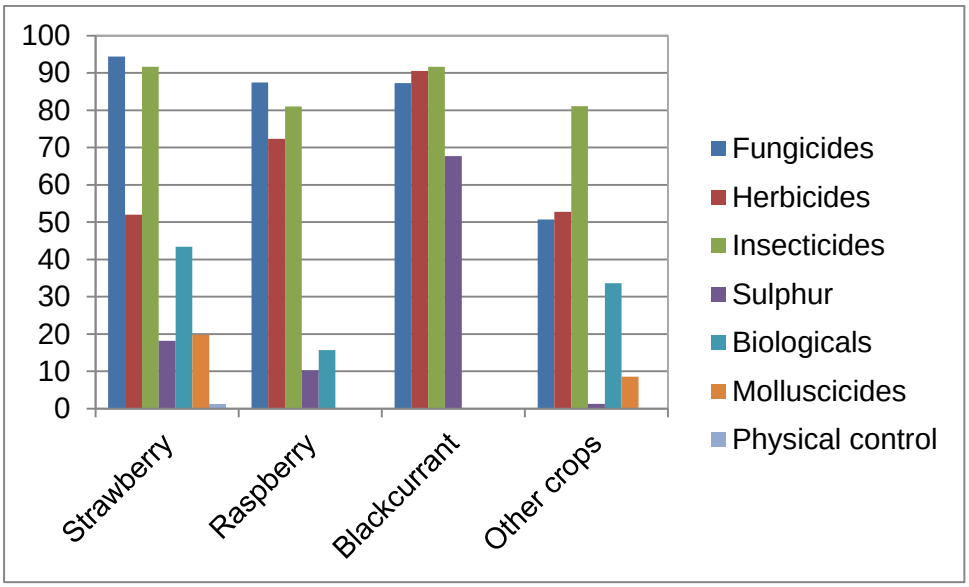
Note: invertebrate biological control agents are applied by number of organisms rather than weight therefore data are not presented. Insecticides include acaricides.

Figure 8 Weight of pesticide (kg) applied per hectare of crop grown 2011/12-16



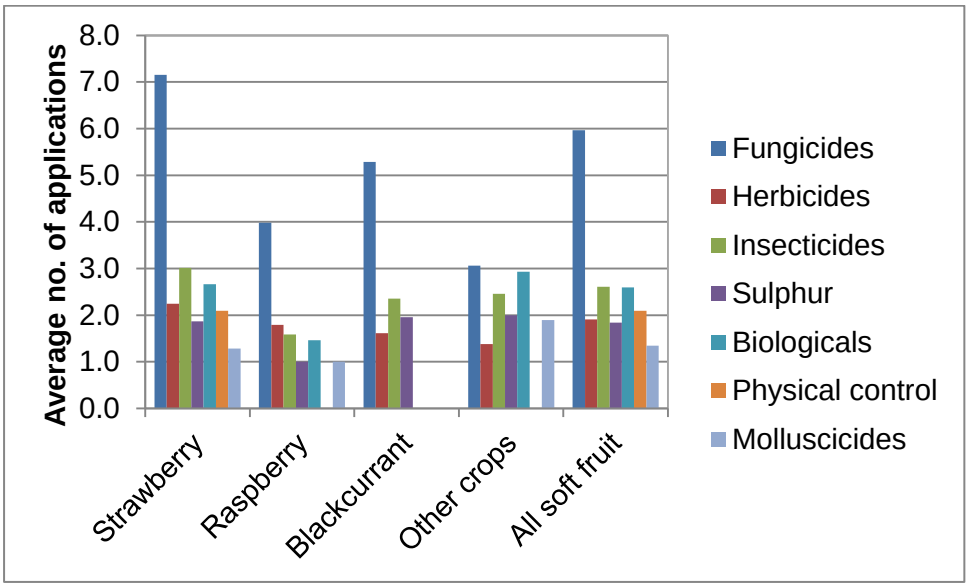
Note: Insecticides include acaricides

Figure 9 Percentage of soft fruit crops treated with pesticides - 2016



Note: Insecticides include acaricides. Biologicals includes biopesticides and biological control agents

Figure 10 Average number of pesticide applications on treated area of soft fruit crops - 2016



Note: Insecticides include acaricides. Biologicals includes biopesticides and biological control agents

Integrated pest management

For the first time in this series of surveys, additional data collection was conducted in relation to grower adoption of Integrated Pest Management (IPM) measures. This is a summary of the data; please refer to Appendix 6 for the full dataset. Growers were asked a series of questions about the IPM activities that they implemented for their soft fruit crop production. Unlike the other statistics in this report, the figures relating to IPM are not raised (i.e. are not national estimates) but represent only the responses of those surveyed.

In total IPM data was collected from 28 growers, representing 33 holdings and 68 per cent of the sampled soft fruit crop area (14 per cent of the census area). Of these growers, 82 per cent did not have an IPM plan, 11 per cent of growers completed their own IPM plan and seven per cent had a plan completed by their agronomist (Figure 42). Despite the majority of growers not completing an IPM plan uptake of a wide range of IPM activities was encountered. Growers were asked about their IPM activities in relation to three categories; risk management, pest monitoring and pest control.

A number of risk management measures were reported by the growers surveyed (Table 50). Just over half (54 per cent) of all growers used crop rotation to manage the risk of pest damage. A similar proportion (54 per cent) of growers tested their soils in order to tailor inputs to improve crop performance. 61 per cent of growers managed their seed bed agronomy to reduce risk. Almost 40 per cent of growers amended cultivation methods at sowing to try to increase crop success. 57 per cent of the growers surveyed also considered risk management when selecting seeds and/or varieties. Almost 30 per cent of respondents sowed catch or cover crops as part of their crop production cycle. Eighty two per cent of growers sampled adopted techniques to protect or enhance populations of beneficial insects and almost a third of growers manipulated environmental factors to control pest risk. The majority (93 per cent) of respondents adopted good crop hygiene techniques to reduce risk.

A number of pest monitoring activities were also recorded (Table 51). Seventy one per cent of growers reported that they regularly monitored crop growth stages and 86 per cent monitored and identified pests on their crops. Over a third (39 per cent) of respondents also used specialist diagnostics when dealing with pests that were more problematic to identify or monitor.

The pest control measures reported by the growers surveyed are presented in Table 52. Almost all of the growers (96 per cent) used non-chemical control in partnership or instead of chemical control. Almost half (46 per cent) of growers stated that they targeted their pesticide applications using monitoring data. In addition, almost a third of growers stated that they followed anti-resistance strategies. Finally, 71 per cent of growers stated that they monitored the success of their crop protection measures.

2016 Pesticide usage

All strawberries (protected and non-protected crops)

- An estimated 995 hectares of strawberries were grown in 2016. This consists of 75 ha of non-protected crops and 920 ha of protected crop
- Pesticides were applied to 18,222 treated hectares. Fungicides and insecticides were the most commonly applied pesticides (Figure 11)
- 96 per cent of the crop was treated with a pesticide
- 7,869 kilograms of pesticide were applied to the crop
- Strawberry crops received on average 11.3 pesticide sprays (Table 1). These sprays included 7.2 fungicide and three insecticide/acaricide applications (applied to 94 and 92 per cent of the crop area). They also received on average 2.2 herbicide, 2.7 biological, 1.9 sulphur and 1.3 molluscicide applications (applied to 52, 43, 18 and 20 per cent respectively)
- In relation to timings of pesticide applications, fungicides and insecticides/acaricides were applied between February and October, 60 per cent of sulphur was applied in July and herbicides were applied throughout the year with a third applied in February (Figure 12)
- The most common variety encountered was Sonata, accounting for 84 per cent of the sample area
- 13 per cent of strawberries encountered in the sample were under one year old, 39 per cent were between one and two years old and 48 percent were over two years old
- 52 per cent of the crop sampled was grown directly in the soil, with the remainder being grown in bags or troughs. 44 per cent of the crop sampled was grown on a table top system
- 43 per cent of the crop sampled was grown with a ground mulch or straw
- 95 per cent of the crop sampled was grown under protection, of this 73 per cent were in temporary tunnels and 27 per cent were in permanent tunnels
- Pollinators were used on 78 per cent of the strawberry crop sampled; six per cent had no pollinators with the remainder unknown. On the sampled area using pollinators 87 per cent were bumble bees and 11 per cent were bumble and honey bees
- 99 per cent of the strawberry crops surveyed were harvested in 2016. 93 per cent were for fresh market, six per cent for pick-your-own and one per cent for processing
- Reasons for use on strawberry crops are presented in Figures 13 to 15. Ninety eight per cent of the use of herbicides was for general weed control with the remainder specified for couch

Summary of pesticide use on all strawberries:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	10,593	5,682	94	Myclobutanil (1,608)
Herbicides	2,001	1,510	52	Diquat (828)
Insecticides/acaricides	3,858	322	92	Lambda-cyhalothrin (886), Abamectin (858)
Molluscicides	253	59	20	Metaldehyde (194)
Sulphur	339	185	18	N/A
Biopesticides	780	64		*Bacillus subtilis* (767)
Biological control agents	374	N/A		*Steinernema kraussei* (114), *heterorhabditis bacteriophora* (113)
Physical control	24	47	1	Carbonic acid diamide/urea (24)

N/A = not applicable

Figure 11 Use of pesticides on all strawberry crops (percentage of total area treated with formulations) - 2016

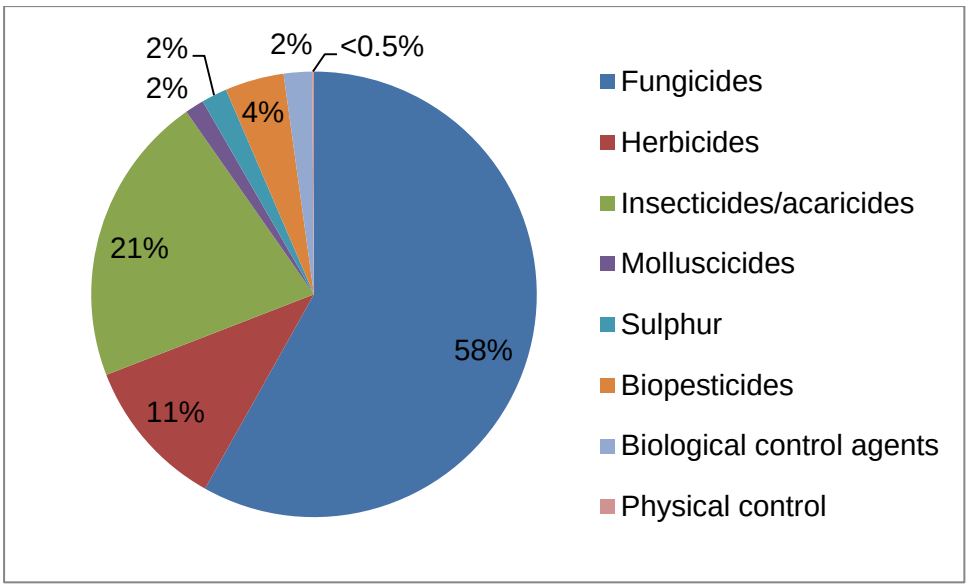
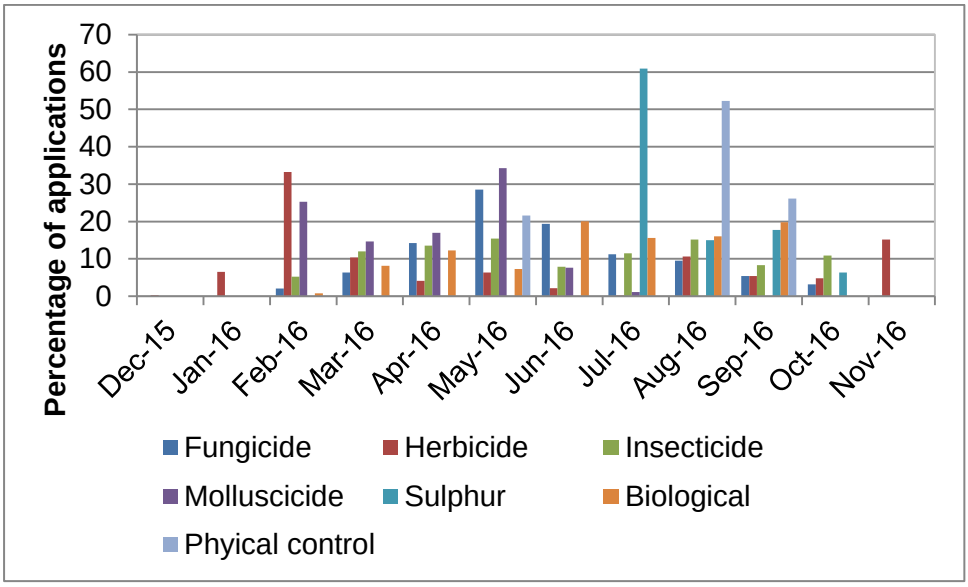


Figure 12 Timings of pesticide applications on all strawberries - 2016



Note: Insecticides include acaricides. Biologicals includes biopesticides and biological control agents

Figure 13 Reasons for use of fungicides on all strawberry crops (where specified) - 2016

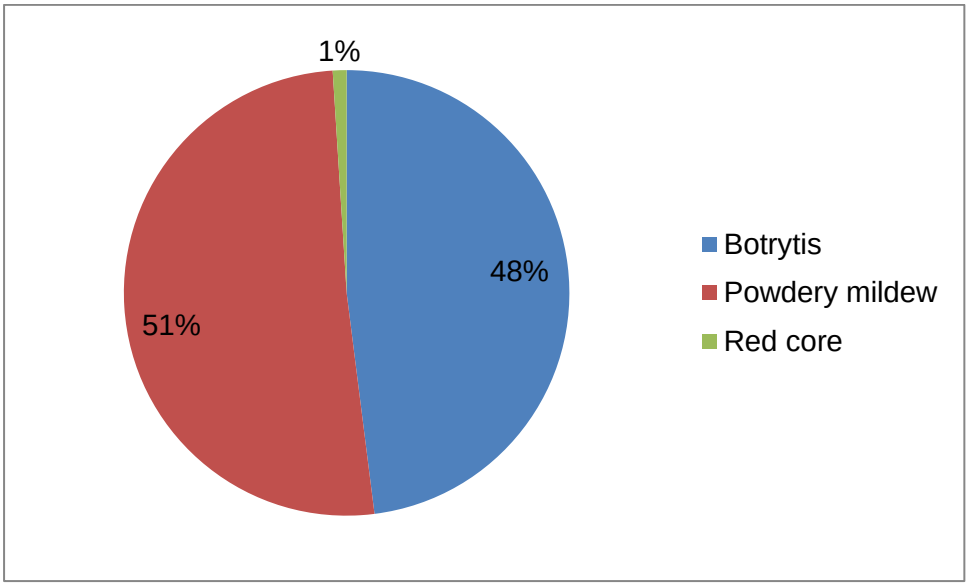


Figure 14 Reasons for use of insecticides and acaricides on all strawberry crops (where specified) – 2016

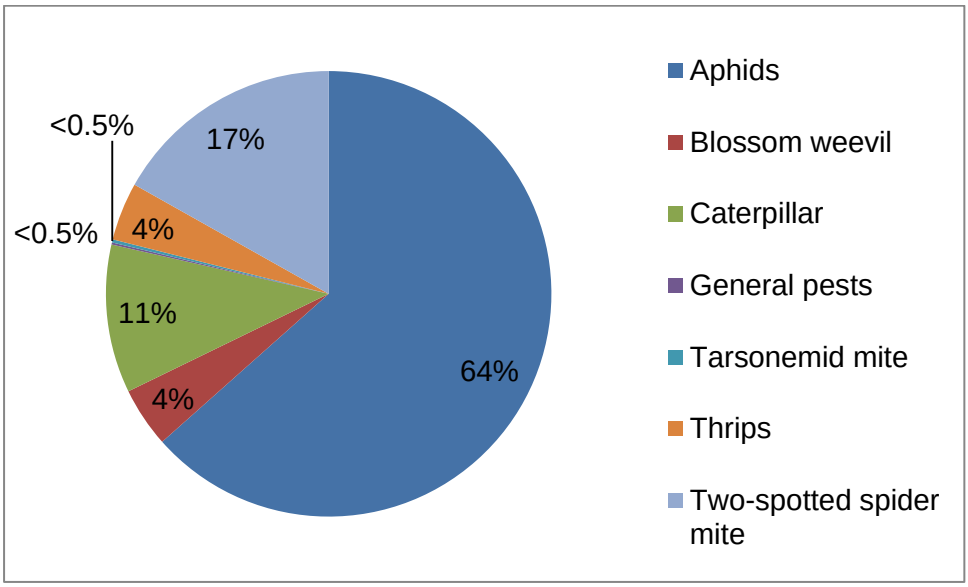
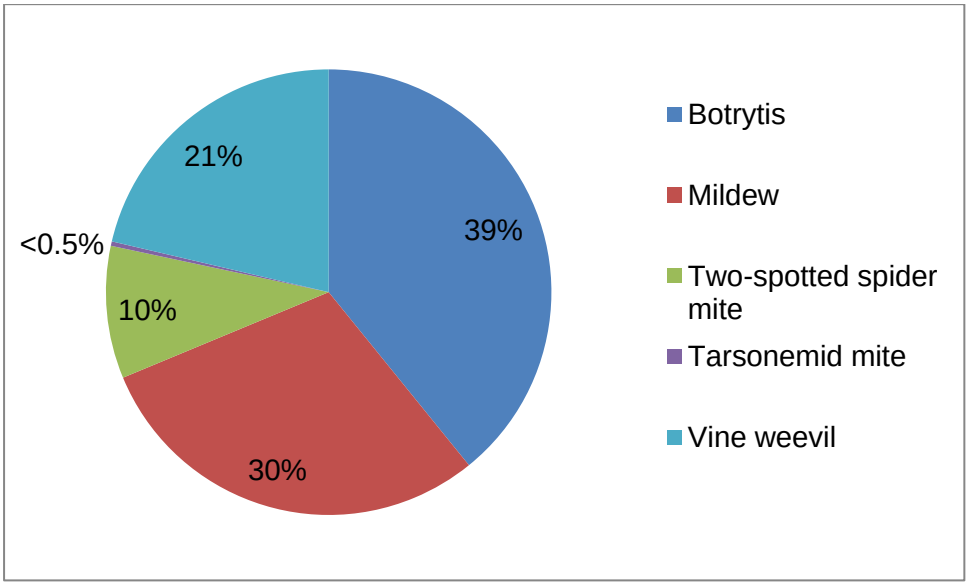


Figure 15 Reasons for use of biologicals on all strawberry crops (where specified) – 2016



Note: biologicals include biopesticides and biological control agents

Non-protected strawberries

- An estimated 75 hectares of non-protected strawberry were grown in Scotland in 2016. This included an estimated two hectares recorded in the mixed and other soft fruit section of the census
- Pesticides were applied to 182 treated hectares. Fungicides and herbicides were the most commonly applied pesticides (Figure 16)
- 41 per cent of the crop was treated with a pesticide
- 156 kilograms of pesticide were applied to the crop
- Symphony was the most common variety encountered, accounting for 56 per cent of the sample area
- Non-protected strawberry crops received on average 4.3 pesticide applications (Table 1). These included 2.9 herbicide and 2.6 fungicide applications
- Fungicides were applied to non-protected strawberries between April and August. Herbicides applications were spread throughout the year with 42 per cent applied in March and insecticides were all applied in June (Figure 17)

Summary of pesticide use on non-protected strawberries:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	109	72	38	Fenhexamid (45)
Herbicides	68	83	25	Isoxaben (17), napropamide (17)
Insecticides/acaricides	2	<0.5	2	Lambda-cyhalothrin (2)
Molluscicides	3	1	2	Ferric phosphate (3)

Figure 16 Use of pesticides on non-protected strawberries (percentage of total area treated with formulations) - 2016

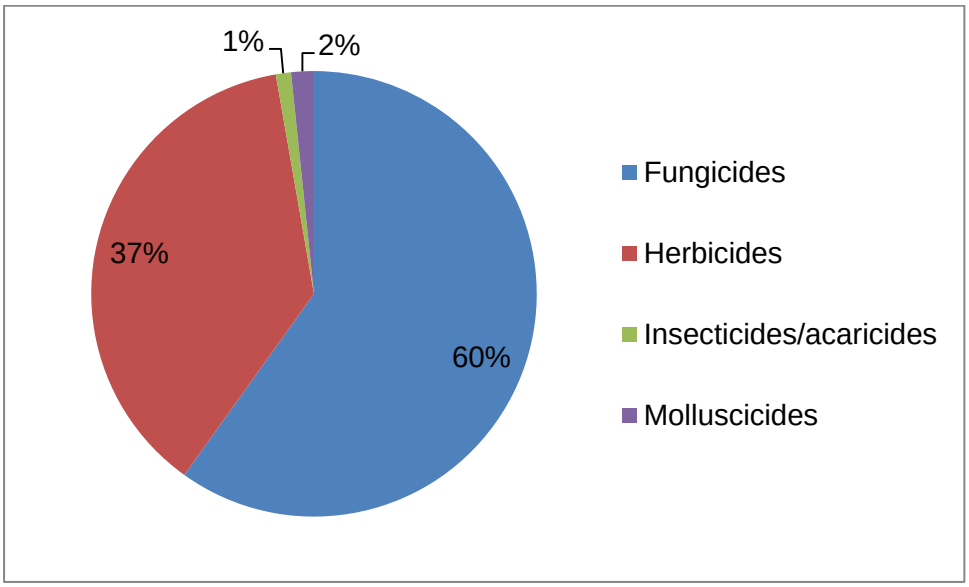
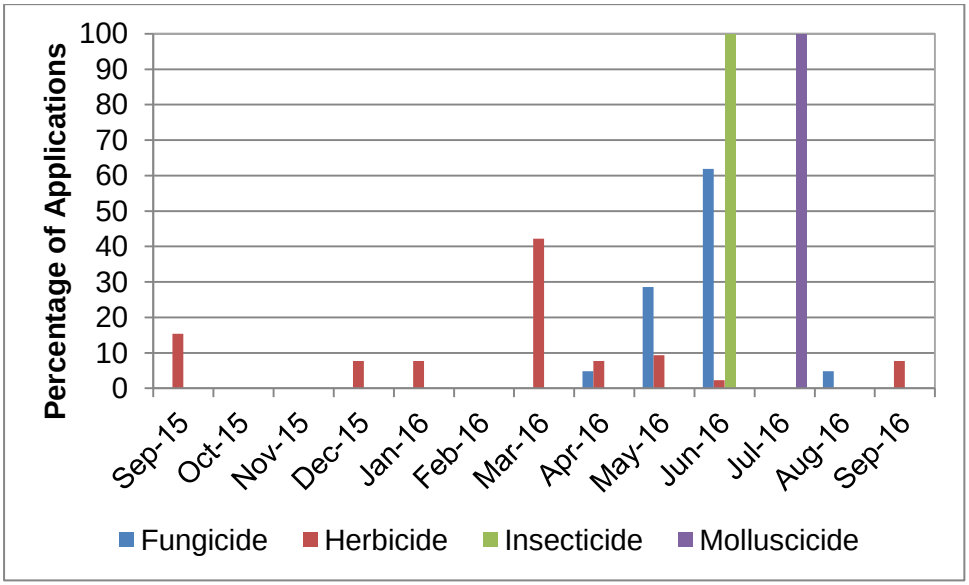


Figure 17 Timings of pesticide applications on non-protected strawberries - 2016



Protected strawberries

- An estimated 920 hectares of protected strawberry were grown in Scotland in 2016. Based on the ratio encountered in the sample, it is estimated that 71 per cent of the crop was semi-protected (grown under temporary tunnels) and 29 per cent permanently protected (grown in permanent tunnels or glasshouses)
- Pesticides were applied to 18,039 treated hectares. Fungicides and insecticides were the most commonly applied pesticides (Figure 18)
- Over 99 per cent of the crop was treated with a pesticide
- 7,715 kilograms of pesticide were applied to the crop
- The most common variety encountered was Sonata, accounting for 87 per cent of the sample area
- Protected strawberry crops received on average 11.6 pesticide applications (Table 1). These included 7.3 fungicide, 3.0 insecticide, 2.7 biological, 2.2 herbicide, 1.9 sulphur and 1.3 molluscicide applications
- In relation to timings of pesticide applications, fungicides and insecticides were applied between February and October. Herbicide use was spread throughout the year with 34 per cent applied in February (Figure 19)

Summary of pesticide use on protected strawberries:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	10,483	5,611	99	Myclobutanil (1,603)
Herbicides	1,933	1,427	54	Diquat (828)
Insecticides/acaricides	3,856	322	99	Lambda-cyhalothrin (884), abamectin (858)
Molluscicides	250	59	21	Metaldehyde (194)
Sulphur	339	185	20	N/A
Biopesticides	780	64		*Bacillus subtilis* (767)
Biological control agents	374	N/A		*Steinernema kraussei* (114), *Heterorhabditis bacteriophora* (113)
Physical control	24	47	1	Carbonic acid diamide/urea (24)

N/A = not applicable

Figure 18 Use of pesticides on protected strawberries (percentage of total area treated with formulations) - 2016

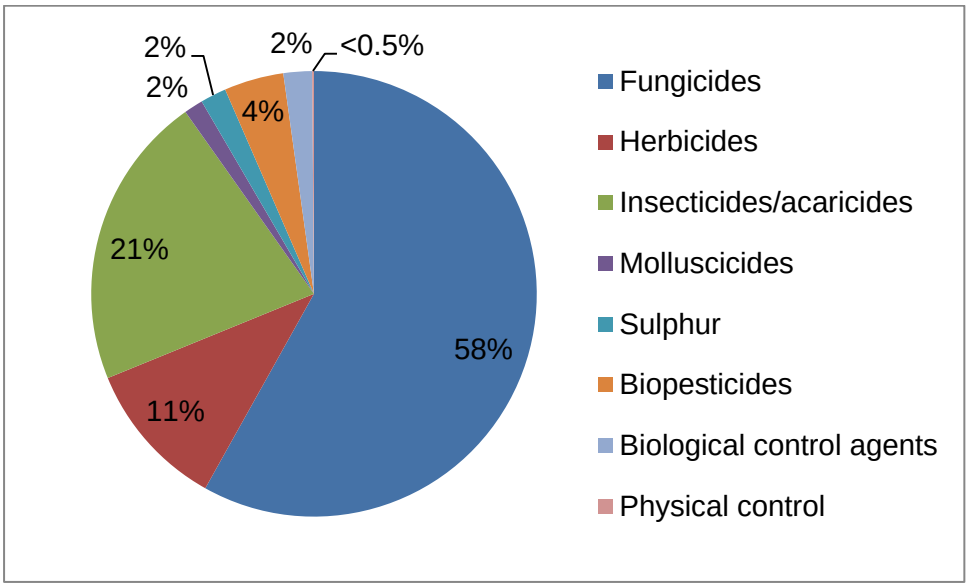
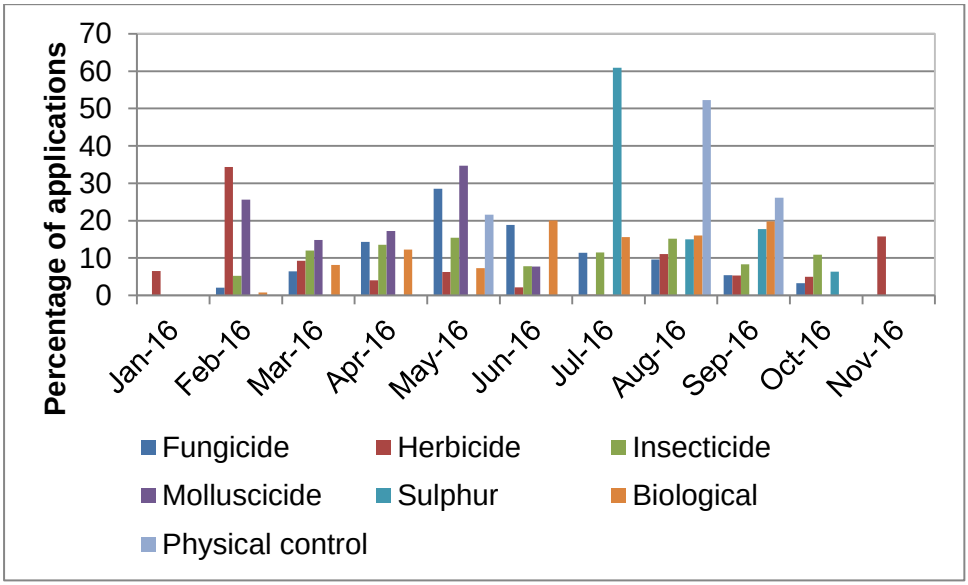


Figure 19 Timings of pesticide applications on protected strawberries - 2016



Note: Insecticides include acaricides. Biologicals includes biopesticides and biological control agents

All raspberries (protected and non-protected crops)

- An estimated 329 hectares of raspberries were grown in 2016. This consists of 131 ha of non-protected crops and 199 ha of protected crop
- Pesticides were applied to 2,596 treated hectares. Fungicides and herbicides were the most commonly applied pesticides
- 92 per cent of the crop received a pesticide treatment
- 1,723 kilograms of pesticide were applied to the crop
- Raspberry crops received on average 6.4 pesticide sprays (Table 1). These sprays included 4.0 fungicide, 1.8 herbicide, 1.6 insecticide/acaricide and 1.5 biological applications
- 34 per cent of herbicides were applied in March, 36 per cent of insecticides in May, 48 per cent of fungicides in June and 68 per cent of biologicals were applied in July (Figure 21)
- The most common variety encountered was Glen Ample accounting for 43 per cent of the sample area
- Six per cent of the raspberries encountered in the sample were under two years old, 81 per cent were between two and five years old and two per cent were over five years old with the remainder unknown
- 70 per cent of the crop sampled was grown directly in the soil, 25 per cent were grown in pots with the remainder unknown
- 15 per cent of the crop encountered was grown using a ground mulch
- 21 per cent of the raspberry crop sampled was grown outdoors, 57 per cent were in temporary tunnels and 22 per cent was grown under permanent tunnels
- Pollinators were used on 70 per cent of the raspberry crops surveyed, 20 per cent used no pollinators with the remainder unknown. Of the sampled area using pollinators 29 per cent were bumble bees, 19 per cent were honey bees and 52 per cent were bumble and honey bees
- 97 per cent of the raspberry crops surveyed were harvested in 2016. 83 per cent were for fresh market, 14 per cent for processing and three per cent for pick-your-own
- Reasons for use on raspberry crops are presented in Figures 22-24. Eighty-eight per cent of the use of Biologicals was for the control of two spotted spider mite with the remainder specified for vine weevil

Summary of pesticide use on all raspberries:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	1,322	772	87	Fenhexamid (351)
Herbicides	719	638	72	Diquat (201)
Insecticides/acaricides	446	36	81	Abamectin (152)
Molluscicides	<0.5	<0.5	<0.5	Ferric phosphate (<0.5)
Sulphur	34	270	10	N/A
Biopesticides	72	7		*Bacillus subtilis* (64)
Biological control agents	3	N/A		*Phytoseiulus persimilis* (3)

N/A = not applicable

Figure 20 Use of pesticides on all raspberries (percentage of total area treated with formulations) - 2016

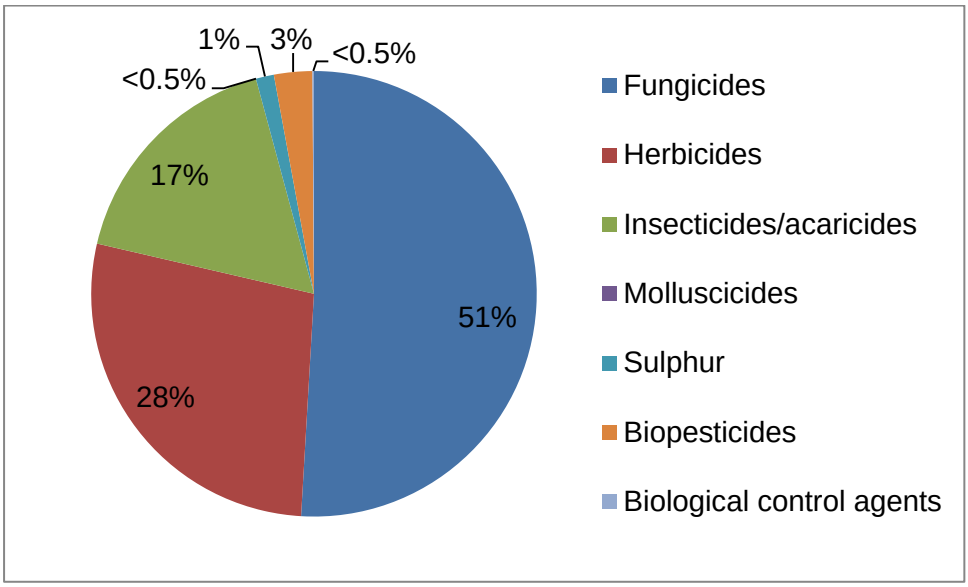
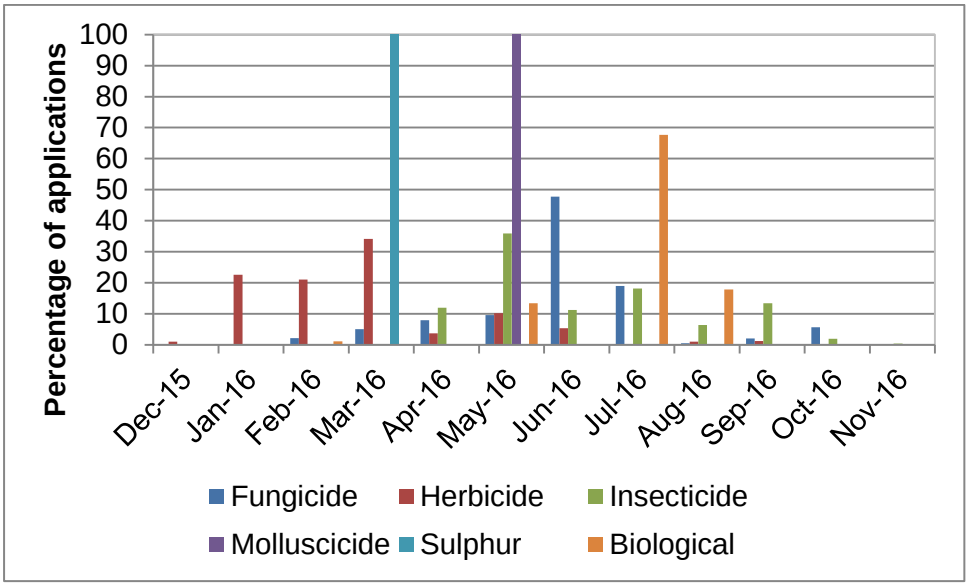


Figure 21 Timings of pesticide applications on all raspberries - 2016



Note: Insecticides include acaricides. Biologicals includes biopesticides and biological control agents

Figure 22 Reasons for use of fungicides on all raspberry crops (where specified) – 2016

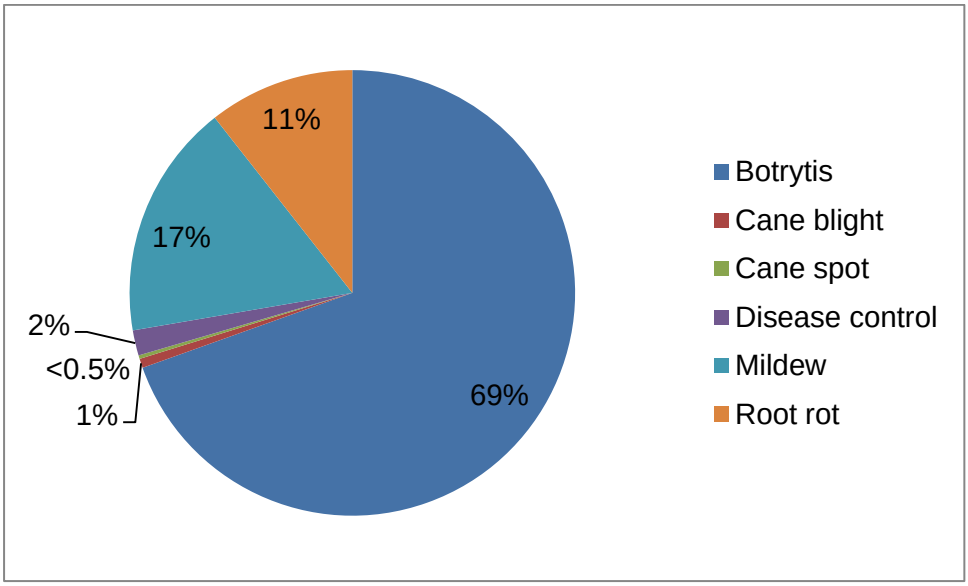


Figure 23 Reasons for use of herbicides on all raspberry crops (where specified) – 2016

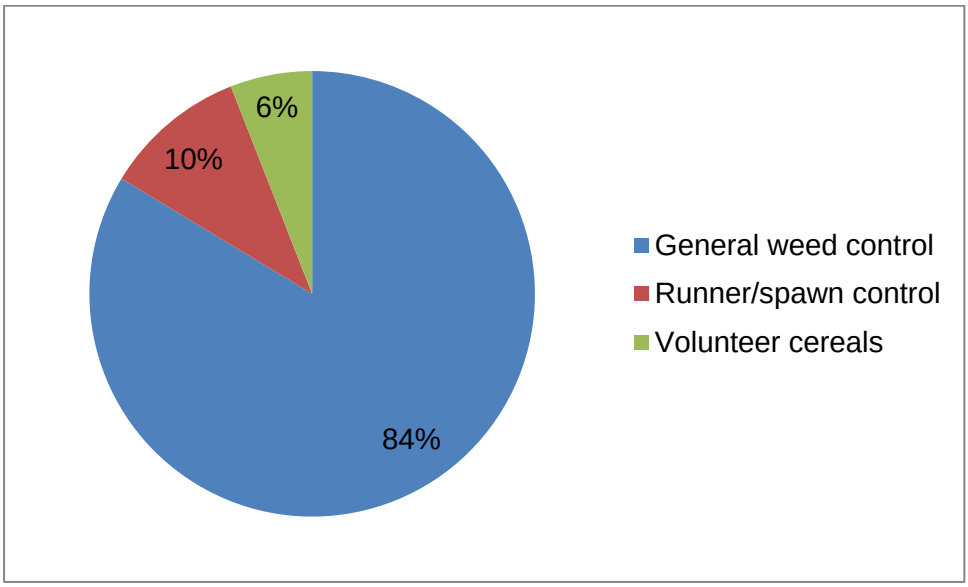
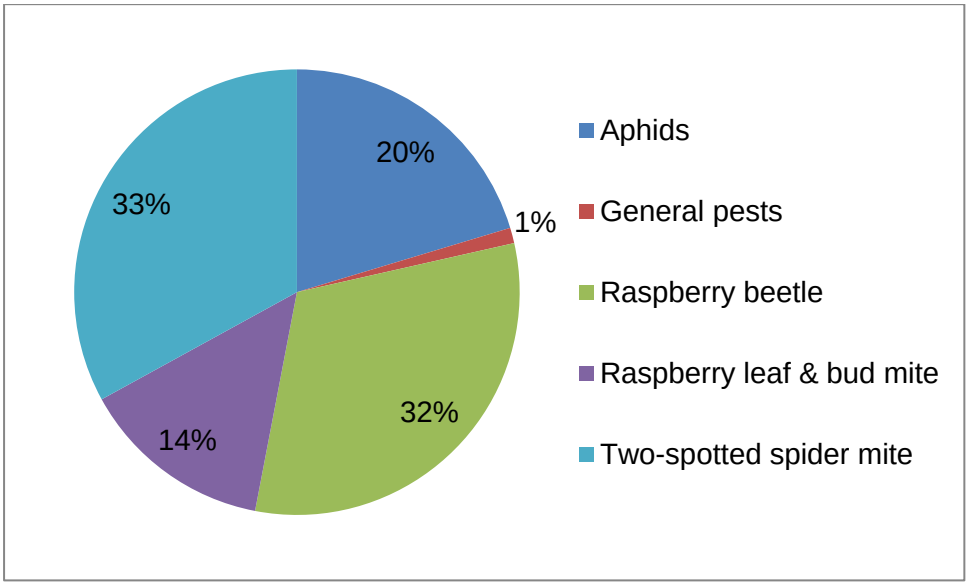


Figure 24 Reasons for use of insecticides/acaricides on all raspberry crops (where specified) – 2016



Non-protected raspberries

- An estimated 131 hectares of non-protected raspberries were grown in Scotland in 2016. This included an estimated three hectares recorded in the mixed and other crop category in the census
- Pesticides were applied to 1,032 treated hectares. Fungicides and herbicides were the most commonly applied pesticides (Figure 25)
- 81 per cent of the crop was treated with a pesticide
- 846 kilograms of pesticide were applied to the crop
- Glen Ample and Glen Ericht were the most common varieties encountered, accounting for 30 and 23 per cent of the sample area respectively
- Non-protected raspberries received on average six applications of pesticides (Table1). These sprays included 4.2 fungicide, 2.1 herbicide, 1.1 insecticide and 1.0 sulphur applications
- In relation to timings, 58 per cent of fungicides and 51 per cent of insecticide/acaricides were applied in June. 56 per cent of herbicides were applied in March (Figure 26)

Summary of pesticide use on non-protected raspberries:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	507	267	69	Fenhexamid (161)
Herbicides	414	306	81	Diquat (122)
Insecticides/acaricides	77	3	52	Deltamethrin (67)
Sulphur	34	270	26	N/A

N/A = not applicable

Figure 25 Use of pesticides on non-protected raspberries (percentage of total area treated with formulations) - 2016

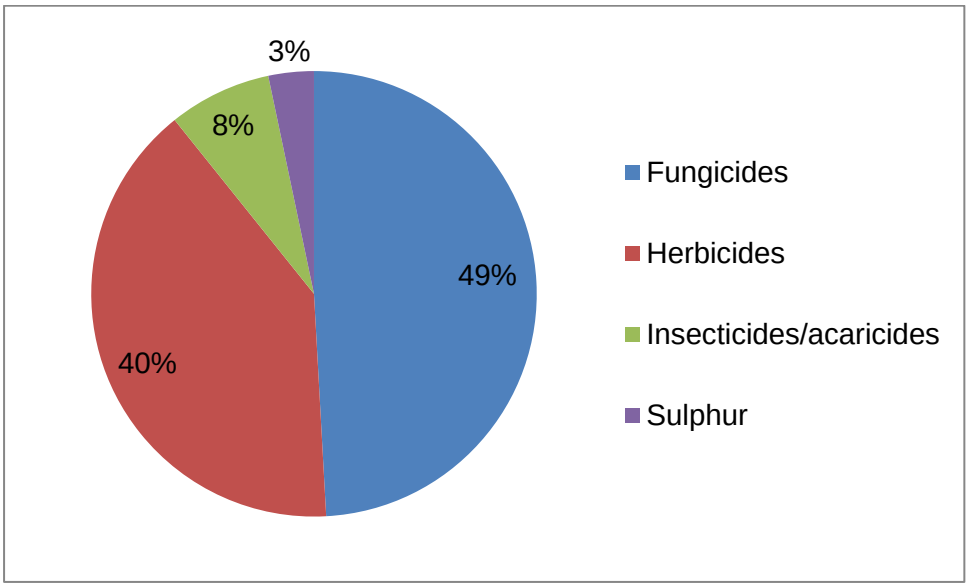
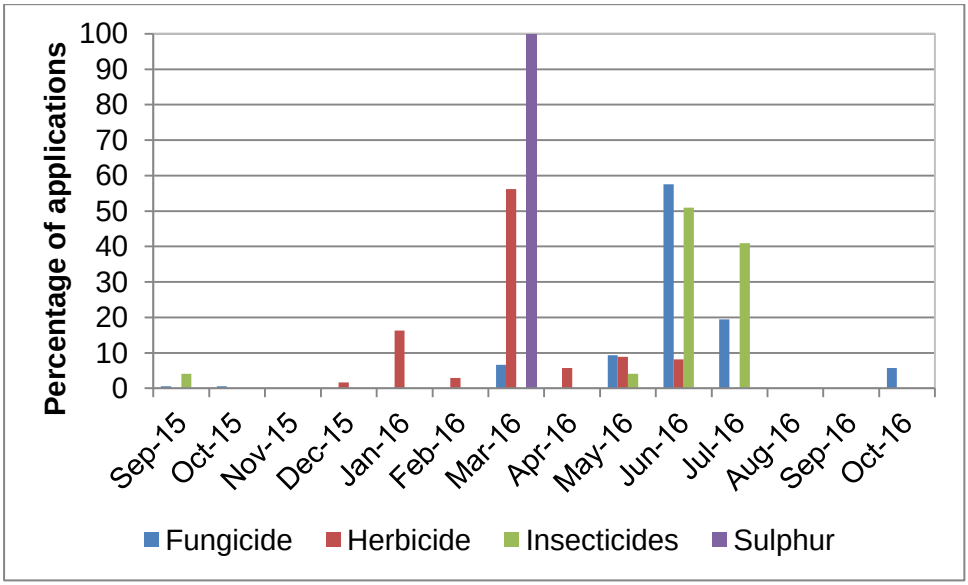


Figure 26 Timings of pesticide applications on non-protected raspberries - 2016



Protected raspberries

- An estimated 199 hectares of protected raspberries were grown in Scotland in 2016. Based on the ratio encountered in the sample, it is estimated that 73 per cent of the crops was semi-protected (grown under temporary tunnels) and 27 per cent permanently protected (grown in permanent tunnels or glasshouses)
- Pesticides were applied to 1,565 treated hectares. Fungicides and insecticides were the most commonly applied pesticides (Figure 27)
- Almost the entire crop (>99 per cent) received a pesticide treatment
- 877 kilograms of pesticide were applied to the crop
- Glen Ample was the principal variety encountered, accounting for 47 per cent of the sample area
- Protected raspberries received on average 6.6 applications of pesticides (Table 1). These sprays included 3.9 fungicide, 1.7 insecticide and 1.5 herbicide and biological applications
- The majority of herbicide use was in January and February, whereas fungicide use was spread throughout the season with 42 per cent applied in June. Insecticide use peaked in May and 68 per cent of biologicals were applied in July (Figure 28)

Summary of pesticide use on protected raspberries:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	815	505	99	Fenhexamid (189), boscalid/pyraclostrobin (152)
Herbicides	305	332	67	Diquat (79), carfentrazone-ethyl (78)
Insecticides/acaricides	370	33	>99	Abamectin (152)
Molluscicides	<0.5	<0.5	<0.5	Ferric phosphate (<0.5)
Biopesticides	72	7		*Bacillus subtilis* (64)
Biological control agents	3	N/A		*Phytoseiulus persimilis* (3)

N/A = not applicable

Figure 27 Use of pesticides on protected raspberries (percentage of total area treated with formulations) - 2016

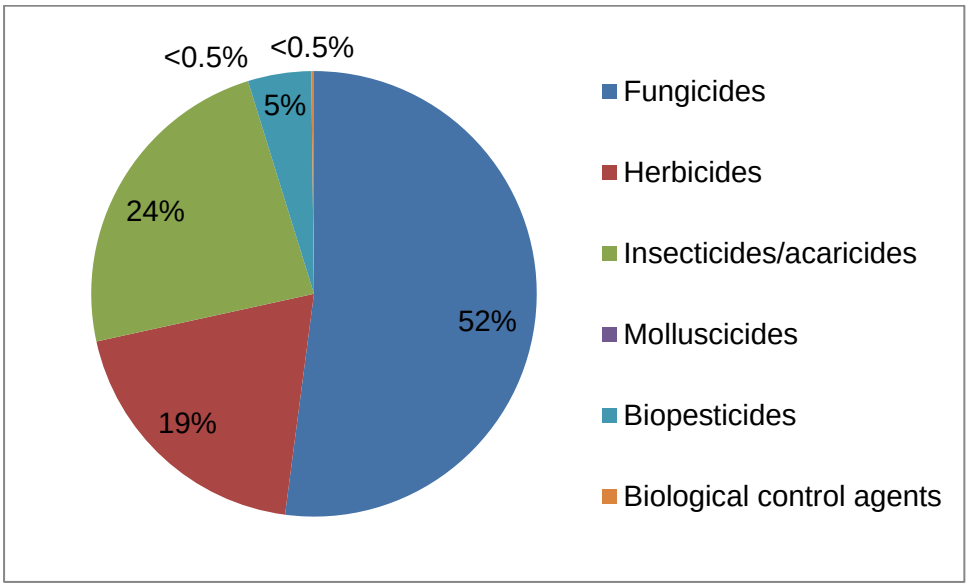
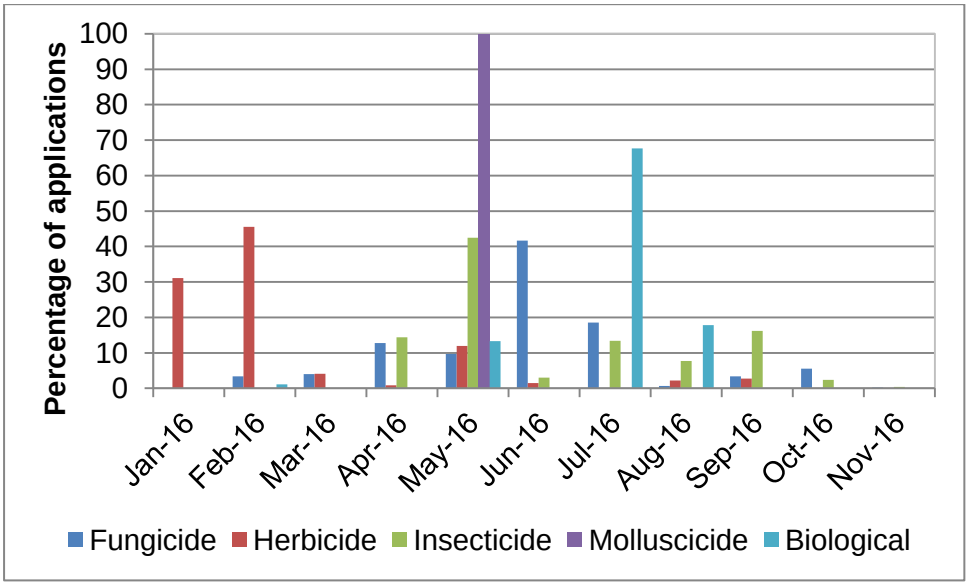


Figure 28 Timings of pesticide applications on protected raspberries - 2016



Note: Insecticides include acaricides. Biologicals includes biopesticides and biological control agents

Blackcurrants

- The total estimated area of blackcurrants grown in Scotland in 2016 was 304 hectares. This includes two hectares which were included in the mixed and other soft fruit census category
- Pesticides were applied to 3,372 treated hectares. Fungicides were the most commonly applied pesticides (Figure 29)
- Almost the entire crop (99 per cent) received a pesticide treatment
- 4,520 kilograms of pesticide were applied to blackcurrant crops (71 per cent of which was sulphur)
- Blackcurrants received on average 8.1 pesticide applications. These spays included 5.3 fungicide, 2.4 insecticide, 1.6 herbicide and 2.0 sulphur applications
- In relation to timings, fungicides were predominately used in May and June. Fifty-nine percent of herbicides were applied in February, 53 per cent of insecticides in June and all sulphur was applied in March and April (Figure 30)
- Ben Kilbreck was the principal variety encountered, accounting for 30 per cent of the area surveyed
- 47 per cent of blackcurrants encountered were five years old or less, seven per cent were between six and 10 years old and three per cent were older than 11 years old with the remainder unknown
- All of the blackcurrant crops sampled were grown in the soil without protection
- 80 per cent of the blackcurrant crops surveyed were harvested in 2016
- 97 per cent of the blackcurrant crops surveyed were for processing, two per cent was for fresh market and one per cent was for pick-your-own
- Reasons for pesticide use are provided in Figures 31 and 32. General weed control was the only reason given for herbicide use

Summary of pesticide use on blackcurrants

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	1,459	412	87	Myclobutanil (518)
Herbicides	968	839	91	Diquat (268), pendimethalin (256)
Insecticides/acaricides	943	62	92	Lambda-cyhalothrin (387), thiacloprid (345)
Sulphur	402	3,207	68	N/A

N/A = not applicable

Figure 29 Use of pesticides on blackcurrants (percentage of total area treated with formulations) - 2016

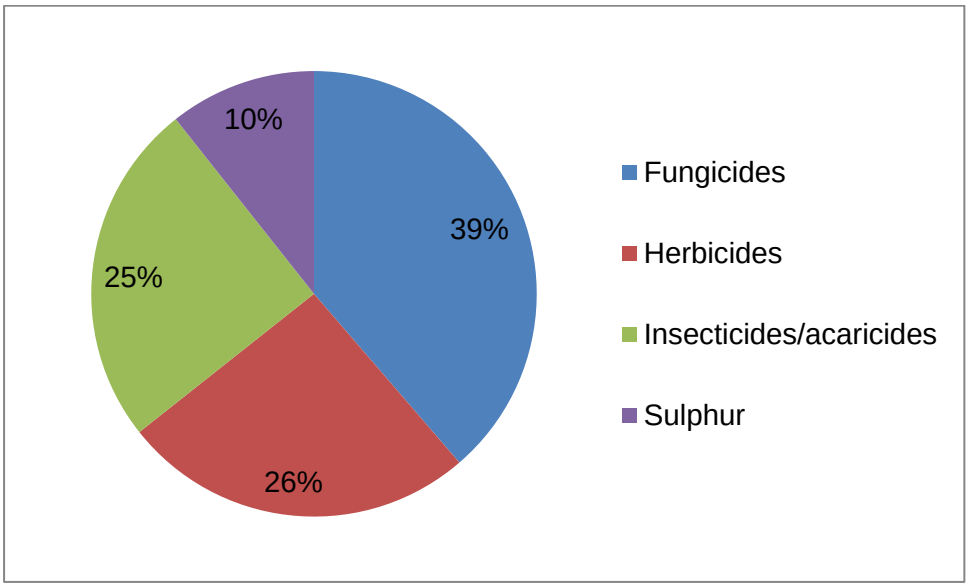


Figure 30 Timings of pesticide applications on blackcurrants - 2016

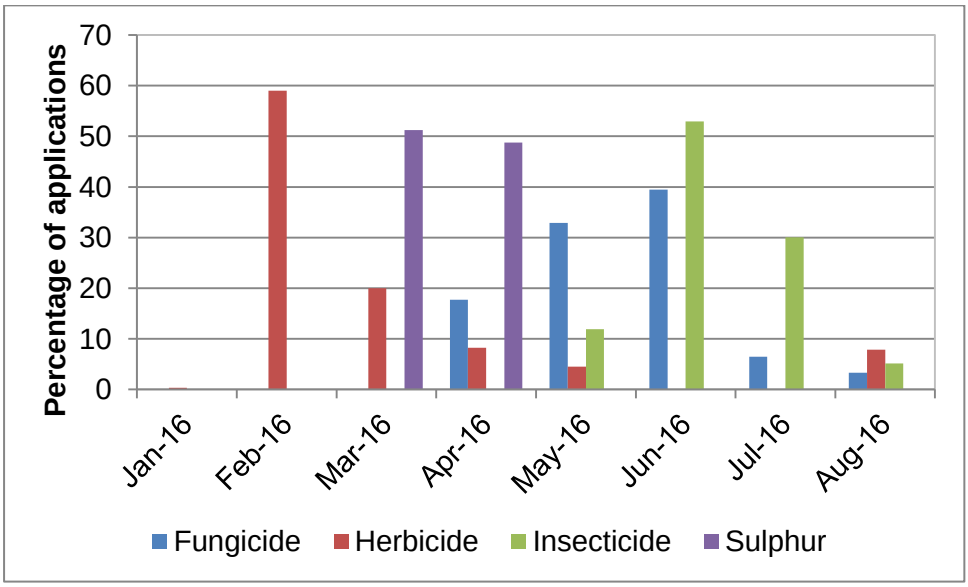
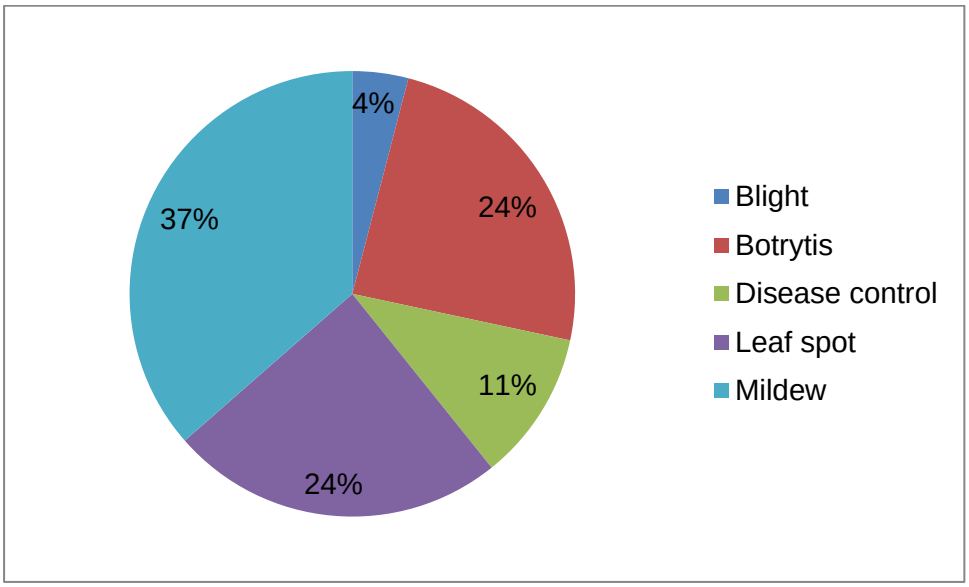
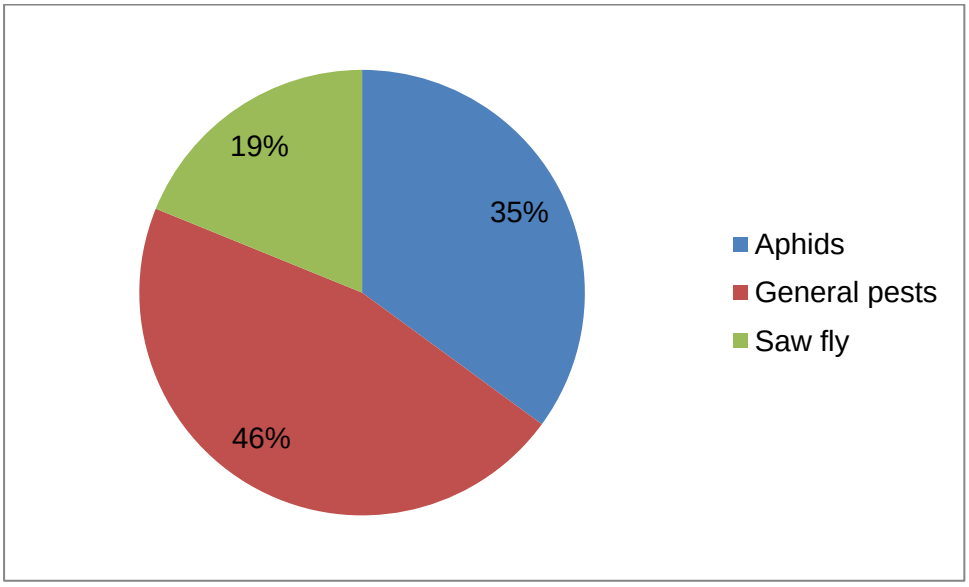


Figure 31 Reasons for use of fungicides on blackcurrant crops (where specified) – 2016



Note: No reasons were provided for blackcurrants grown for processing, therefore reasons only relate to crops grown for the pick your own or fresh market

Figure 32 Reasons for use of insecticides on blackcurrant crops (where specified) – 2016



Note: No reasons were provided for blackcurrants grown for processing, therefore reasons only relate to crops grown for the pick your own or fresh market

All other soft fruit crops (protected and non-protected crops)

- An estimated 248 hectares of other soft fruit was grown in 2016. This consists of 68 hectares of non-protected crop and 180 hectares of protected crop
- The crops encountered in this category were blueberry, blackberry, gooseberry and redcurrant as well as minor crops aronia (chokeberry), jostaberry, loganberry, tayberry, tummelberry and whitecurrant
- Pesticides were applied to 1,469 treated hectares, insecticides and fungicides were the most commonly applied pesticides (Figure 33)
- 84 per cent of the crop was treated with a pesticide
- 618 kilograms of pesticide were applied to the other soft fruit crops
- Other soft fruit crops received on average 5.8 pesticide applications. These sprays included 3.1 fungicide, 2.5 insecticide, 2.9 biological and 1.4 herbicide applications
- Fungicide and insecticides were applied between March and August. Herbicides were predominately applied between January and March and Biological control agents were applied throughout the spring, summer and autumn (Figure 34)
- 23 per cent of other soft fruits crops sampled were five years old or less, 33 per cent were six to 10 years old, 26 per cent were over 10 years old and the age of 18 per cent of the surveyed crops were unknown
- 80 per cent of the other soft fruit crops surveyed were grown in the soil, with the remainder being grown in pots
- 37 per cent of the crop was grown outdoors, 44 per cent was grown under temporary tunnels and 19 per cent was grown under permanent protection
- 18 per cent of the sampled crop was grown using a ground mulch
- Pollinators were used on 47 per cent of the other soft fruit crops sampled, 30 per cent had no pollinators and the remainder was unknown. Of the sampled area using pollinators, 54 per cent were bumble bees, 18 per cent were honey bees and 28 per cent were both bumble and honey bees
- 88 per cent of the crops surveyed were harvested in 2016 (one per cent was not harvested with the remainder unknown). 96 per cent were for fresh market and one per cent for processing and three per cent for pick-your own
- Reasons for pesticide use are provided in Figures 35 and 36. General weed control was the only reason given for herbicide use. Aphids and vine weevils were the only specified reasons for the use of biological control agents

Summary of pesticide use on all other soft fruits:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	414	189	51	Cyprodinal/fludioxonil (155)
Herbicides	270	354	53	Diquat (107)
Insecticides/acaricides	494	42	81	Thiacloprid (268)
Molluscicides	40	8	9	Ferric phosphate (40)
Sulphur	6	25	1	N/A
Biological control agents	245	N/A	34	*Heterorhabditis bacteriophora* (136)

N/A = not applicable

Figure 33 Use of pesticides on all other soft fruit crops (percentage of total area treated with formulations) - 2016

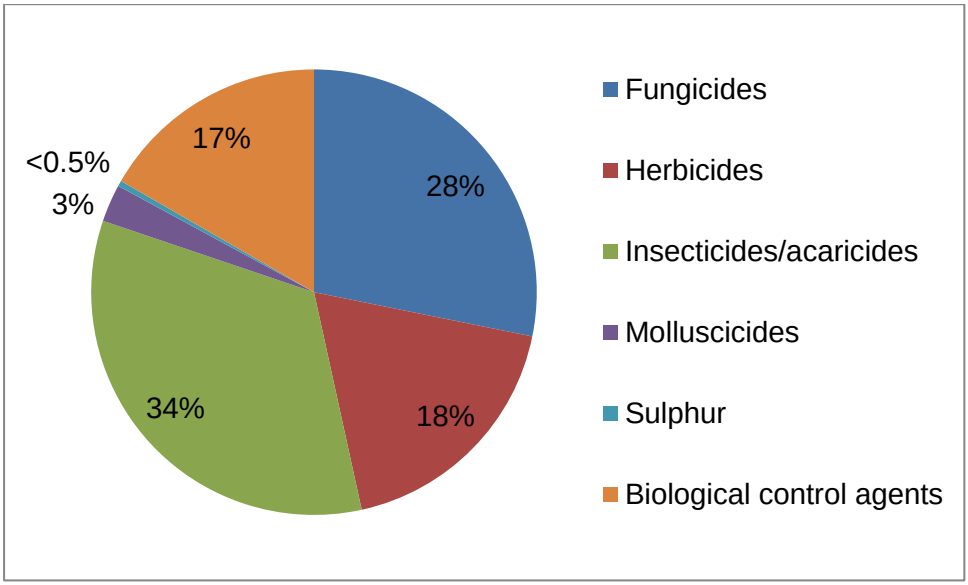
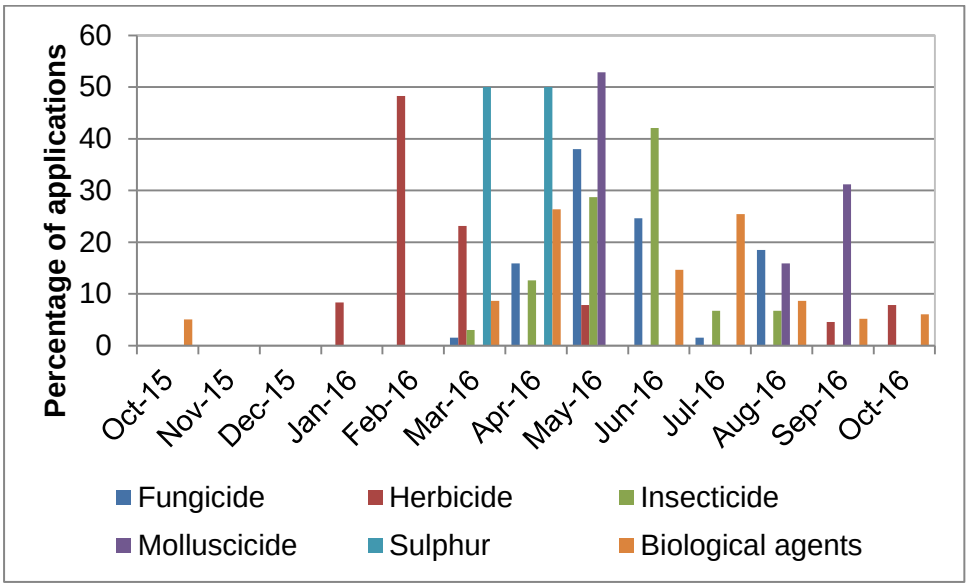


Figure 34 Timings of pesticide applications on all other soft fruit crops - 2016



Note: Insecticides include acaricides

Figure 35 Reasons for use of fungicides on all other soft fruit crops (where specified) – 2016

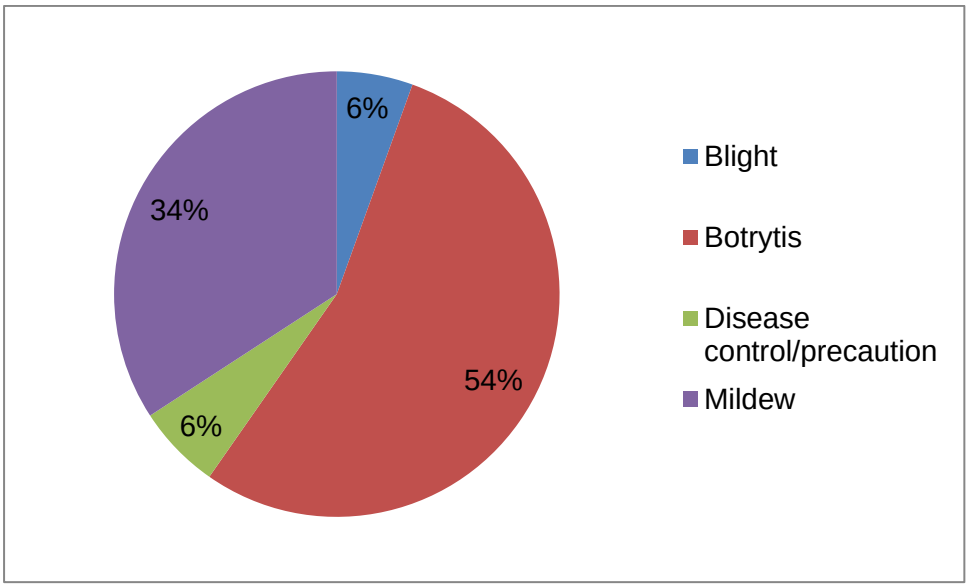
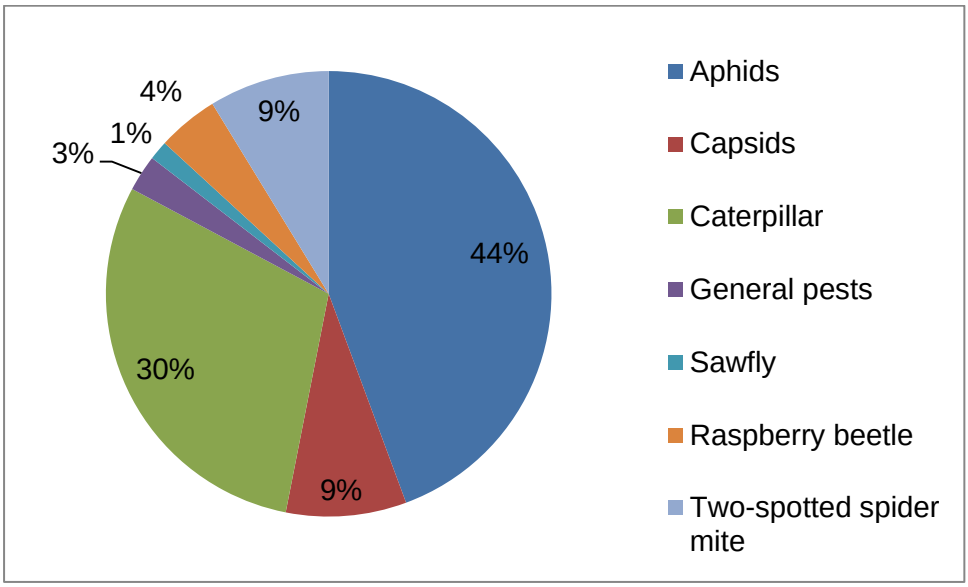


Figure 36 Reasons for use of insecticides on all other soft fruit crops (where specified) – 2016



Non-protected other soft fruit crops

- The total estimated area of non-protected other soft fruit crops is 68 hectares. An estimated 27 hectares recorded in the non-protected census category were temporarily covered with Spanish tunnels. Estimated pesticide use on these crops have been included with the protected other soft fruit crop
- The crops encountered in this category were blueberry, blackberry, gooseberry and redcurrant as well as the minor crops aronia (chokeberry), jostaberry, loganberry, tayberry, tummelberry and whitecurrant
- Pesticides were applied to 228 treated hectares. Fungicides and herbicides were the most commonly applied pesticides (Figure 37)
- 41 per cent of non-protected other crops were treated with a pesticide
- 124 kilograms of pesticide were applied
- Non-protected other soft fruit crops received on average 4.9 pesticide applications. These sprays included 3.9 fungicide, 1.6 herbicide and 1.4 insecticide applications
- Herbicides were all applied in the first three months of the year. Fungicides were applied between March and August and insecticides between May and August (Figure 38)

Summary of pesticide use on non-protected other soft fruits:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	125	41	37	Myclobutanil (26)
Herbicides	72	72	36	Diquat (22)
Insecticides/acaricides	29	2	31	Deltamethrin (13), Thiacloprid (11)
Sulphur	2	9	2	N/A

N/A = not applicable

Figure 37 Use of pesticides on non-protected other soft fruit crops (percentage of total area treated with formulations) - 2016

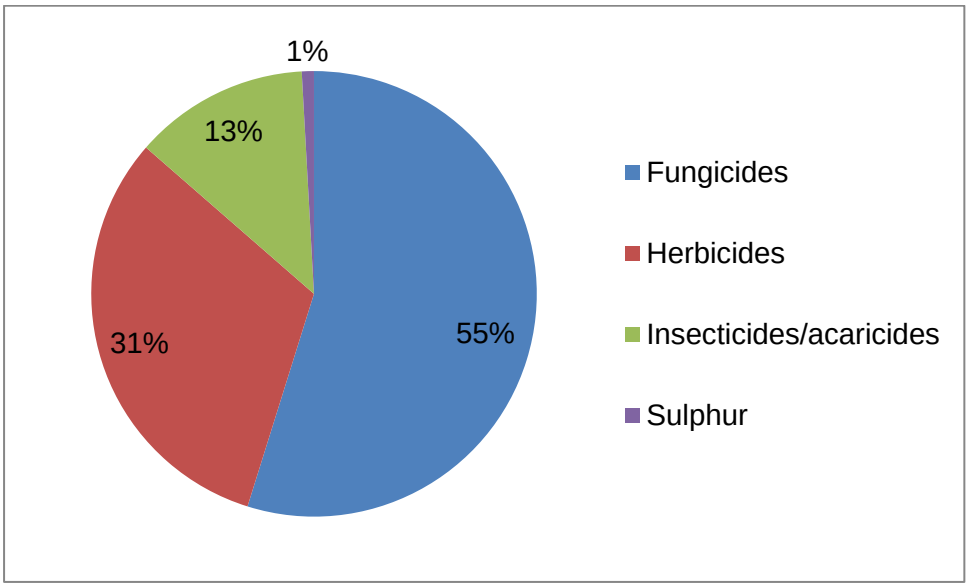
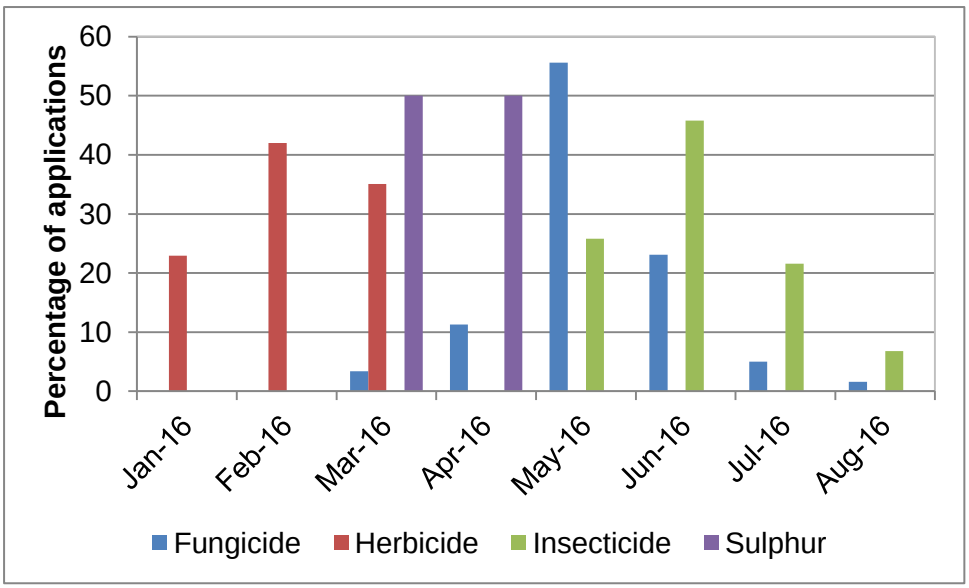


Figure 38 Timings of pesticide applications on non-protected other soft fruit crops - 2016



Note: Insecticides include acaricides

Protected other soft fruit crops

- The total estimated area of protected other soft fruit crops in 2016 is 180 hectares. It is estimated that 65 per cent of the crop was semi-protected grown under temporary tunnels with 35 per cent grown under permanent tunnels or glasshouses
- The crops encountered in this category were blueberry and blackberry
- Pesticides were applied to 1,240 treated hectares. Insecticides/acaricides and fungicides were the most commonly applied pesticides (Figure 39)
- The entire crop area was treated with a pesticide
- 494 kilograms of pesticide were applied
- Protected crops received on average 6.0 pesticide applications. These sprays included 2.9 fungicide and biological, 2.6 insecticide, 1.9 molluscicide and 1.3 herbicide applications
- Fungicide and insecticides were applied between March and August. Herbicides were predominately applied between January and March and Biological control agents were applied throughout the spring, summer and autumn (Figure 40)

Summary of pesticide use on non-protected other soft fruits:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	289	150	56	Cyprodinal/fludioxonil (151)
Herbicides	197	281	59	Diquat (85)
Insecticides/acaricides	465	40	>99	Thiacloprid (257)
Molluscicides	40	8	12	Ferric phosphate (40)
Sulphur	4	15	1	N/A
Biological control agents	245	N/A	46	*Heterorhabditis bacteriophora* (136)

N/A = not applicable

Figure 39 Use of pesticides on protected other soft fruit crops (percentage of total area treated with formulations) - 2016

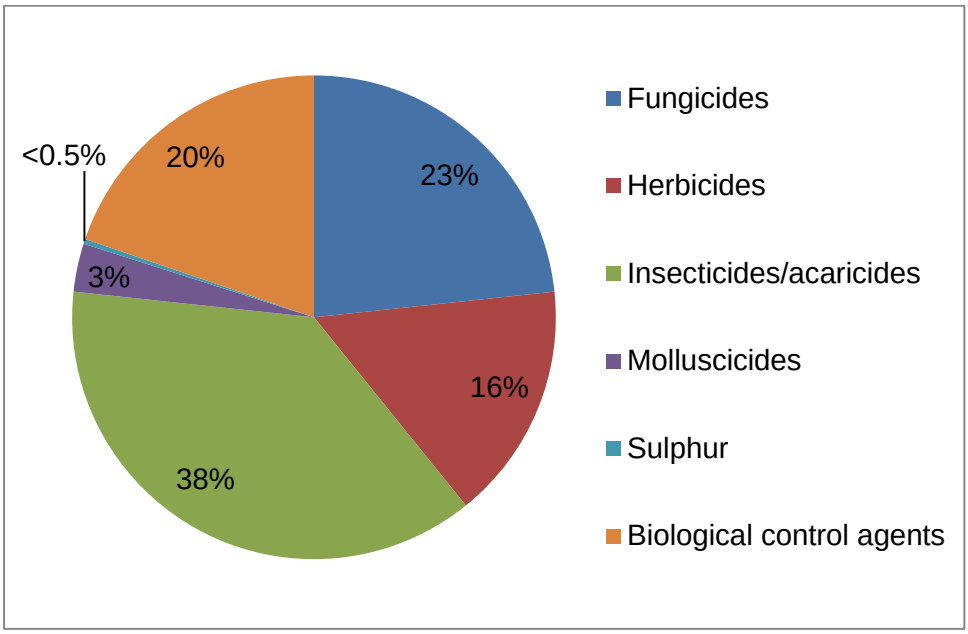
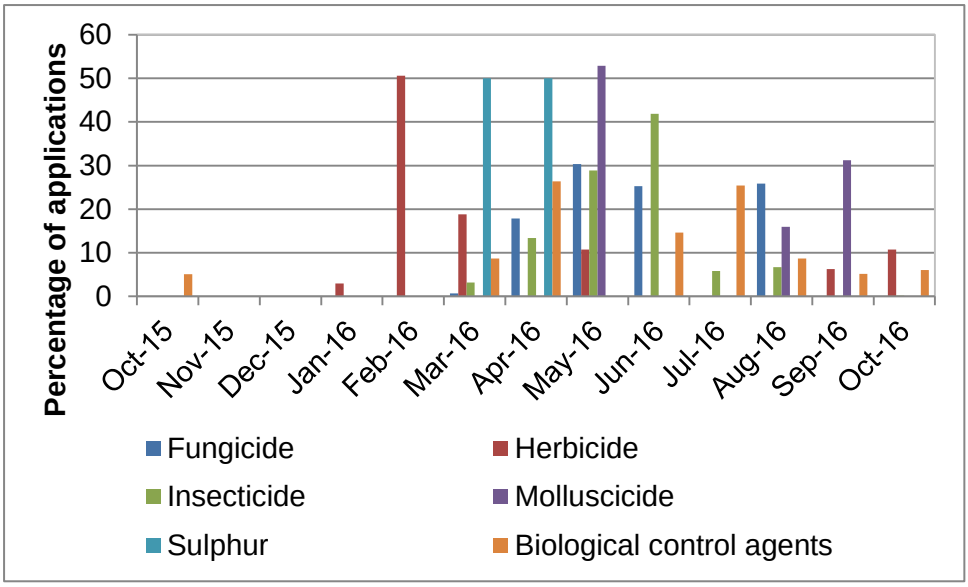


Figure 40 Timings of pesticide applications on protected other soft fruit crops - 2016



Note: Insecticides include acaricides

Appendix 1 – Estimated application tables

Table 1 Percentage of each crop treated with pesticides and mean number of spray applications - 2016

	All Strawberry		All Raspberry		All Blackcurrant		All other soft fruit		All soft fruit	
	%	sp apps	%	sp apps	%	sp apps	%	sp apps	**%**	**sp apps**
Insecticides/acaricides	92	3.0	81	1.6	92	2.4	81	2.5	**88**	**2.6**
Molluscicides	20	1.3	<0.5	1.0	0	0.0	9	1.9	**12**	**1.3**
Biologicals[(1)]	43	2.7	16	1.5	0	0.0	34	2.9	**30**	**2.6**
Fungicides	94	7.2	87	4.0	87	5.3	51	3.1	**86**	**6.0**
Sulphur	18	1.9	10	1.0	68	2.0	1	2.0	**23**	**1.8**
Herbicides	52	2.2	72	1.8	91	1.6	53	1.4	**62**	**1.9**
Physical control	1	2.1	0	0.0	0	0.0	0	0.0	**1**	**2.1**
Any pesticide	**96**	**11.3**	**92**	**6.4**	**99**	**8.1**	**84**	**5.8**	**94**	**9.3**

Cont…

Table 1 Percentage of each crop treated with pesticides and mean number of spray applications - 2016 continued

	Non-protected strawberry		Protected Strawberry		Non-protected raspberry		Protected raspberry		Non-protected other soft fruit		Protected other soft fruit	
	%	sp apps	%	sp apps	%	sp apps	%	sp apps	%	sp apps	%	sp apps
Insecticides/acaricides	2	1.0	99	3.0	52	1.1	>99	1.7	31	1.4	>99	2.6
Molluscicides	2	2.0	21	1.3	0	0.0	<0.5	1.0	0	0.0	12	1.9
Biologicals(1)	0	0.0	47	2.7	0	0.0	26	1.5	0	0.0	46	2.9
Fungicides	38	2.6	99	7.3	69	4.2	99	3.9	37	3.9	56	2.9
Sulphur	0	0.0	20	1.9	26	1.0	0	0.0	2	2.0	1	2.0
Herbicides	25	2.9	54	2.2	81	2.1	67	1.5	36	1.6	59	1.3
Physical control	0	0.0	1	2.1	0	0.0	0	0.0	0	0.0	0	0.0
Any pesticide	**41**	**4.3**	**>99**	**11.6**	**81**	**6.0**	**>99**	**6.6**	**41**	**4.9**	**100**	**6.0**

Note: (1) Biologicals include biopesticides and biological control agents
The average number of spray applications is calculated only on the areas using each pesticide group and therefore the minimum number of applications is always going to be one (see appendix 3 – definitions and notes for details)

Table 2 Strawberry insecticide and acaricide formulations - 2016

Area (ha) and percentage of crop treated

Insecticides/acaricides	Non-protected strawberry		Protected Strawberry		All Strawberry		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Abamectin	0	0	858	59	**858**	**55**	959
Chlorpyrifos	0	0	159	17	**159**	**16**	738
Clofentezine	0	0	595	35	**595**	**32**	704
Deltamethrin	0	0	165	18	**165**	**17**	188
Etoxazole	0	0	162	18	**162**	**16**	287
Fenpyroximate	0	0	2	<0.5	**2**	**<0.5**	101
Lambda-cyhalothrin	2	2	884	81	**886**	**75**	496
Pirimicarb	0	0	88	10	**88**	**9**	947
Pymetrozine	0	0	284	29	**284**	**27**	416
Pyrethrins	0	0	60	6	**60**	**6**	371
Spinosad	0	0	51	6	**51**	**5**	70
Spirodiclofen	0	0	37	4	**37**	**4**	174
Spiromesifen	0	0	5	1	**5**	**<0.5**	64
Tebufenpyrad	0	0	72	8	**72**	**7**	32
Thiacloprid	0	0	433	34	**433**	**32**	291
All insecticides	**2**	**2**	**3,856**	**99**	**3,858**	**92**	**6,186**
Area grown	75		920		995		972

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 3 Strawberry biological, molluscicide and physical control formulations - 2016

Area (ha) and percentage of crop treated

Biological control agents	Non-protected Strawberry		Protected Strawberry		All Strawberry		2014[2]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Heterorhabditis bacteriophora	0	0	113	7	**113**	**6**	53
Neoseiulus californicus	0	0	9	<0.5	**9**	**<0.5**	0
Neoseiulus cucumeris	0	0	70	3	**70**	**3**	138
Phytoseiulus persimilis	0	0	68	7	**68**	**7**	29
Steinernema kraussei	0	0	114	12	**114**	**11**	125
All biological control agents	**0**		**374**		**374**		**379**
Biopesticides							
Bacillus subtilis	0	0	767	40	**767**	**37**	1,509
Beauveria bassiana ATCC - 74040	0	0	6	1	**6**	**1**	85
Beauveria bassiana GHA	0	0	7	1	**7**	**1**	0
All biopesticides	**0**		**780**		**780**		**1,749**
All biologicals[1]	**0**	**0**	**1,154**	**47**	**1,154**	**43**	**2128**
Molluscicides							
Ferric phosphate	3	2	56	4	**59**	**4**	67
Metaldehyde	0	0	194	17	**194**	**16**	260
All molluscicides	**3**	**2**	**250**	**21**	**253**	**20**	**395**
Physical control							
Carbonic acid diamide/urea	0	0	24	1	**24**	**1**	**325**
Area grown	**75**		**920**		**995**		972

(1) All biologicals includes biopesticides and biological control agents
(2) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 4 Strawberry fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides	Non-protected Strawberry		Protected Strawberry		All Strawberry		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Azoxystrobin	0	0	1,109	82	**1,109**	**76**	1,237
Boscalid/pyraclostrobin	5	7	782	64	**788**	**59**	514
Bupirimate	5	7	852	73	**857**	**68**	1,181
Chlorothalonil	16	7	0	0	**16**	**1**	36
Cyflufenamid	0	0	70	7	**70**	**6**	0
Cyprodinil/fludioxonil	2	2	1,199	95	**1,201**	**88**	1,191
Dimethomorph	0	0	104	11	**104**	**10**	178
Fenamidone/fosetyl-aluminium	5	7	150	16	**155**	**15**	91
Fenhexamid	45	38	1,182	84	**1,227**	**81**	1,593
Fenpropimorph	12	9	334	19	**346**	**19**	536
Iprodione	5	7	1,073	82	**1,078**	**76**	1,390
Kresoxim-methyl	0	0	242	21	**242**	**20**	699
Mepanipyrim	0	0	54	6	**54**	**5**	347
Meptyldinocap	0	0	250	21	**250**	**19**	392
Myclobutanil	5	7	1,603	88	**1,608**	**82**	2,201
Penconazole	0	0	177	14	**177**	**13**	40
Potassium hydrogen carbonate	0	0	217	13	**217**	**12**	1,438
Pyrimethanil	8	9	319	32	**327**	**30**	539
Quinoxyfen	0	0	768	64	**768**	**60**	731
All fungicides	**109**	**38**	**10,483**	**99**	**10,593**	**94**	**15,655**
Sulphur	0	0	339	20	**339**	**18**	1,307
Area grown	75		920		995		972

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 5 Strawberry herbicide formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	Non-protected Strawberry		Protected Strawberry		All Strawberry		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Carfentrazone-ethyl	0	0	103	11	**103**	**10**	0
Clopyralid	10	7	23	3	**34**	**3**	0
Cycloxydim	5	7	0	0	**5**	**1**	1
Diquat	1	1	828	40	**828**	**37**	1,507
Glufosinate-ammonium	0	0	73	6	**73**	**6**	686
Glyphosate	0	0	85	8	**85**	**7**	56
Isoxaben	17	22	324	33	**341**	**32**	88
Lenacil	2	2	0	0	**2**	**<0.5**	43
Metamitron	5	7	23	3	**29**	**3**	60
Napropamide	17	22	383	39	**400**	**38**	163
Pendimethalin	2	2	0	0	**2**	**<0.5**	21
Phenmedipham	5	2	0	0	**5**	**<0.5**	5
Propyzamide	5	7	90	9	**96**	**9**	37
All herbicides	**68**	**25**	**1,933**	**54**	**2,001**	**52**	**2,671**
Area grown	75		920		995		972

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 6 Raspberry insecticide and acaricide formulations - 2016

Area (ha) and percentage of crop treated

Insecticides/acaricides	Non-protected raspberry		Protected raspberry		All raspberry		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Abamectin	0	0	152	73	**152**	**44**	280
Chlorpyrifos	3	2	33	16	**36**	**11**	281
Clofentezine	0	0	6	3	**6**	**2**	251
Deltamethrin	67	50	27	14	**94**	**28**	12
Lambda-cyhalothrin	3	2	28	14	**31**	**10**	32
Pyrethrins	0	0	5	2	**5**	**1**	18
Tebufenpyrad	0	0	6	3	**6**	**2**	0
Thiacloprid	3	2	113	53	**116**	**33**	94
All insecticides/acaricides	**77**	**52**	**370**	**>99**	**446**	**81**	**1,184**
Area grown	131		199		329		314

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 7 Raspberry biological and molluscicide formulations - 2016

Area (ha) and percentage of crop treated

Biological control agents	Non-protected raspberry		Protected raspberry		All raspberry		2014[2]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Neoseiulus californicus	0	0	<0.5	<0.5	**<0.5**	**<0.5**	0
Phytoseiulus persimilis	0	0	3	1	**3**	**1**	0
Steinernema kraussei	0	0	<0.5	<0.5	**<0.5**	**<0.5**	29
All biological agents	**0**		**3**		**3**		**45**
Biopesticides							
Bacillus subtilis	0	0	64	24	**64**	**15**	0
Bacillus thuringiensis var. kurstaki	0	0	7	4	**7**	**2**	0
All biopesticides	**0**		**72**		**72**		**8**
All biologicals[1]	**0**	**0**	**75**	**26**	**75**	**16**	**53**
Molluscicides							
Ferric phosphate	0	0	<0.5	<0.5	**<0.5**	**<0.5**	0
All molluscicides	**0**	**0**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**12**
Area grown	131		199		329		314

(1) All biologicals includes biopesticides and biological control agents
(2) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 8 Raspberry fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides	Non-protected raspberry		Protected raspberry		All raspberry		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Azoxystrobin	6	2	51	24	**57**	**15**	146
Boscalid/pyraclostrobin	26	19	152	77	**179**	**54**	20
Bupirimate	29	22	0	0	**29**	**9**	15
Cyprodinil/fludioxonil	78	43	158	75	**236**	**62**	195
Dimethomorph	63	48	61	31	**124**	**38**	36
Fenhexamid	161	51	189	77	**351**	**66**	320
Fenpropimorph	0	0	7	4	**7**	**2**	24
Fluazinam	0	0	33	16	**33**	**10**	6
Iprodione	40	28	69	24	**109**	**26**	15
Myclobutanil	34	26	35	18	**69**	**21**	0
Pyrimethanil	34	26	46	22	**80**	**24**	62
Tebuconazole	35	25	13	4	**48**	**12**	17
All fungicides	**507**	**69**	**815**	**99**	**1,322**	**87**	**856**
Sulphur	34	26	0	0	**34**	**10**	
Area grown	131		199		329		314

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 9 Raspberry herbicide formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	Non-protected raspberry		Protected raspberry		All raspberry		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Carfentrazone-ethyl	37	28	78	39	**115**	**35**	105
Diquat	122	81	79	40	**201**	**56**	128
Fluazifop-P-butyl	34	26	0	0	**34**	**10**	12
Glyphosate	0	0	15	8	**15**	**5**	29
Isoxaben	79	61	33	16	**112**	**34**	52
Lenacil	1	1	4	2	**5**	**2**	1
Napropamide	29	22	64	32	**94**	**28**	26
Pendimethalin	68	52	0	0	**68**	**21**	39
Propyzamide	44	34	32	16	**76**	**23**	3
All herbicides	**414**	**81**	**305**	**67**	**719**	**72**	**434**
Area grown	131		199		329		314

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 10 Blackcurrant insecticide and acaricide formulations - 2016

Area (ha) and percentage of crop treated

Insecticides/acaricides	Blackcurrants		2014[1]
	(Ha)	(%)	(Ha)
Deltamethrin	1	<0.5	0
Lambda-cyhalothrin	387	68	435
Spinosad	57	19	0
Spirotetramat	153	27	67
Thiacloprid	345	72	279
All insecticides/acaricides	**943**	**92**	**1,656**
Area grown	304		341

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]
Note: no biologicals were recorded on blackcurrants

Table 11 Blackcurrant fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides	Blackcurrants		2014[1]
	(Ha)	(%)	(Ha)
Boscalid/pyraclostrobin	200	66	485
Chlorothalonil	<0.5	<0.5	47
Copper oxychloride	2	<0.5	0
Cyprodinil/fludioxonil	198	65	355
Dodine	1	<0.5	0
Fenhexamid	84	28	188
Fenpropimorph	3	<0.5	5
Kresoxim-methyl	397	67	84
Myclobutanil	518	87	387
Penconazole	3	<0.5	0
Pyrimethanil	53	17	105
All fungicides	**1,459**	**87**	**1,667**
Sulphur	402	68	633
Area grown	304		341

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 12 Blackcurrant herbicide formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	Blackcurrants		2014[1]
	(Ha)	(%)	(Ha)
Diquat	268	63	304
Flufenacet/metribuzin	191	63	301
Glyphosate	107	34	42
Isoxaben	143	47	2
Napropamide	1	<0.5	1
Pendimethalin	256	84	303
Propyzamide	1	<0.5	5
All herbicides	**968**	**91**	**982**
Area grown	304		341

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 13 Other soft fruit insecticide, molluscicide and biological formulations - 2016

Area (ha) and percentage of crop treated

Insecticides/acaricides	Non-protected other soft fruit		Protected other soft fruit		All other soft fruit crops		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Abamectin	0	0	25	14	**25**	**10**	7
Deltamethrin	13	9	0	0	**13**	**3**	1
Lambda-cyhalothrin	5	5	52	29	**57**	**22**	57
Pyrethrins	0	0	125	39	**125**	**28**	109
Spinosad	0	0	7	4	**7**	**3**	0
Thiacloprid	11	17	257	93	**268**	**72**	155
All insecticides/acaricides	**29**	**31**	**465**	**>99**	**494**	**81**	**410**
Molluscicides							
Ferric phosphate	0	0	40	12	**40**	**9**	1
All molluscicides	**0**	**0**	**40**	**12**	**40**	**9**	**4**
Biological control agents							
Aphidoletes aphidimyza	0	0	23	12	**23**	**9**	0
Heterorhabditis bacteriophora	0	0	136	39	**136**	**29**	0
Parasitic wasps	0	0	25	7	**25**	**5**	0
Steinernema kraussei	0	0	61	19	**61**	**14**	42
All biological agents	**0**	**0**	**245**	**46**	**245**	**34**	**42**
Area grown	68		180		248		172

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 14 Other soft fruit fungicide and sulphur formulations - 2016

Area (ha) and percentage of crop treated

Fungicides	Non-protected other soft fruit		Protected other soft fruit		All other soft fruit crops		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Azoxystrobin	0	0	28	15	**28**	**11**	12
Boscalid/pyraclostrobin	14	11	29	15	**42**	**14**	6
Bupirimate	4	6	0	0	**4**	**2**	28
Copper oxychloride	2	2	4	1	**6**	**1**	4
Cyprodinil/fludioxonil	4	6	151	56	**155**	**42**	137
Fenhexamid	15	22	28	15	**42**	**17**	50
Fenpropimorph	23	16	0	0	**23**	**4**	27
Myclobutanil	26	23	0	0	**26**	**6**	42
Penconazole	14	10	0	0	**14**	**3**	0
Pyrimethanil	14	10	50	28	**64**	**23**	4
Quinoxyfen	9	6	0	0	**9**	**2**	13
All fungicides	**125**	**37**	**289**	**56**	**414**	**51**	**327**
Sulphur	2	2	4	1	**6**	**1**	4
Area grown	68		180		248		172

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 15 Other soft fruit herbicide formulations - 2016

Area (ha) and percentage of crop treated

Herbicides	Non-protected other soft fruit		Protected other soft fruit		All other soft fruit crops		2014[1]
	(Ha)	(%)	(Ha)	(%)	**(Ha)**	**(%)**	(Ha)
Diquat	22	32	85	47	**107**	**43**	63
Flufenacet/metribuzin	13	19	2	1	**15**	**6**	2
Glyphosate	0	0	55	12	**55**	**9**	9
Isoxaben	11	17	2	1	**13**	**5**	3
Napropamide	8	12	52	29	**60**	**24**	45
Pendimethalin	10	15	0	0	**10**	**4**	1
Propyzamide	9	13	2	1	**10**	**4**	17
All herbicides	**72**	**36**	**197**	**59**	**270**	**53**	**158**
Area grown	68		180		248		172

(1) For full list of formulations recorded in 2014 please refer to the 2014 report[3]

Table 16 Strawberry insecticide and acaricide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Insecticides/acaricides	Non-protected strawberry			Protected strawberry			All strawberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Abamectin	0	0	0	858	59	6	**858**	**55**	**6**
Chlorpyrifos	0	0	0	159	17	75	**159**	**16**	**75**
Clofentezine	0	0	0	595	35	76	**595**	**32**	**76**
Deltamethrin	0	0	0	165	18	1	**165**	**17**	**1**
Etoxazole	0	0	0	162	18	5	**162**	**16**	**5**
Fenpyroximate	0	0	0	2	<0.5	<0.5	**2**	**<0.5**	**<0.5**
Lambda-cyhalothrin	2	2	<0.5	884	81	8	**886**	**75**	**8**
Pirimicarb	0	0	0	88	10	25	**88**	**9**	**25**
Pymetrozine	0	0	0	284	29	57	**284**	**27**	**57**
Pyrethrins	0	0	0	60	6	3	**60**	**6**	**3**
Spinosad	0	0	0	51	6	4	**51**	**5**	**4**
Spirodiclofen	0	0	0	37	4	1	**37**	**4**	**1**
Spiromesifen	0	0	0	5	1	1	**5**	**<0.5**	**1**
Tebufenpyrad	0	0	0	72	8	9	**72**	**7**	**9**
Thiacloprid	0	0	0	433	34	52	**433**	**32**	**52**
All insecticides/acaricides	**2**	**2**	**<0.5**	**3,856**	**99**	**322**	**3,858**	**92**	**322**
Area grown	75			920			995		

Table 17 Strawberry biological, molluscicide and physical control active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Biological control agents	Non-protected strawberry			Protected strawberry			All strawberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Heterorhabditis bacteriophora	0	0	NA	113	7	NA	**113**	**6**	**NA**
Neoseiulus californicus	0	0	NA	9	<0.5	NA	**9**	**<0.5**	**NA**
Neoseiulus cucumeris	0	0	NA	70	3	NA	**70**	**3**	**NA**
Phytoseiulus persimilis	0	0	NA	68	7	NA	**68**	**7**	**NA**
Steinernema kraussei	0	0	NA	114	12	NA	**114**	**11**	**NA**
All biological agents	**0**		**NA**	**374**		**NA**	**374**		**NA**
Biopesticides									
Bacillus subtilis	0	0	0	767	40	62	**767**	**37**	**62**
Beauveria bassiana ATCC - 74040	0	0	0	6	1	1	**6**	**1**	**1**
Beauveria bassiana GHA	0	0	0	7	1	1	**7**	**1**	**1**
All biopesticides	**0**		**0**	**780**		**64**	**780**		**64**
All biologicals(1)	**0**	**0**	**0**	**1,154**	**47**	**421**	**1,154**	**43**	**421**
Molluscicides									
Ferric phosphate	3	2	1	56	4	12	**59**	**4**	**12**
Metaldehyde	0	0	0	194	17	47	**194**	**16**	**47**
All molluscicides	**3**	**2**	**1**	**250**	**21**	**59**	**253**	**20**	**59**
Physical control									
Carbonic acid diamide/urea	0	0	0	24	1	47	**24**	**1**	**47**
Area grown	75			920			995		

(1) All biologicals includes biopesticides and biological control agents. NA = not applicable

Note: invertebrate biological control agents are applied by number of organisms rather than weight therefore data are not presented

Table 18 Strawberry fungicide and sulphur active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Fungicides	Non-protected strawberry			Protected strawberry			All strawberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Azoxystrobin	0	0	0	1,109	82	276	**1,109**	**76**	**276**
Boscalid	5	7	2	782	64	264	**788**	**59**	**266**
Bupirimate	5	7	2	852	73	295	**857**	**68**	**297**
Chlorothalonil	16	7	16	0	0	0	**16**	**1**	**16**
Cyflufenamid	0	0	0	70	7	1	**70**	**6**	**1**
Cyprodinil	2	2	<0.5	1,199	95	448	**1,201**	**88**	**448**
Dimethomorph	0	0	0	104	11	155	**104**	**10**	**155**
Fenamidone	5	7	<0.5	150	16	36	**155**	**15**	**36**
Fenhexamid	45	38	27	1,182	84	864	**1,227**	**81**	**891**
Fenpropimorph	12	9	8	334	19	242	**346**	**19**	**251**
Fludioxonil	2	2	<0.5	1,199	95	299	**1,201**	**88**	**299**
Fosetyl-aluminium	5	7	5	150	16	358	**155**	**15**	**363**
Iprodione	5	7	4	1,073	82	791	**1,078**	**76**	**795**
Kresoxim-methyl	0	0	0	242	21	36	**242**	**20**	**36**
Mepanipyrim	0	0	0	54	6	22	**54**	**5**	**22**
Meptyldinocap	0	0	0	250	21	52	**250**	**19**	**52**
Myclobutanil	5	7	<0.5	1,603	88	133	**1,608**	**82**	**133**

Cont…

Table 18 Strawberry fungicide and sulphur active substances - 2016 continued

Area (ha), Quantity (kg) and percentage of crop treated

Fungicides	Non-protected strawberry			Protected strawberry			All strawberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Penconazole	0	0	0	177	14	8	**177**	**13**	**8**
Potassium hydrogen carbonate	0	0	0	217	13	935	**217**	**12**	**935**
Pyraclostrobin	5	7	1	782	64	66	**788**	**59**	**67**
Pyrimethanil	8	9	6	319	32	232	**327**	**30**	**238**
Quinoxyfen	0	0	0	768	64	96	**768**	**60**	**96**
All fungicides	**122**	**38**	**72**	**12,615**	**99**	**5,611**	**12,736**	**94**	**5,682**
Sulphur	0	0	0	339	20	185	**339**	**18**	**185**
Area grown	75			920			995		

Table 19 Strawberry herbicide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Herbicides	Non-protected strawberry			Protected strawberry			All strawberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Carfentrazone-ethyl	0	0	0	103	11	3	**103**	**10**	**3**
Clopyralid	10	7	2	23	3	2	**34**	**3**	**4**
Cycloxydim	5	7	2	0	0	0	**5**	**1**	**2**
Diquat	1	1	<0.5	828	40	352	**828**	**37**	**352**
Glufosinate-ammonium	0	0	0	73	6	45	**73**	**6**	**45**
Glyphosate	0	0	0	85	8	110	**85**	**7**	**110**
Isoxaben	17	22	3	324	33	31	**341**	**32**	**34**
Lenacil	2	2	4	0	0	0	**2**	**<0.5**	**4**
Metamitron	5	7	18	23	3	24	**29**	**3**	**43**
Napropamide	17	22	42	383	39	759	**400**	**38**	**801**
Pendimethalin	2	2	2	0	0	0	**2**	**<0.5**	**2**
Phenmedipham	5	2	2	0	0	0	**5**	**<0.5**	**2**
Propyzamide	5	7	7	90	9	101	**96**	**9**	**109**
All herbicides	**68**	**25**	**83**	**1,933**	**54**	**1,427**	**2,001**	**52**	**1,510**
Area grown	75			920			995		

Table 20 Raspberry insecticide and acaricide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Insecticides/acaricides	Non-protected raspberry			Protected raspberry			All raspberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Abamectin	0	0	0	152	73	1	**152**	**44**	**1**
Chlorpyrifos	3	2	2	33	16	16	**36**	**11**	**18**
Clofentezine	0	0	0	6	3	1	**6**	**2**	**1**
Deltamethrin	67	50	1	27	14	<0.5	**94**	**28**	**1**
Lambda-cyhalothrin	3	2	<0.5	28	14	<0.5	**31**	**10**	**<0.5**
Pyrethrins	0	0	0	5	2	<0.5	**5**	**1**	**<0.5**
Tebufenpyrad	0	0	0	6	3	<0.5	**6**	**2**	**<0.5**
Thiacloprid	3	2	<0.5	113	53	14	**116**	**33**	**14**
All insecticides/acaricides	**77**	**52**	**3**	**370**	**>99**	**33**	**446**	**81**	**36**
Area grown	131			199			329		

Table 21 Raspberry biological and molluscicide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Biological control agents	Non-protected raspberry			Protected raspberry			All raspberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Neoseiulus californicus	0	0	NA	<0.5	<0.5	NA	**<0.5**	**<0.5**	**NA**
Phytoseiulus persimilis	0	0	NA	3	1	NA	**3**	**1**	**NA**
Steinernema kraussei	0	0	NA	<0.5	<0.5	NA	**<0.5**	**<0.5**	**NA**
All biological agents	**0**		**NA**	**3**		**NA**	**3**		**NA**
Biopesticides									
Bacillus subtilis	0	0	0	64	24	7	**64**	**15**	**7**
Bacillus thuringiensis var. kurstaki	0	0	0	7	4	0	**7**	**2**	**<0.5**
All biopesticides	**0**		**0**	**72**		**7**	**72**		**7**
All biologicals(1)	**0**	**0**		**75**	**26**		**75**	**16**	
Molluscicides									
Ferric phosphate	0	0	0	<0.5	<0.5	<0.5	**<0.5**	**<0.5**	**<0.5**
Area grown	131			199			329		

(1) All biologicals includes biopesticides and biological control agents
Note: invertebrate biological control agents are applied by number of organisms rather than weight therefore data are not presented
NA = not applicable

Table 22 Raspberry fungicide and sulphur active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Fungicides	Non-protected raspberry			Protected raspberry			All raspberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Azoxystrobin	6	2	2	51	24	13	**57**	**15**	**14**
Boscalid	26	19	10	152	77	51	**179**	**54**	**61**
Bupirimate	29	22	7	0	0	0	**29**	**9**	**7**
Cyprodinil	78	43	23	158	75	59	**236**	**62**	**82**
Dimethomorph	63	48	65	61	31	92	**124**	**38**	**157**
Fenhexamid	161	51	90	189	77	138	**351**	**66**	**228**
Fenpropimorph	0	0	0	7	4	5	**7**	**2**	**5**
Fluazinam	0	0	0	33	16	25	**33**	**10**	**25**
Fludioxonil	78	43	15	158	75	39	**236**	**62**	**55**
Iprodione	40	28	30	69	24	51	**109**	**26**	**81**
Myclobutanil	34	26	3	35	18	2	**69**	**21**	**5**
Pyraclostrobin	26	19	2	152	77	13	**179**	**54**	**15**
Pyrimethanil	34	26	14	46	22	15	**80**	**24**	**28**
Tebuconazole	35	25	6	13	4	3	**48**	**12**	**8**
All fungicides	**612**	**69**	**267**	**1,125**	**99**	**505**	**1,737**	**87**	**772**
Sulphur	34	26	270	0	0	0	**34**	**10**	**270**
Area grown	131			199			329		

Table 23 Raspberry herbicide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Herbicides	Non-protected raspberry			Protected raspberry			All raspberry		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Carfentrazone-ethyl	37	28	1	78	39	4	**115**	**35**	**5**
Diquat	122	81	61	79	40	29	**201**	**56**	**90**
Fluazifop-P-butyl	34	26	4	0	0	0	**34**	**10**	**4**
Glyphosate	0	0	0	15	8	27	**15**	**5**	**27**
Isoxaben	79	61	16	33	16	8	**112**	**34**	**24**
Lenacil	1	1	1	4	2	10	**5**	**2**	**11**
Napropamide	29	22	66	64	32	203	**94**	**28**	**269**
Pendimethalin	68	52	89	0	0	0	**68**	**21**	**89**
Propyzamide	44	34	68	32	16	51	**76**	**23**	**118**
All herbicides	**414**	**81**	**306**	**305**	**67**	**332**	**719**	**72**	**638**
Area grown	131			199			329		

Table 24 Blackcurrant insecticide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Insecticides/acaricides	Blackcurrants		
	(Ha)	(%)	(Kg)
Deltamethrin	1	<0.5	<0.5
Lambda-cyhalothrin	387	68	4
Spinosad	57	19	5
Spirotetramat	153	27	11
Thiacloprid	345	72	41
All insecticides/acaricides	**943**	**92**	**62**
Area grown	304		

Table 25 Blackcurrant fungicide and sulphur active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Fungicides	Blackcurrants		
	(Ha)	(%)	(Kg)
Boscalid	200	66	80
Chlorothalonil	<0.5	<0.5	<0.5
Copper oxychloride	2	<0.5	2
Cyprodinil	198	65	74
Dodine	1	<0.5	1
Fenhexamid	84	28	62
Fenpropimorph	3	<0.5	2
Fludioxonil	198	65	49
Kresoxim-methyl	397	67	40
Myclobutanil	518	87	40
Penconazole	3	<0.5	<0.5
Pyraclostrobin	200	66	20
Pyrimethanil	53	17	41
All fungicides	**1,856**	**87**	**412**
Sulphur(1)	402	68	3,207
Area grown	304		

(1) Sulphur can be used on blackcurrants as an insecticide to control big bud mite. Sulphur can also be used as a fungicide or as a foliar fertiliser

Table 26 Blackcurrant herbicide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Herbicides	Blackcurrants		
	(Ha)	(%)	(Kg)
Diquat	268	63	107
Flufenacet	191	63	114
Glyphosate	107	34	155
Isoxaben	143	47	36
Metribuzin	191	63	83
Napropamide	1	0	4
Pendimethalin	256	84	338
Propyzamide	1	0	2
All herbicides	**1,159**	**91**	**839**
Area grown	304		

Table 27 Other soft fruit insecticide, molluscicide and biological active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Insecticides/acaricides	Non-protected other soft fruit			Protected other soft fruit			All other soft fruit		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Abamectin	0	0	0	25	14	<0.5	**25**	**10**	**<0.5**
Deltamethrin	13	9	<0.5	0	0	0	**13**	**3**	**<0.5**
Lambda-cyhalothrin	5	5	<0.5	52	29	<0.5	**57**	**22**	**<0.5**
Pyrethrins	0	0	0	125	39	8	**125**	**28**	**8**
Spinosad	0	0	0	7	4	1	**7**	**3**	**1**
Thiacloprid	11	17	1	257	93	31	**268**	**72**	**32**
All insecticides/acaricides	**29**	**31**	**2**	**465**	**<100**	**40**	**494**	**81**	**42**
Molluscicides									
Ferric phosphate	0	0	0	40	12	8	**40**	**9**	**8**
Biological control agents									
Aphidoletes aphidimyza	0	0	NA	23	12	NA	**23**	**9**	**NA**
Heterorhabditis bacteriophora	0	0	NA	136	39	NA	**136**	**29**	**NA**
Parasitic wasps	0	0	NA	25	7	NA	**25**	**5**	**NA**
Steinernema kraussei	0	0	NA	61	19	NA	**61**	**14**	**NA**
All biological agents	**0**		**NA**	**245**		**NA**	**245**		**NA**
Area grown	68			180			248		

Note: invertebrate biological control agents are applied by number of organisms rather than weight therefore data are not presented
NA = not applicable

Table 28 Other soft fruit fungicide and sulphur active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Fungicides	Non-protected other soft fruit			Protected other soft fruit			All other soft fruit		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Azoxystrobin	0	0	0	28	15	7	**28**	**11**	**7**
Boscalid	14	11	3	29	15	10	**42**	**14**	**13**
Bupirimate	4	6	2	0	0	0	**4**	**2**	**2**
Copper oxychloride	2	2	2	4	1	4	**6**	**1**	**6**
Cyprodinil	4	6	2	151	56	40	**155**	**42**	**42**
Fenhexamid	15	22	8	28	15	21	**42**	**17**	**29**
Fenpropimorph	23	16	14	0	0	0	**23**	**4**	**14**
Fludioxonil	4	6	1	151	56	27	**155**	**42**	**28**
Myclobutanil	26	23	1	0	0	0	**26**	**6**	**1**
Penconazole	14	10	<0.5	0	0	0	**14**	**3**	**<0.5**
Pyraclostrobin	14	11	1	29	15	2	**42**	**14**	**3**
Pyrimethanil	14	10	3	50	28	40	**64**	**23**	**43**
Quinoxyfen	9	6	1	0	0	0	**9**	**2**	**1**
All fungicides	**143**	**37**	**41**	**468**	**56**	**150**	**611**	**51**	**189**
Sulphur	2	2	9	4	1	15	**6**	**1**	**25**
Area grown	68			180			248		

Table 29 Other soft fruit herbicide active substances - 2016

Area (ha), Quantity (kg) and percentage of crop treated

Herbicides	Non-protected other soft fruit			Protected other soft fruit			All other soft fruit		
	(Ha)	(%)	(Kg)	(Ha)	(%)	(Kg)	**(Ha)**	**(%)**	**(Kg)**
Diquat	22	32	11	85	47	35	**107**	**43**	**46**
Flufenacet	13	19	8	2	1	1	**15**	**6**	**9**
Glyphosate	0	0	0	55	12	79	**55**	**9**	**79**
Isoxaben	11	17	2	2	1	<0.5	**13**	**5**	**3**
Metribuzin	13	19	6	2	1	1	**15**	**6**	**6**
Napropamide	8	12	24	52	29	163	**60**	**24**	**187**
Pendimethalin	10	15	11	0	0	0	**10**	**4**	**11**
Propyzamide	9	13	12	2	1	2	**10**	**4**	**14**
All herbicides	**85**	**36**	**72**	**199**	**59**	**281**	**284**	**53**	**354**
Area grown	68			180			248		

Table 30 Mode of action/chemical group of insecticide active substances - 2016

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active substances	Chemical Group	IRAC Group	Total Soft Fruit	
				(Ha)	(Kg)
Acetylcholinesterase (Ache) inhibitors	Pirimicarb	Carbamate	1A	88	25
	Chlorpyrifos	Organophosphate	1B	195	92
All Ache inhibitors				**283**	**117**
Sodium channel modulators	Deltamethrin	Pyrethroid	3A	273	2
	Lambda-Cyhalothrin	Pyrethroid	3A	1,360	13
	Pyrethrins	Pyrethrin	3A	190	12
All sodium channel modulators				**1,823**	**26**
Nicotinic acetylcholine receptor (naAChR) competitive modulators	Thiacloprid	Neonicotinoid	4A	1,163	140
All naAChR competitive modulators				**1,163**	**140**
Nicotinic acetylcholine receptor (naAChR) allosteric modulators	Spinosad	Spinosyns	5	115	10
All naAChR allosteric modulators				**115**	**10**
Glutamate-gated chloride channel (GluCl) allosteric modulators	Abamectin	Avermectins	6	1,035	7
All GluCl allosteric modulators				**1,035**	**7**
Chordotonal organ TRPV channel modulators	Pymetrozine	Pyridine azomethine derivatives	9B	284	57
All chordotonal organ TRPV channel modulators				**284**	**57**

Cont …

Table 30 Mode of action/chemical group of insecticide active substances - 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active substances	Chemical Group	IRAC Group	Total Soft Fruit	
				(Ha)	(Kg)
Mite growth inhibitors	Clofentezine	Tetrazine	10A	601	77
	Etoxazole	Etoxazole	10B	162	5
All mite growth inhibitors				**763**	**82**
Mitochondrial complex I electron transport inhibitors	Fenpyroximate	METI acaricides/insecticides	21A	2	0
	Tebufenpyrad	METI acaricides/insecticides	21A	78	9
All mitochondrial complex I electron transport inhibitors				**80**	**9**
Inhibitors of acetyl CoA carboxylase	Spirotetramat	Tetramic acid	23	153	11
	Spirodiclofen	Tetronic acid	23	37	1
	Spiromesifen	Tetronic acid	23	5	1
All Inhibitors of acetyl CoA carboxylase				**195**	**13**
All insecticides				**5,741**	**461**
Area grown				1,876	

Note: Active substances have been grouped by their mode of action. Full details on mode of action classification can be found on the Insecticide Resistance Action Committee (IRAC) webpage[(7)].

Table 31 Mode of action/chemical group of fungicide active substances - 2016

Area (ha) and quantity (kg) of active substances for all crops

Mode of action	Active substance	Group name	Chemical Group	FRAC Group	Total Soft Fruit	
					(Ha)	(Kg)
Amino acids and protein synthesis	Cyprodinil	Anilino - pyrimidine	Anilino - pyrimidine	9	1,789	646
	Mepanipyrim	Anilino - pyrimidine	Anilino - pyrimidine	9	54	22
	Pyrimethanil	Anilino - pyrimidine	Anilino - pyrimidine	9	524	350
All amino acids and protein synthesis					**2,368**	**1,018**
Cell wall biosynthesis	Dimethomorph	Carboxylic acid amide	Morpholine/cinamic acid amides	40	228	312
All cell wall biosynthesis					**228**	**312**
Multi-site contact activity	Chlorothalonil	Chloronitriles	Chloronitriles	M5	16	16
	Copper oxychloride	Inorganic	Inorganic	M1	8	8
All multi-site contact activity					**25**	**24**
Not classified	Potassium hydrogen carbonate	Diverse	Diverse	NC	217	935
All not classified					**217**	**935**
Nucleic acids synthesis	Bupirimate	Hydroxy-(2-amino-) pyrimidines	Hydroxy-(2-amino-) pyrimidines	8	891	306
All nucleic acids synthesis					**891**	**306**
Respiration	Boscalid	SDHI	Pyridine-carboxamides	7	1,208	419
	Azoxystrobin	Qo inhibitor	Methoxy-acrylates	11	1,194	297
	Fenamidone	Qo inhibitor	Imidazolinones	11	155	36
	Kresoxim-methyl	Qo inhibitor	Oximino-acetates	11	639	76

Cont…

Table 31 Mode of action/chemical group of fungicide active substances - 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of action	Active substance	Group name	Chemical Group	FRAC Group	Total Soft Fruit	
					(Ha)	(Kg)
Respiration	Pyraclostrobin	Qo inhibitor	Methoxy-carbamates	11	1,208	105
	Fluazinam		2,6-dinitro-anilines	29	33	25
	Meptyldinocap		Dinitrophenyl crotonates	29	250	52
All respiration					**4,687**	**1,011**
Signal transduction	Iprodione	Dicarboximide	Dicarboximide	2	1,187	876
	Fludioxonil	Phenylpyrroles	Phenylpyrroles	12	1,789	431
	Quinoxyfen	Azanaphthalenes	Aryloxyquinoline	13	777	97
All signal transduction					**3,753**	**1,404**
Sterol biosynthesis in membranes	Myclobutanil	DeMethylation inhibitor	Triazole	3	2,221	180
	Penconazole	DeMethylation inhibitor	Triazole	3	193	9
	Tebuconazole	DeMethylation inhibitor	Triazole	3	48	8
	Fenpropimorph	Morpholine	Morpholine	5	379	273
	Fenhexamid	(SBI: Class III)	Hydroxyanilides	17	1,704	1,211
All sterol biosynthesis in membranes					**4,547**	**1,681**
Unknown mode of action	Cyflufenamid	Phenyl-acetamide	Phenyl-acetamide	U6	70	1
	Dodine	Guanidines	Guanidines	U12	1	1
	Fosetyl-aluminium	Phosphonates	Ethyl phosphonates	33	155	363
All unknown mode of action					**226**	**365**
All fungicides					**16,940**	**7,055**
Sulphur					781	3,687
Area grown					1,876	

Note: Active substances have been grouped by their mode of action. Full details on mode of action classification can be found on the Fungicide Resistance Action Committee (FRAC) webpage[8].

Table 32 Mode of action/chemical group of herbicide active substances - 2016

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active substances	Chemical Group	HRAC Group	Total Soft Fruit	
				(Ha)	(Kg)
Inhibition of acetyl CoA carboxylase	Cycloxydim	Cyclohexanedione	A	5	2
	Fluazifop-P-Butyl	Aryloxyphenoxy-propionate	A	34	4
All inhibition of acetyl CoA carboxylase				**39**	**7**
Inhibition of photosynthesis at photosystem II	Lenacil	Uracil	C1	7	14
	Metamitron	Triazinone	C1	29	43
	Metribuzin	Triazinone	C1	205	90
	Phenmedipham	Phenyl-carbamate	C1	5	2
All inhibition of photosynthesis at photosystem II				**245**	**149**
Photosystem-I-electron diversion	Diquat	Bibyridylium	D	1,404	595
All photosystem-I-electron diversion				**1,404**	**595**
Inhibition of protoporphyrinogen oxidase	Carfentrazone-Ethyl	Triazolinone	E	218	8
All Inhibition of protoporphyrinogen oxidase				**218**	**8**
Inhibition of EPSP synthase	Glyphosate	Glycine	G	262	370
All inhibition of EPSP synthase				**262**	**370**
Inhibition of glutamine synthetase	Glufosinate-Ammonium	Phosphinic acid	H	73	45
All inhibition of glutamine synthetase				**73**	**45**
Microtubule assembly inhibition	Pendimethalin	Dinitroaniline	K1	336	440
	Propyzamide	Benzamide	K1	183	243
All microtubule assembly inhibition				**519**	**683**

Cont…

Table 32 Mode of action/chemical group of herbicide active substances - 2016 continued

Area (ha) and quantity (kg) of active substances for all crops

Mode of Action	Active substances	Chemical Group	HRAC Group	Total Soft Fruit	
				(Ha)	(Kg)
Inhibition of VLCFAs	Flufenacet	Oxyacetamide	K3	205	123
	Napropamide	Acetamide	K3	555	1,261
All inhibition of VLCFAs				**760**	**1,384**
Inhibition of cell wall synthesis	Isoxaben	Benzamide	L	609	97
All inhibition of cell wall synthesis				**609**	**97**
Action like indole acetic acid	Clopyralid	Pyridine carboxylic acid	O	34	4
All action like indole acetic acid				**34**	**4**
All herbicides				**4,163**	**3,342**
Area grown				1,876	

Note: Active substances have been grouped by their mode of action. Full details on mode of action classification can be found on the Herbicide Resistance Action Committee (HRAC) webpage[(9)].

Table 33 Principal active substance by area - 2016

Area (ha) treated with the 20 most used active substances on all soft fruit crops surveyed

	Active substance	Type[(1)]	2016	2014	% change
1	Myclobutanil	F	**2,221**	2,630	-16
2	Fludioxonil	F	**1,789**	1,878	-5
3	Cyprodinil	F	**1,789**	1,878	-5
4	Fenhexamid	F	**1,704**	2,151	-21
5	Diquat	H	**1,404**	2,001	-30
6	Lambda-cyhalothrin	I	**1,360**	1,020	33
7	Pyraclostrobin	F	**1,208**	1,024	18
8	Boscalid	F	**1,208**	1,024	18
9	Azoxystrobin	F	**1,194**	1,395	-14
10	Iprodione	F	**1,187**	1,405	-16
11	Thiacloprid	I	**1,163**	820	42
12	Abamectin	I	**1,035**	1,246	-17
13	Bupirimate	F	**891**	1,235	-28
14	*Bacillus subtilis*	BP	**831**	1,509	-45
15	Sulphur	SU	**781**	1,964	-60
16	Quinoxyfen	F	**777**	746	4
17	Kresoxim-methyl	F	**639**	783	-18
18	Isoxaben	H	**609**	145	319
19	Clofentezine	I	**601**	956	-37
20	Napropamide	H	**555**	235	136

(1) Pesticide type = BP: Biopesticide, F: Fungicide, H: Herbicide, I: Insecticide/acaricide, SU: Sulphur

Table 34 Principal active substance by weight - 2016

Quantity (kg) of the 20 most used active substances on all soft fruit crops surveyed

	Active substance	Type[(1)]	2016	2014	% change
1	Sulphur	SU	**3,687**	5,913	-38
2	Napropamide	H	**1,261**	587	115
3	Fenhexamid	F	**1,211**	1,446	-16
4	Potassium hydrogen carbonate	F	**935**	4,527	-79
5	Iprodione	F	**876**	1,051	-17
6	Cyprodinil	F	**646**	688	-6
7	Diquat	H	**595**	882	-33
8	Pendimethalin	H	**440**	443	-1
9	Fludioxonil	F	**431**	459	-6
10	Boscalid	F	**419**	385	9
11	Glyphosate	H	**370**	172	115
12	Fosetyl-aluminium	F	**363**	215	69
13	Pyrimethanil	F	**350**	497	-30
14	Dimethomorph	F	**312**	293	6
15	Bupirimate	F	**306**	408	-25
16	Azoxystrobin	F	**297**	344	-14
17	Fenpropimorph	F	**273**	365	-25
18	Propyzamide	H	**243**	74	228
19	Myclobutanil	F	**180**	220	-18
20	Thiacloprid	I	**140**	100	40

(1) Pesticide type = F: Fungicide, H: Herbicide, I: Insecticide, SU: Sulphur

Table 35 Pesticides encountered in the soft fruit survey for the first time in 2016

Active substance	Type[(1)]	Area treated (ha)	Amount used (kg)
Cyflufenamid	F	70	1
Aphidoletes aphidimyza	B	23	N/A
Neoseiulus californicus	B	10	N/A
Beauveria bassiana GHA	BP	7	1

(1) Pesticide type = B: Biological control agent, BP: Biopesticide, F: Fungicide
N/A = arthropod biological control agents are applied by number of organisms rather than weight therefore data are not presented

Table 36 Total soft fruit crop, comparison with previous years

Pesticide usage 2016, 2014 & 2011/12[(1)], total pesticide treated area (ha) of formulations, active substances (a.s.) and quantities used (kg)

	2011/12[(1)]			2014			2016		
	Formulations (ha)	**a.s. (ha)**	**kg**	**Formulations (ha)**	**a.s. (ha)**	**kg**	**Formulations (ha)**	**a.s. (ha)**	**kg**
Insecticides/acaracides	7,744	7,744	1,340	9,435	9,435	1,480	5,741	5,741	461
Molluscicides	747	747	193	412	412	109	293	293	68
Fungicides	19,007	22,071	14,240	18,505	21,498	13,436	13,788	16,940	7,055
Sulphur	1,131	1,131	3,171	1,964	1,964	5,913	781	781	3,687
Herbicides	3,309	3,386	1,949	4,246	4,549	3,110	3,958	4,163	3,342
Biological control agents	426	426	N/A	466	466	N/A	622	622	N/A
Biopesticides	1,787	1,787	153	1,759	1,759	136	852	852	70
Physical control	347	347	289	42	325	447	6	24	47
All pesticides	**34,498**	**37,639**	**21,183**	**36,828**	**40,407**	**24,494**	**26,041**	**29,416**	**14,729**
Area grown (ha)[(2)]	1,662			1,800			1,876		

(1) Note: 2014 was the first soft fruit report to contain both non-protected and protected soft fruit which makes data comparison with previous surveys difficult. Non-protected and semi-protected data from the 2012 Soft Fruit Crop survey have been amalgamated with protected data from the 2011 Protected Edible report to allow some comparison. Data users should be aware that there have been minor differences in crop range, crop areas and methods used for estimating pesticide use between surveys. Please see appendix 4 – survey methodology for changes in method between years. (2) Area grown includes multi-cropping. N/A = not applicable.

Appendix 2 – Survey statistics

Census and sample information

Table 37 Census crop areas 2016

Census area (ha) of arable crops grown in Scotland

	Scotland 2016	Scotland 2014	% change
Strawberry	993	913	9
Raspberry	326	311	5
Blackcurrants	302	308	-2
Blueberries	132	45	192
Mixed and other soft fruits	122	166	-27
All soft fruit	**1,876**	**1,744**	**8**

Note: Data taken from the 2016 and 2014 June Agricultural Census.
All areas exclude multi-cropping.
It was estimated from crops encountered in the 2016 sample, that 7 ha of the mixed and other soft fruit categories in the census were raspberry, strawberry, blueberry or blackcurrant

Table 38 Distribution of soft fruit sample - 2016

Number of holdings surveyed in each region and size group

Size[(1)] (ha)	North	Angus	South	Scotland
0.01 - 4.99	17	2	8	**27**
5.00 - 9.99	1	3	1	**5**
10.00 - 19.99	1	5	0	**6**
20 +	0	9	0	**9**
All sizes	**19**	**19**	**9**	**47**

(1) Refers to the total area of soft fruit crops grown on the holding, including those grown in the open and those grown under glasshouse or walk-in plastic structures

Table 39 Non-protected soft fruit sample areas - 2016

Area (ha) of non-protected soft fruit crops in sample

Size[1] (ha)	Scotland[2]
0.01 - 4.99	7.80
5.00 - 9.99	22.56
10.00 - 19.99	27.30
20 +	109.57
All sizes	**167.23**

Table 40 Non-protected soft fruit census areas - 2016

Area (ha) of soft fruit grown in the open in Scotland

Size[1] (ha)	Scotland[2]
0.01 - 4.99	85.47
5.00 - 9.99	79.52
10.00 - 19.99	92.85
20 +	346.29
All sizes	**604.13**

(1) Size refers to area of soft fruit grown in the open on holding
(2) Regional data have not been provided in order to prevent disclosure of information relating to fewer than five holdings

Table 41 Protected soft fruit sample areas - 2016

Area (ha) of protected soft fruit crops in sample

Size[1] (ha)	Scotland[2]
0.01 - 4.99	8.01
5.00 - 9.99	7.62
10.00 - 19.99	37.38
20 +	172.80
All sizes	**225.81**

Table 42 Protected soft fruit census areas - 2016

Area (ha) of soft fruit grown under protection in Scotland

Size[1] (ha)	Scotland[2]
0.01 - 4.99	38.17
5.00 - 9.99	59.20
10.00 - 19.99	291.69
20 +	883.23
All sizes	**1,272.29**

(1) Refers to the total area of soft fruit crops grown on the holding, including those grown in the open and those grown under glasshouse or walk-in plastic structures.
(2) Regional data have not been provided in order to prevent disclosure of information relating to fewer than five holdings

Table 43 Non-protected soft fruit raising factors -2016

Size[1] (ha)	North	Angus	South
0.01 - 4.99	7.5853	113.5417	7.9421
5.00 - 9.99	2.1429	4.3118	2.1354
10.00 - 19.99	1.5868	3.8681	
20 +		3.1178	

Table 44 Protected soft fruit raising factors -2016

Size[1] (ha)	Scotland
0.01 - 4.99	4.7628
5.00 - 9.99	7.7689
10.00 - 19.99	7.8035
20 +	5.1113

(1) Refers to the total area of soft fruit crops grown on the holding, including those grown in the open and those grown under glasshouse or walk-in plastic structures.
Note: Raising factors are calculated by comparing the sampled crop area to the census crop area

Table 45 Non-protected soft fruit first and second adjustment factors -2016

	North Adj. 1	Angus Adj. 1	South Adj. 1	Adj 2
Strawberries	90.3498	2.5874	0.7493	1.0000
Raspberries	1.7040	1.2735	0.7390	1.0000
Blackcurrants	0.8480	0.7686	0.4361	1.0000
Other soft fruit	0.6236	3.1319	3.8629	1.0000

Table 46 Protected soft fruit first and second adjustment factors -2016

	Scotland Adj. 1	Adj 2
Strawberries	1.2624	1.0000
Raspberries	0.4435	1.0000
Other soft fruit	1.6044	1.0000

Response rates

The table below summarises the number of holdings who were contacted during the survey.

Table 47 Response rate - 2016

	2016	% total
Target sample (no. of holdings)	82	100
Total achieved	**47**	**57**
Total number of refusals/non-contact	41	
Total number of farms approached	**88**	

Financial burden to farmers

In order to minimise the burden on farmers, the survey team used non-visit methods of collection such as email, post or telephone call, where possible.

To determine the total burden that the 2016 Soft Fruit Crop Survey and the Integrated Pest Management Survey placed on those providing the information, the surveyors recorded the time that 36 respondents spent providing the data during the surveys. This sample represents 77 per cent of growers surveyed. Information was recorded from all strata of the sample to ensure that the overall estimate of burden was representative. The median time taken to provide the information was 21 minutes.

The following formula was used to estimate the total cost of participating:

Burden (£) = No. surveyed x median time taken (hours) x typical hourly rate* (* using median "Full Time Gross" hourly pay for Scotland of £13.48)[10]

The total financial burden to all growers resulting from participation in the 2016 Soft Fruit Crop Survey and the Integrated Pest Management Survey was calculated to be £222.

Appendix 3 - Definitions and notes

1) '**Pesticide**' is used throughout this report to include commercial formulations containing active substances (a.s.) used as herbicides, fungicides, insecticides, molluscicides, biological control agents, growth regulators, seed treatments and physical control. A pesticide product consists of one or more active substances co-formulated with other materials.

2) An **active substance** (or active ingredient) is any substance or micro-organism which has a general or specific action: against harmful organisms; or on plants, parts of plants or plant products.

3) In this report the term '**formulation**(s)' is used to describe the pesticide active substance or mixture of active substances in a product(s). It does not refer to any of the solvents, pH modifiers or adjuvants also contained within a product that contribute to its efficacy.

4) **Biological control** is use of a micro-organism, such as a bacteria or virus, or, macro-organisms, such as insect predators or nematodes that are used to control insect pests, weeds and diseases. In this report biologicals which do not require to be authorised are referred to as biological control agents. These are generally macro-organisms such as parasites or predators. Biologicals which do require to be authorised like other pesticides are referred to as **biopesticides**. Biopesticides are pesticides that are derived from natural materials and include micro-organisms (bacteria, fungus, virus or protozoa) to control pest populations or compounds such as semio-chemicals that cause behavioural changes in the target pest. In previous surveys biopesticides were included in the biological control agent category.

5) A **fungicide** is a pesticide used to control fungal diseases in plants.

6) A **herbicide** is a pesticide used to control unwanted vegetation (weed killer).

7) An **insecticide** is a pesticide used to control insects. An **acaricide** is a pesticide used to control mites. As some products are approved for use against both insects and mites, insecticide and acaricide use have been combined in this report.

8) A **molluscicide** is a pesticide used to control slugs and snails.

9) A **physical control agent** is a substance that is used to control pests with a mode of action that is physical. For example, by blocking insect spiracles causing death by suffocation.

10) **Basic area** is the planted area of crop which was treated with a given pesticide or pesticide group, irrespective of the number of times it was applied to that area. Basic areas are not presented anywhere in the report, but their values are used to calculate the percentage of crop treated with a given pesticide or pesticide group.

11) **Area treated** is the basic area of a crop treated with a given pesticide multiplied by the number of treatments that area received. These terms are synonymous with “spray area” and “spray hectare” which have appeared in previous reports. For example, if a field of five hectares gets sprayed with the same fungicide twice, the basic area is five hectares, and the treated area is 10 hectares.

12) **Non-protected crops** are crops grown outdoors without any protection during their production cycle.

13) **Protected crops** are crops grown under both permanent protection and semi-permanent protection. **Permanent protection** refers to crops grown in glasshouses or polythene tunnels for the entire duration of their production cycle. **Semi-permanent protection** refers to crops grown outdoors which are covered with polythene tunnels at some stage during production.

14) Farmers/growers can apply pesticides to crops by a number of different methods. Multiple pesticides can be applied to a crop in a single tank mix. For example a crop could be sprayed with two different fungicides and an insecticide at the same time.

15) In this report each pesticide is reported in three formats. The area of each pesticide is reported as both a formulation (mixture of active substances in a product) and as individual active substances. Quantities of active substance are also reported (Tables 2 to 15 for formulation data, Tables 16 to 29 for active substance and quantity data). All three different formats are provided to satisfy the needs of all data users and allow them to assess pesticide use trends. Some users may be interested in use of pesticide products which contain a number of active substances, thus formulation data would be required. Other users are interested in particular active substances which may be formulated on their own or in combination with other active substances. Therefore active substance data would be required. In addition, both quantity and area of pesticide applications are important indicators of changes in use over time. Different pesticides are applied at different dose rates and only by comparing both area and quantity can trends in use be elucidated.

16) It should be noted that some herbicides may not have been applied directly to the crop itself but either as land preparation treatments prior to sowing/planting the crop, or to the ground beneath crops grown on table tops, or the pathways between crops.

17) The areas of crop grown include successional sowings during the same season; therefore the areas of crops grown can be larger than the total area of glasshouses and polytunnels. This is referred to throughout the report as **multi-cropping**. No multi-cropping was encountered during the 2016 survey.

18) The **June Agricultural Census**[11] is conducted annually by the Scottish Government's Rural and Environmental Science Analytical Services (RESAS). The June Agricultural Census collects data on land use, crop areas, livestock and the number of people working on agricultural holdings. For this report the

June Agricultural Census was used to draw a sample of growers growing the relevant crops to participate in the survey

19) Throughout this report the term '**census area**' refers to the total area for a particular crop or group of crops recorded within the June Agricultural Census. These are the areas which the sampled areas are raised to. Please see Appendix 4 for details. The June Agricultural Census Form is divided up into different categories which relates to a particular crop or group of crops. These are referred to as '**census categories**' throughout this report.

20) Where quoted in the text or within figures, reasons for application are the grower's stated reasons for use of that particular pesticide on that crop and may not always seem appropriate. It should be noted that growers do not always provide reasons; therefore those presented in the figures only reflect those specified and may not reflect overall reasons for use.

21) Due to rounding, there may be slight differences in totals both within and between tables.

22) Data from the 2014 soft fruit survey[3] and data amalgamated from the 2011 protected edible[5] and 2012 soft fruit[4] surveys are provided for comparison purposes in Table 36. However, it should be noted that there may be minor differences in the range of crops surveyed, together with changes in areas of each of the crops grown. Changes from previous surveys are described in Appendix 4. When comparisons are made between surveys it is important to note that there may be changes in the area of crop grown. In order to take this into account, comparisons have been made on a per hectare grown basis, i.e. the number of hectares that have been sprayed (treated hectares) has been divided by the area of crop grown for each survey, and the weight (kilograms) applied has also been divided by the area of crop grown. This is to enable like for like comparisons between surveys, so that changes in pesticide use patterns are not masked by changes in crop area.

23) **Table top systems** are used where crops are grown on a structure built on stilts, straw bales or polystyrene blocks. This system reduces pest pressure and allows the fruit to be grown at a height which is easier for picking.

24) **Ground mulch** is a layer of material spread over the surface of the soil prior to planting in order to advance the crop by retaining heat. The mulch can be made of a material such as plastic or a biodegradable mesh. Natural materials such as grass cuttings or wood chippings are used too. If the mulch is opaque, it can also be used to suppress weed growth. Pots and bags can be placed on top of mulch.

25) To aid **pollination,** some growers introduce beehives to the tunnels to improve the fruit set as naturally occurring pollinators are unable to access tunnels.

26) The **age** of crops are reported as soft fruit farms may have plants which are a range of ages in order to allow time for the maturation of the crop allowing for a continuous supply of fruit.

27) The term **harvested** refers to plants that were harvested during 2016. This can include perennial crops planted the previous year and plants such as strawberries planted in early 2016. Some plants which are not harvested can include young plants such as raspberries which are normally harvested in their second year.

28) **Fresh market** refers to crops which are picked and sold to consumers without processing. This can include sales direct to the public or to supermarkets for resale.

29) **Processing** refers to crops normally grown under contract or sold for jam, pulp, juice, canning or freezing.

30) **Pick-your-own** refers to farms which operate a pick-your-own business on their soft fruit crops.

31) The **average number of applications** indicated in the text for each crop is based on the occurrence of a chemical group on at least ten per cent of the area grown. The average number of applications is calculated only on the areas using each pesticide group and therefore the minimum number of applications is always going to be one. Several pesticides may be applied as a tank mix as part of the same spray event; therefore the average number of pesticide sprays reported is less than the sum of sprays of each chemical group.

32) **Integrated pest management** The sustainable use directive[12] defines IPM as follows; "'integrated pest management' means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. 'Integrated pest management' emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

Appendix 4 – Survey methodology

Sampling and data collection

Using the June 2016 Agricultural Census[11], two samples were drawn representing soft fruit cultivation in Scotland. The first sample was selected from holdings growing soft fruit crops grown in the open (non-protected crops) and the second from holdings growing soft fruit crops in glasshouses or under walk-in plastic structures (protected crops). Protected and non-protected crops are recorded separately in the Agricultural Census. Separate samples were drawn to ensure non-protected crops were not under-represented in the sample; however, pesticide information was collected for all soft fruit crops grown on all holdings

The country was divided into 11 land-use regions (Figure 41). Each sample was stratified by these land-use regions and according to holding size. The holding size groups were based on the total area of soft fruit crops grown. The sampling fractions used within both regions and size groups were based on the areas of relevant crops grown rather than number of holdings, so that smaller holdings would not dominate the sample.

The survey covered pesticide applications to soft fruit crops where all or the majority of the growing season was in 2016. As well as recording treatments applied directly to the crop, data was also collected on land preparation treatments prior to sowing or planting the crop.

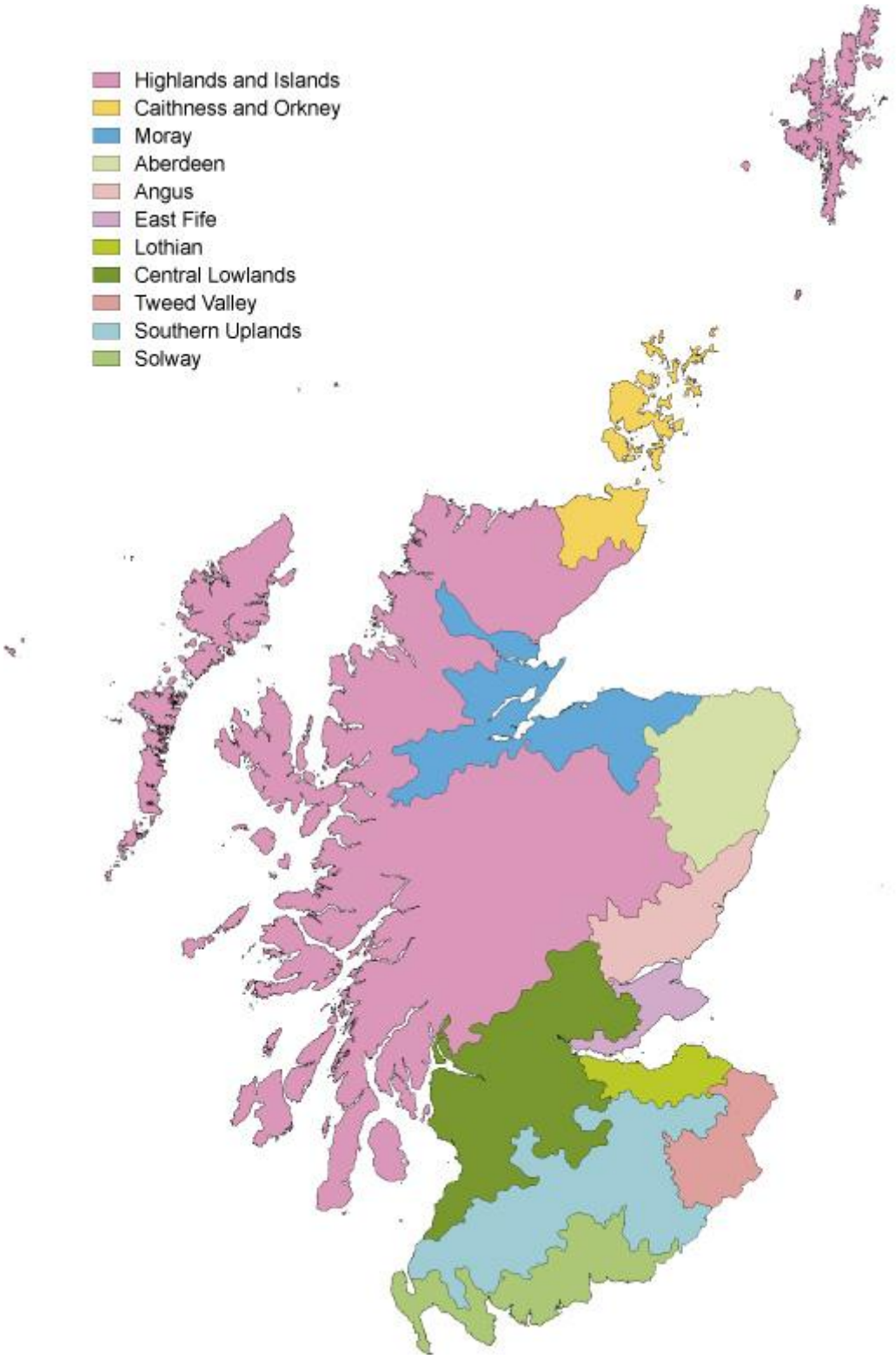
Following an introductory letter and phone call, data were collected by either personal interview during a visit to the holding or during a phone interview or by email. Where necessary, information was also collected from agronomists and contractors. In total, information was collected from 47 holdings growing soft fruit crops (Table 38). These holdings represent 21 per cent of the total crop area grown.

Raising factors

National pesticide use was estimated by ratio raising. This is a standard statistical technique for producing estimates from a sample. It is the same methodology used by the other UK survey teams and has been used for all historical datasets produced by the Pesticide Survey Unit, allowing comparability over time. The sample data were multiplied by raising factors (Table 43 & 44). These factors were calculated by comparing the sampled area in each of the two samples to the areas recorded in the Agricultural Census within each region and size group. An adjustment (Table 44 & 46) was made for each crop within each region by applying the raising factors to the sample area of each crop grown and comparing this with the census area. This adjustment modifies the estimate to take into account differences in composition of crops encountered in the sample and those present in the population. A second adjustment is applied if crops which are present in the population are not encountered in all strata of the sample, this adjustment was not necessary in the 2016 survey. Due to the distribution of soft fruit crops in Scotland the land use regions were amalgamated into three areas before raising for the non-protected sample: the North (Highlands & Islands,

Caithness & Orkney, Moray and Aberdeen), Angus (the main fruit growing region in Scotland) and the South (East Fife, Lothian, Central Lowlands, Tweed Valley, Southern Uplands and Solway). Protected Crops were raised at a national level as region has less influence on pesticide use on crops grown in a protected environment.

Figure 41 Land use regions of Scotland[13]



Changes from previous years

There are a number of changes which should be noted when comparing the 2016 data with the previous survey.

As with the previous surveys two samples were drawn in 2016 representing soft fruit cultivation in Scotland. The first sample was selected from holdings growing soft fruit crops grown in the open (non-protected crops) and the second from holdings growing soft fruit crops in glasshouses or under walk-in plastic structures (protected crops). Separate samples were drawn to ensure non-protected crops were not under-represented in the sample. In the previous survey, only information relating to non-protected crops was collected from the non-protected sample and the size group was based on the total area of non-protected crops grown on that holding, likewise for the protected crops in the protected sample. However in the 2016 survey, pesticide information was collected for all soft fruit crops (protected and non-protected) grown on all holdings and the size groups were based on the total soft fruit crop area grown on the holding. Pesticide use is influenced by farm size and basing the size groups on total soft fruit on each holding is the most appropriate method of sample selection.

In 2016,biopesticides have been grouped separately from biological control agents. In previous reports, all biological based pest control was presented under the category of biological control. However, as biopesticides require to be authorised like conventional pesticides, they can have a range of different functions including fungicides and insecticides and their rates of application can be collected, they are now reported separately. Biopesticide values have been re-calculated for the previous reports to allow for accurate comparisons.

The 2016 report contains a number of new data formats to help improve report quality for users. Data relating to the average number of applications for each crop and type of pesticide have been included in Table 1 and Figure 10. Pesticide application timings for each crop have been included in the pesticide usage section. Insecticides, fungicides and herbicides have been classified into groups according to their mode of action in Tables 30-32. In addition, data on Integrated Pest Management activities (has been collected and are reported in Appendix 6.

Data from the 2014 soft fruit survey and data amalgamated from the 2011 protected edible[(5)] and 2012 soft fruit[(4)] surveys are provided for comparison purposes in Table 35. The previous survey in 2014 was the first soft fruit report to include pesticide usage data for crops grown both in the open and under temporary and permanent protection. Non-protected and semi-protected data from the 2012 Soft Fruit Crop survey have been amalgamated with protected data from the 2011 Protected Edible report to allow some longer-term comparisons. It should be noted that there was a number of changes in survey method between these survey years. The changes are fully outlined in Appendix 4 of the 2014 soft fruit survey report[(3)].

Finally, the total number of refusals to participate in this voluntary survey (47 per cent) has increased from 32 per cent in 2014. This has resulted in a 2016 sample size 43 per cent lower than the target. It is possible that this decrease in sample size may influence the estimates made in this report, although the

very similar relative standard errors for total soft fruit reported between the last two surveys provides some reassurance that the statistical robustness of the data has not been compromised.

Data quality assurance

The dataset undergoes several validation processes as follows; (i) checking for any obvious errors upon data receipt (ii) checking and identifying inconsistencies with use and pesticide approval conditions once entered into the database (iii) 100 per cent checking of data held in the database against the raw data. Where inconsistencies are found these are checked against the records and with the grower if necessary. Additional quality assurance is provided by sending reports for review to members of the Working Party on Pesticide Usage Surveys and other agricultural experts. In addition, the Scottish pesticide survey unit is accredited to ISO 9001:2015. All survey related processes are documented in Standard Operating Procedures (SOPs) and our output is audited against these SOPs by internal auditors annually and by external auditors every three years.

Main sources of bias

The use of a random stratified sample is an appropriate survey methodology. A stratified random sample, grouped by farm size and region, is used to select holdings used in this survey. Sampling within size groups is based on area rather than numbers of holdings, so that smaller size groups are not over-represented in the sample. The pesticide survey may be subject to measurement bias as it is reliant on farmers/growers recording data accurately. As this survey is not compulsory it may also be subject to non-response bias, as growers on certain farm/holding types may be more likely to respond to the survey than others. Reserve lists of holdings are held for each stratum to allow non-responding holdings to be replaced with similar holdings.

Experience indicates that stratified random sampling, including reserves, coupled with personal interview technique, delivers the highest quality data and minimises non-response bias.

Appendix 5 – Standard errors

The figures presented in this report are produced from surveying a sample of holdings rather than a census of all the holdings in Scotland. Therefore the figures are estimates of the total pesticide use for Scotland and should not be interpreted as exact. To give an indication of the precision of estimates, the report includes relative standard errors (RSE) (Tables 48 & 49). Standard errors are produced using the raising factors. An overall variance is calculated by summing the variance estimates for individual strata (region and size group) multiplied by the square of their raising factors. These variance estimates include a finite population correction. The overall standard error is calculated from the overall variance by taking its square root. This method of standard estimation was implemented as it is both relatively straightforward and has advantages over ratio estimator methods when within-strata sample sizes are small.

Standard errors are expressed as percentage relative standard errors (Tables 48 & 49) for both total pesticide use by area treated and for weight applied. Larger relative standard errors mean that the estimates are less precise. A relative standard error of 0 per cent would be achieved by a census. A relative standard error of 100 per cent indicates that the error in the survey is of the same order as the measurement. Relative standard errors may be reduced with larger sample sizes. However, larger relative standard errors can also result from greater variability in pesticide use among holdings.

The RSE for estimates of total pesticide use on all soft fruit crops (protected and non-protected) was 10 per cent for area and 19 per cent for quantity (Table 48).

The RSE for constituent protected and non-protected crop groups varied from six to 71 per cent for area and four to 41 per cent for weight (Table 49), varying with sample size and uniformity of pesticide regime encountered. However, due to insufficient data, RSE values could not be calculated for all strata and the overall RSE values for protected and non-protected soft fruit should be treated with caution.

Table 48 Relative standard errors for total soft fruit - 2016

Relative standard errors (RSE) for the area treated (ha) with pesticide and for weight of active substance (kg) applied

Crops	Area RSE (%)	Weight RSE (%)
Raspberry	19	25
Strawberry[1]	9	15
Blackcurrant[1]	18	23
Other soft fruit	24	31
All soft fruit crops	**10**	**19**

Table 49 Relative standard errors for protected and non-protected soft fruit crops - 2016

Relative standard errors (RSE) for the area treated (ha) with pesticide and for weight of active substance (kg) applied

Crops	Area RSE (%)	Weight RSE (%)
Protected raspberry[1]	14	25
Protected strawberry[1]	8	15
Protected other soft fruit[1]	6	4
Non-protected raspberry[1]	27	41
Non-protected strawberry[1]	71	11
Non-protected Blackcurrant[1]	18	23
Non-protected other soft fruit[1]	29	23
All non-protected crops[1]	**23**	**26**
All protected crops[1]	**9**	**14**

(1) For these crops standard errors could not be calculated for all strata due to insufficient data in the sample, as these strata have not been used in the aggregate totals for the region and the overall RSE values should be treated with caution

Appendix 6 – Integrated pest management

It is a requirement of the EU Sustainable use of Pesticides Directive (2009/128/EC)[12] that member states should promote low pesticide input pest management, in particular Integrated Pest Management (IPM).

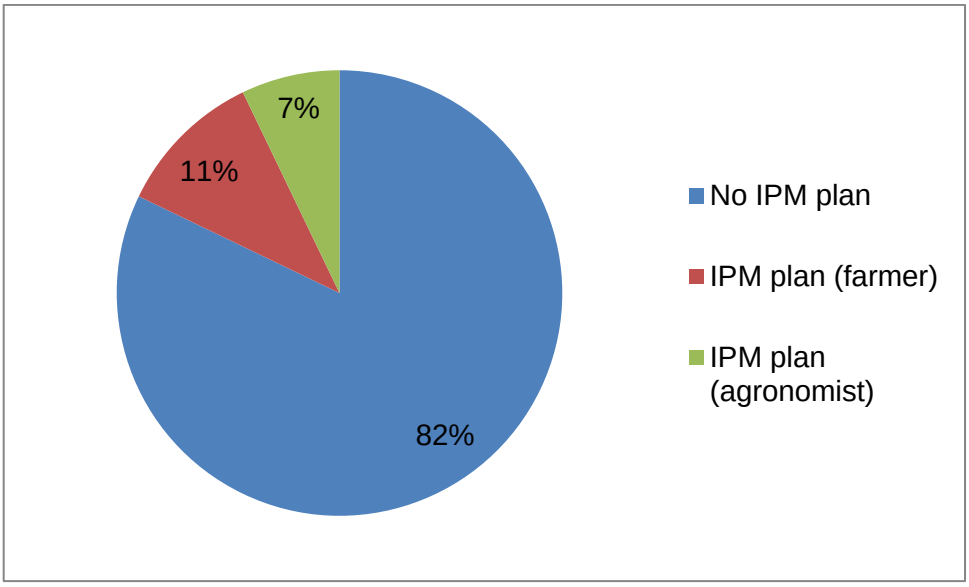
The Directive defines IPM as follows "'integrated pest management' means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. 'Integrated pest management' emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

As part of this survey, additional data collection was conducted in relation to grower adoption of Integrated Pest Management (IPM) measures. The term 'pest' is used to denote diseases, weeds and pests. This data collection was designed to inform the Scottish Government about the current adoption of IPM in the main crop sectors.

All growers were asked a series of questions about the IPM activities that they were implementing in their soft fruit crop production. Unlike the other statistics in this report, the figures reported in this section are not raised (i.e. are not national estimates) but represent only the responses of those surveyed.

In total IPM data was collected from 28 growers, representing 33 holdings and 68 per cent of the sampled soft fruit crop area (14 per cent of the census area). Of these growers, 82 per cent did not have an IPM plan, 11 per cent of growers completed their own IPM plan and seven per cent had a plan completed by their agronomist (Figure 42). Completing an IPM plan is voluntary for Scottish farmers, but this helps meet their legal obligation to take reasonable precautions to protect human health and the environment when using pesticides. Completing an IPM plan will help the landowner/contractor to make the best possible and most sustainable use of all available methods for controlling pests, weeds and diseases.

Figure 42 Percentage of respondents with an IPM plan - 2016



Growers were asked about their IPM activities in relation to three categories; risk management, pest monitoring and pest control. Information was collected about all activities growers conducted in relation to each category. Despite the fact that the majority of growers did not complete an IPM plan, uptake of a wide range of IPM activities was encountered.

Risk management

IPM programs aim to prevent or reduce the risk of pests becoming a threat by minimising the risk of damage occurring that will require subsequent control. Table 50 presents an overview of the risk management measures adopted by the growers surveyed. All the growers sampled used one or more risk management activity.

Just over half (54 per cent) of all growers reported that they used crop rotation to manage the risk of pest damage. Rotation is a basic principal of farming breaking the link between pathogen and host and reducing pest population build-up. It can also improve soil fertility and structure consequently increasing the vigour of subsequent crops. It should be noted that just over three quarters (76 per cent) of the crop area sampled was of crops grown in the soil with the remainder grown in bags, pots or troughs.

A similar proportion (54 per cent) of growers stated that they tested their soils in order to tailor inputs to improve crop performance. Half of the growers tested soil nutrient levels with lower proportions testing for disease, pH and nematodes (Figure 43). By pre-emptively testing for nutritional and pest status farmers' can make informed decisions about inputs required and crop choice for that field.

Sixty one per cent of growers reported that they managed their seed bed agronomy to reduce pest risk and increase crop performance. Half of growers

increased organic matter to improve soil quality while a smaller proportion implemented other measures such as using a stale seed bed, soil or ridge cultivation, considering pest management when planning irrigation and use of raised beds (Figure 44).

Almost 40 per cent of growers reported that they amended cultivation methods at sowing to try to increase crop success. A quarter of growers used peat as a pest free growing media and a smaller proportion used coir. Some growers also varied the sowing date and the planting distance or depth to mitigate for potential pest damage (Figure 45).

Fifty seven per cent of the growers surveyed also stated that they considered risk management when selecting seeds and/or varieties. Forty three per cent selected resistant varieties to reduce damage and almost a third used certified plants. Some growers (11 per cent) also confirmed that they chose to adopt varietal diversification (using a range of varieties) to increase overall resistance to pests and environmental stresses (Figure 46).

Almost 30 per cent of respondents sowed catch or cover crops as part of their crop production cycle (Figure 47). These crops were cultivated to improve soil quality (18 per cent), to manage pests via biofumigation (seven per cent) and to provide habitat for beneficial organisms (four per cent).
Eighty two per cent of growers sampled reported that they adopted techniques to protect or enhance populations of beneficial insects. 46 per cent left uncultivated strips, 39 per cent planted pollen sources and almost a third planted wild flower strips. Other strategies included creation of ponds, hedges, woodland and beetle banks (Figure 48). In addition, a small number of respondents used push-pull strategies to manage pests by using trap crops and repellent treatments on the main crop. For example, growing mayweeds at the end of tunnels to provide a host for aphid predators.

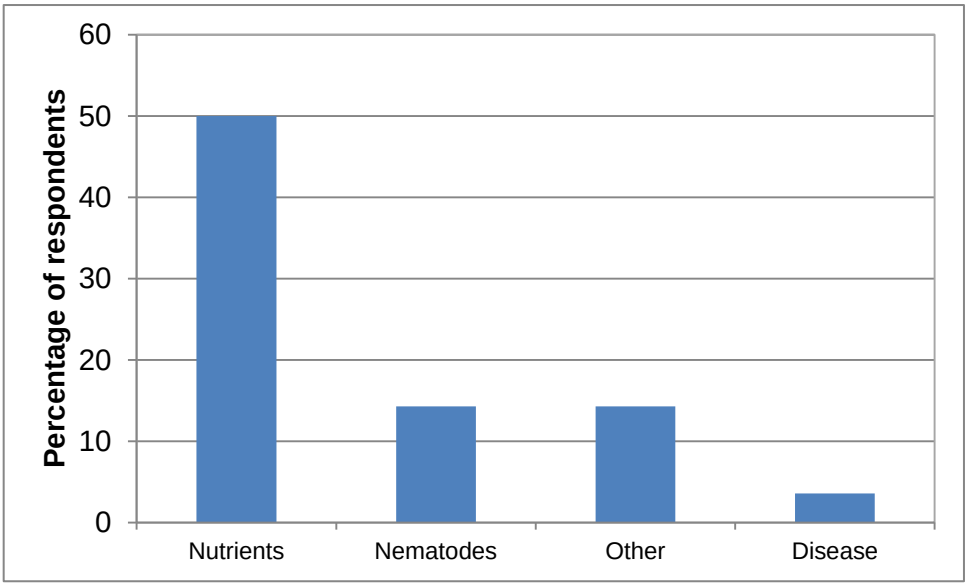
By controlling environmental factors growers can provide optimum growing conditions for plants which can enhance productivity and increase resilience to pests and disease. Almost a third of growers stated that they manipulated environmental factors to reduce pest risk (Figure 49), including ventilation (32 per cent), heating and humidity (both 11 per cent each).

Finally, 93 per cent of the growers sampled reported that they adopted good crop hygiene techniques to reduce risk (Figure 50). These included removal of diseased leaves or fruits (79 per cent), removal of debris between crops (71 per cent) and 43 per cent stated that they controlled risk by using healthy propagation material.

Table 50 Summary of responses to risk management questions - 2016

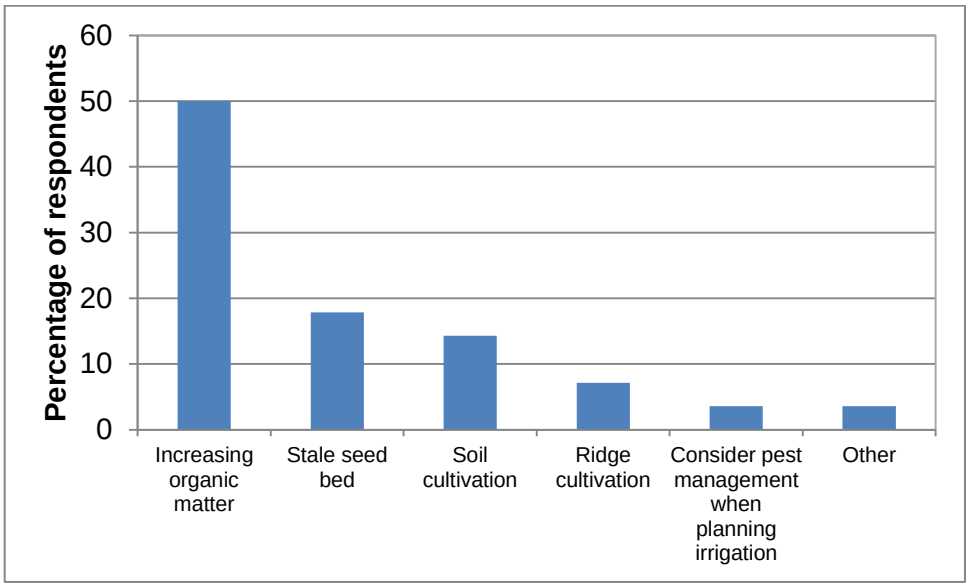
Risk management activity	Percentage yes response
Crop rotation	54
Soil testing	54
Cultivation of seed bed	61
Cultivations at sowing	39
Varietal or seed choice	57
Catch and cover cropping	29
Protection or enhancement of beneficial organism populations	82
Manipulation of environmental factors	32
Crop hygiene	93
Any risk management activity	**100**

Figure 43 Types of soil testing recorded (percentage of respondents) - 2016



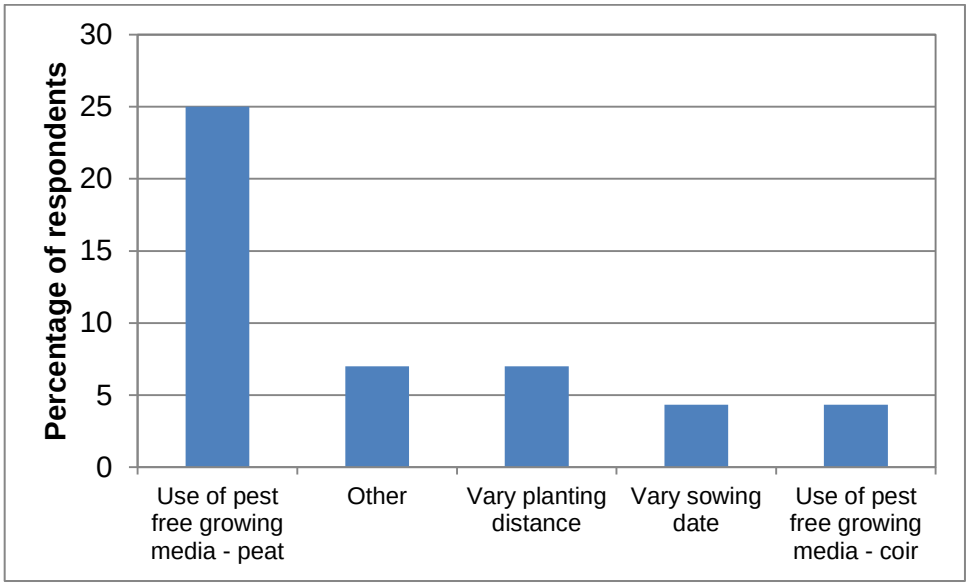
Note: 'other' includes pH

Figure 44 Methods of cultivating seed bed to reduce pest risk (percentage of respondents) - 2016



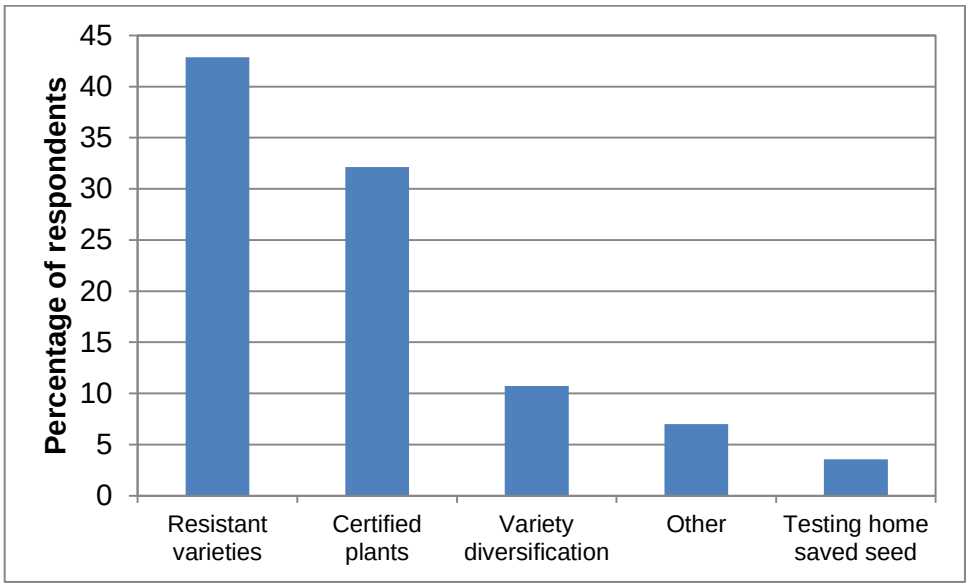
Note: 'other' includes use of raised beds

Figure 45 Methods of cultivating at sowing to reduce pest risk (percentage of respondents) - 2016



Note: 'other' included increasing planting depth and use of new soil in raised beds

Figure 46 Variety and seed choice to reduce pest risk (percentage of respondents) - 2016



Note: 'other' includes buying plants suitable for the region and buying plants from recommended organic supplier

Figure 47 Catch and cover cropping (percentage of respondents) - 2016

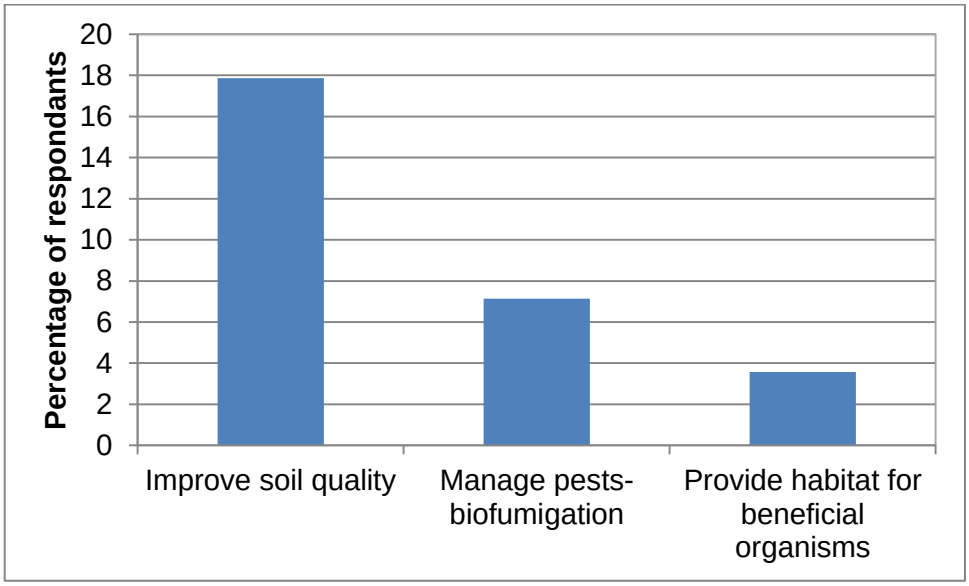
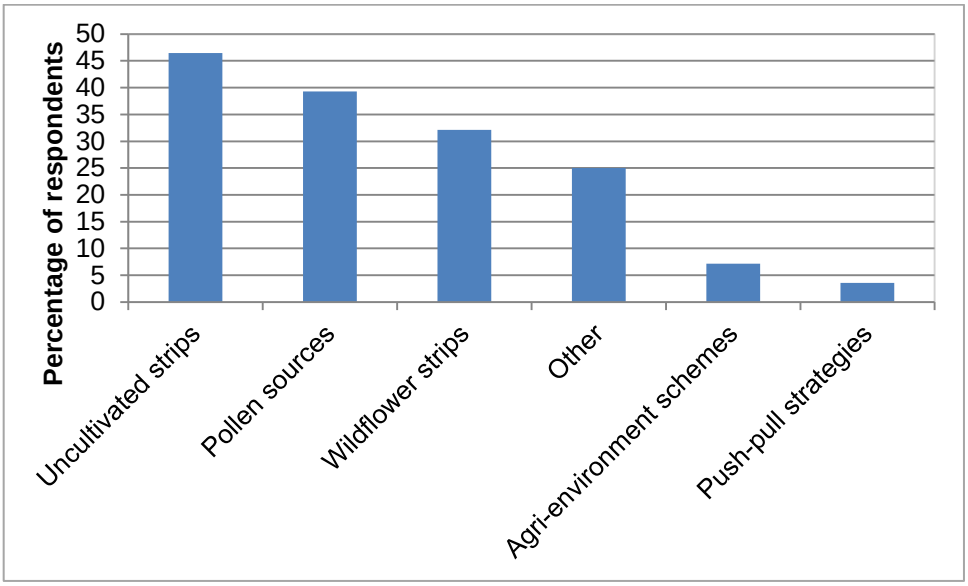


Figure 48 Methods for protecting and enhancing beneficial organism populations (percentage of respondents) - 2016



Note: 'other' includes, beetle banks, buffer zones, grass & water margins, hedges, ponds, woodlands and mown grass paths

Figure 49 Methods for manipulation of environmental factors to reduce pest risk (percentage of respondents) - 2016

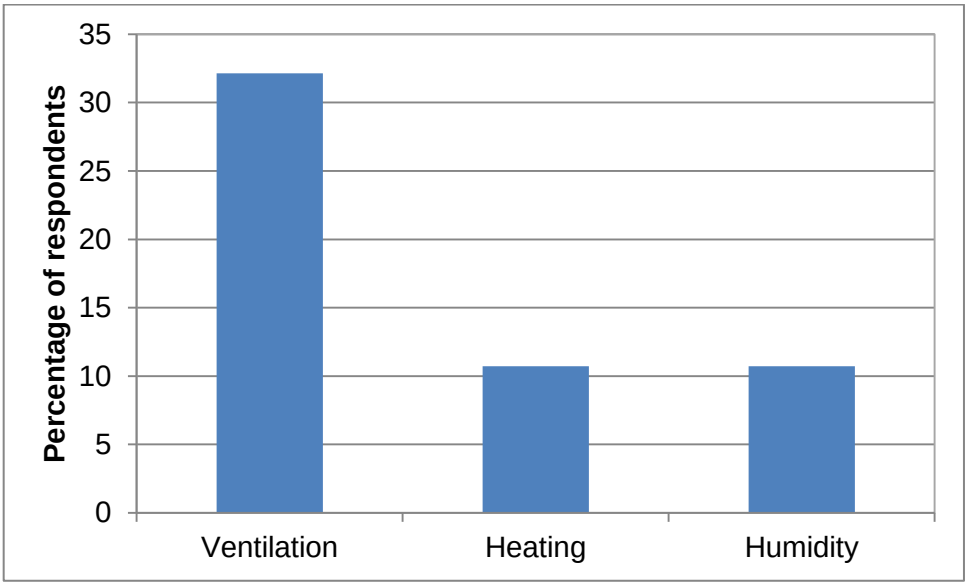
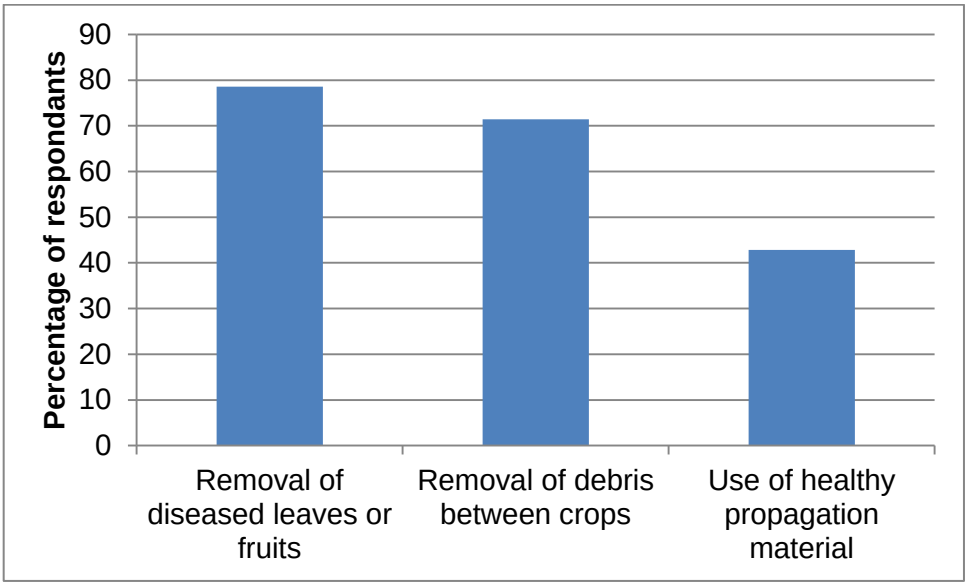


Figure 50 Types of crop hygiene practiced (percentage of respondents) -2016



Pest monitoring

In IPM, pests are monitored to determine whether control is economically justified and to effectively target control options. IPM programs aim to monitor and identify pests, so that appropriate control decisions can be made in conjunction with action thresholds. Table 51 presents an overview of the pest monitoring measures reportedly adopted by the growers surveyed. Eighty nine per cent of the growers sampled implemented one or more pest monitoring activity.

Seventy one per cent of growers stated that they regularly monitored crop growth stages and 86 per cent monitored and identified pests on their crops. Pest monitoring was conducted primarily by self-inspection (86 per cent) but also by use of BASIS qualified agronomists (18 per cent). Other methods included the use of pheromone and sticky traps (21 & four per cent respectively). In addition, some growers used risk warnings and technical bulletins to assess pest pressure (Figure 51).

Over a third (39 per cent) of respondents also reported that they used specialist diagnostics when dealing with pests that were more problematic to identify or monitor. Thirty six per cent used tissue testing to monitor nutritional deficiencies, 14 per cent used clinic services to identify unknown pests and seven per cent used field or pest mapping (Figure 52).

Table 51 Summary of responses to pest monitoring questions - 2016

Pest monitoring activity	Percentage yes response
Setting action thresholds for crops	32
Monitor and identify pests	86
Use of specialist diagnostics	39
Regular monitoring of crop growth stage	71
Any pest monitoring activity	**89**

Figure 51 Methods of monitoring and identifying pests (percentage of respondents) - 2016

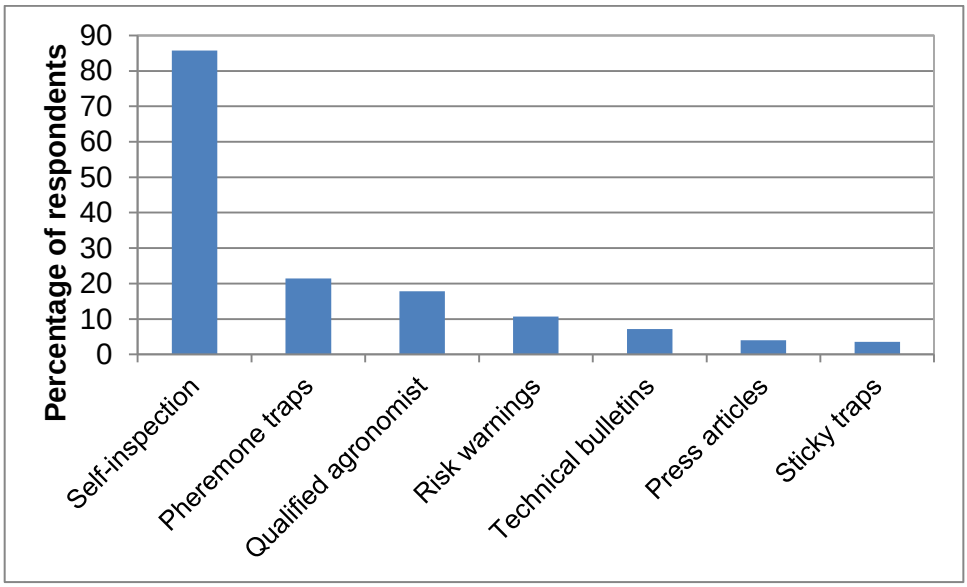
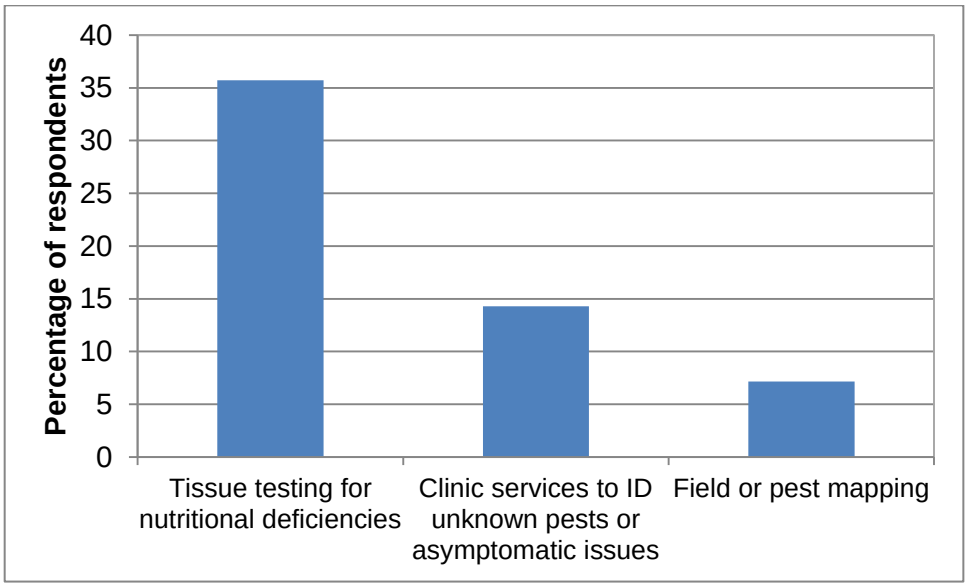


Figure 52 Use of specialist diagnostics (percentage of respondents) - 2016



Pest control

If monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs evaluate the best control method in relation to effectiveness and risk. Control programmes incorporate non-chemical methods alongside, or instead of, chemical control. Use of chemical pest control should be as targeted as possible and the risk of resistance development should be minimised. The effectiveness of the control programme should be reviewed regularly to gauge success and improve their regime as necessary. Table 52 presents an overview of the pest control measures reported by the growers surveyed. Ninety six per cent of growers adopted at least one IPM pest control activity.

Almost all of the growers (96 per cent) stated that they used non-chemical control in partnership or instead of chemical control. A range of control methods were adopted, including physical control measures such as mulches (39 per cent), netting (29 per cent) and fleece (four per cent). Other methods included mechanical weeding (79 per cent), use of biologicals, traps and pheromone mating disruption (Figure 53).

Almost half (46 per cent) of growers stated that they targeted their pesticide applications using monitoring data. Thirty six per cent used spot treatments and 21 per cent reduced their dosage or frequency of applications where possible. Other methods used to minimise pesticide use included drift reduction, weed wiping and use of precision application (Figure 54).

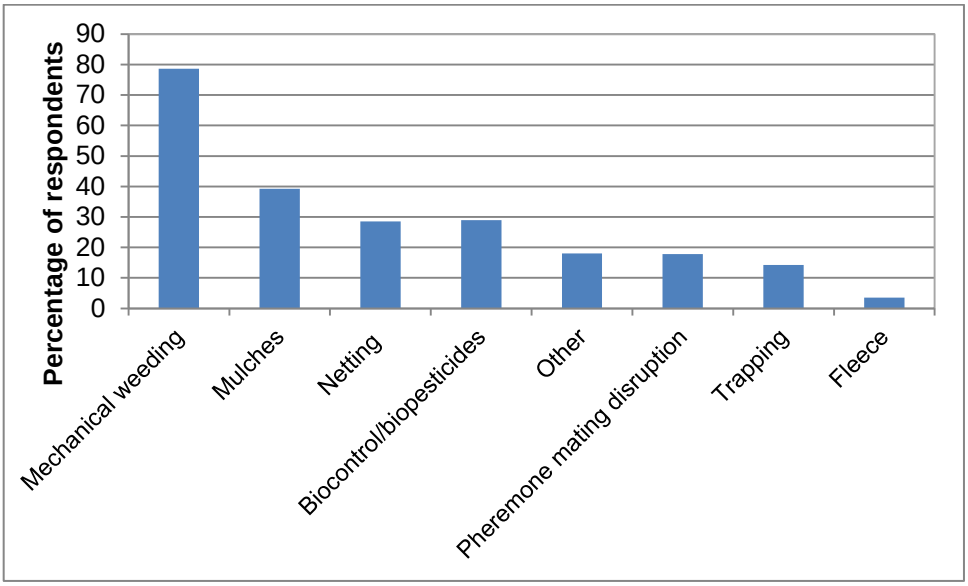
In addition, almost a third of growers stated that they followed anti-resistance strategies. These included 21 per cent minimising the number of applications, 14 per cent using multiple modes of action and 11 per cent using multi-site pesticides in their spray programmes (Figure 55).

Finally, 71 per cent of growers stated that they monitored the success of their crop protection measures. Over two thirds self-inspected control measure success and a quarter had a regular review by an agronomist. Growers also investigated poor pesticide efficiency and conducted a seasonal review of practice (Figure 56).

Table 52 Summary of responses to pest control questions - 2016

Pest control activity	**Percentage yes response**
Non-chemical control used in partnership or instead of chemical control	96
Targeted pesticide application	46
Follow anti-resistance strategies	32
Monitor success of crop protection measures	71
Any pest control activity	**96**

Figure 53 Types of non-chemical control used (percentage of respondents) - 2016



Note: 'other' includes manual control of pests such as caterpillars and slugs, glue bands on trees, copper bands round beds, ash, egg shell and shale to deter slugs and use of soapy water

Figure 54 Methods of targeting pesticide applications using monitoring data (percentage of respondents) - 2016

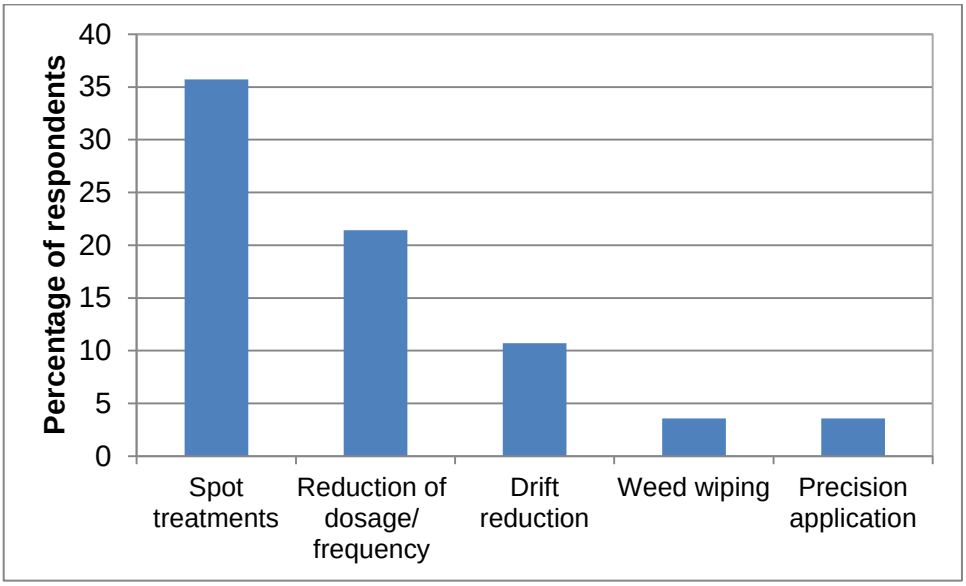
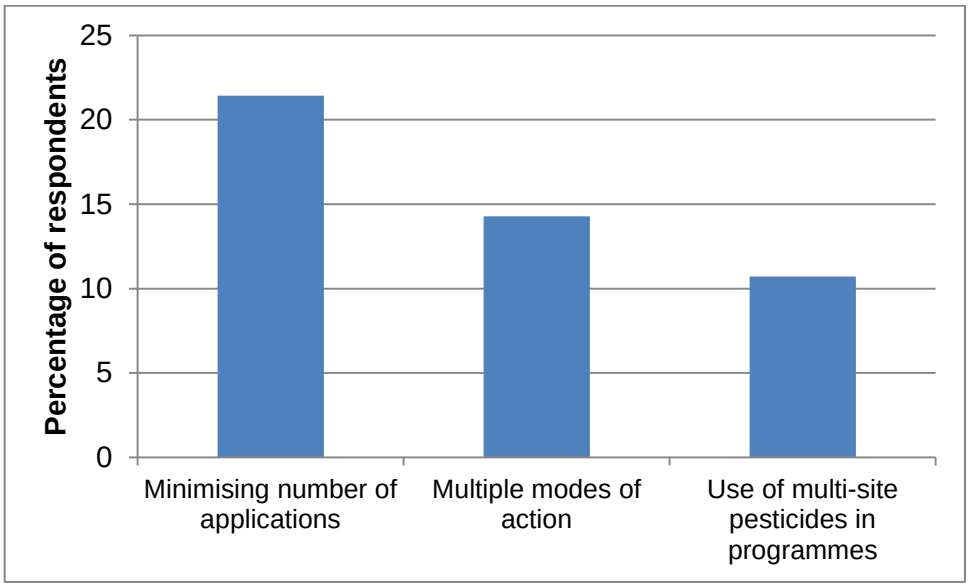
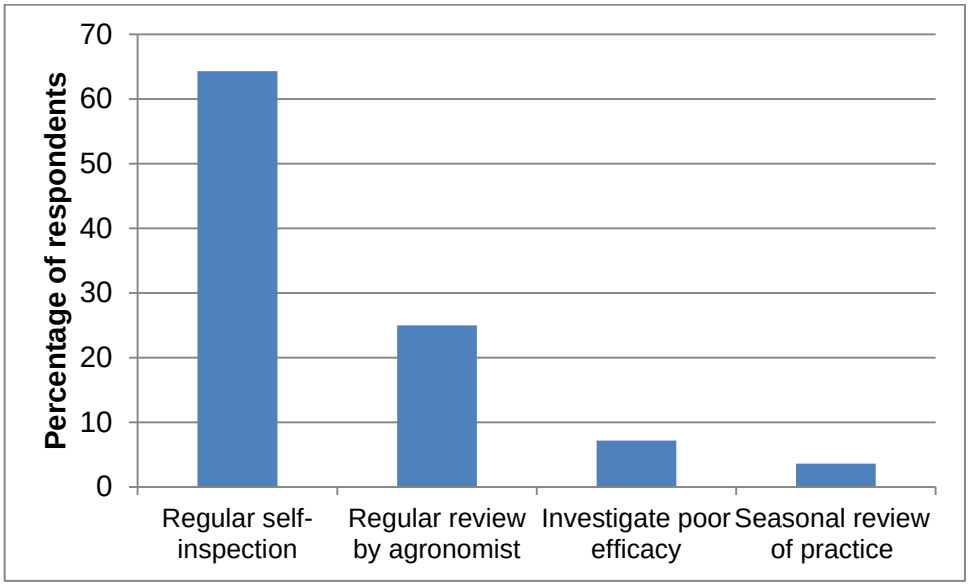


Figure 55 Types of anti-resistance strategies (percentage of respondents) - 2016



Note: multi-site pesticides each act on different metabolic sites within the target weed, fungus or insect pest, thus increasing their effectiveness.

Figure 56 Methods for monitoring success of crop protection measures (percentage of respondents) - 2016



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