

# Pesticide Usage in Scotland



A National Statistics Publication for Scotland



# Soft Fruit Crops 2018

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## Executive summary

This report presents information from a survey of pesticide use on soft fruit crops grown in Scotland in 2018. The crops surveyed included strawberries, raspberries, blackcurrants and other minor soft fruit crops.

The estimated area of soft fruit crops grown in Scotland in 2018 was 2,088 hectares, including 39 hectares of multi-cropping. Strawberries accounted for 56 per cent of the soft fruit area, other soft fruit crops 17 per cent, blackcurrants 14 per cent and raspberries 13 per cent. Data were collected from a total of 72 holdings, collectively representing 44 per cent of the total soft fruit crop area. Ratio raising was used to produce estimates of national pesticide use from the sampled data.

The estimated total area of soft fruit crops treated with a pesticide formulation (area grown multiplied by number of treatments) was ca. 31,800 hectares ( $\pm$  10 per cent Relative Standard Error, RSE) with a combined weight of ca. 17.4 tonnes ( $\pm$  13 per cent RSE). Overall, pesticides were applied to 93 per cent of the soft fruit crop area. Fungicides were applied to 90 per cent of the crop area, insecticides/acaricides to 88 per cent, herbicides to 45 per cent, biologicals to 40 per cent, molluscicides to 24 per cent and sulphur was applied to 23 per cent.

Taking into account changes in crop area, the 2018 total pesticide treated area was 10 per cent higher than that reported in 2016 and 26 per cent lower than in 2014. The weight of pesticides applied to soft fruit crops in 2018 was 18 per cent higher than in 2016 and 37 per cent lower than in 2014. The application of biopesticides, molluscicides, biological control agents, sulphur and fungicides increased from the 2016 survey (208, 152, 63, 25 and 10 per cent increases in treated area respectively). The application of herbicides/desiccants and insecticides/acaricides decreased (34 and 7 per cent decreases in treated area respectively).

Overall pesticide application to soft fruit crops was higher in 2018 than reported in 2016. However, the low pesticide use reported in 2016 was atypical in this data series, influenced by cool climatic conditions, lower pest pressure and a low survey response rate. Pesticide application in 2018 was lower than levels reported in 2014 and 2012.

In terms of area treated, the fungicide fenhexamid was the most commonly used active substance. *Bacillus subtilis* strain QST 713, thiacloprid and diquat were the most used biopesticide, insecticide/acaricide and herbicide/desiccant active substances respectively. Sulphur, which is used at high application rates, was the most commonly used pesticide by weight.

## Introduction

The Scottish Government (SG) is required by legislation<sup>(1)(2)</sup> to carry out post-approval surveillance of pesticide use. This is conducted by the Pesticide Survey Unit at SASA a division of the Scottish Government's Agriculture and Rural Delivery Directorate.

This survey is part of a series of annual reports which are produced to detail pesticide usage in Scotland for arable, vegetable and soft 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 [privacy](#) and [revision](#) policies, [user feedback](#) and detailed background information on survey [methodology](#) and [data uses](#).

Additional information regarding pesticide use can be supplied by the Pesticide Survey unit. Please email [psu@sasa.gov.scot](mailto:psu@sasa.gov.scot) 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 on recent changes in survey data and longer term trends. The pesticide usage section summarises usage on all soft fruit crops in 2018. Appendix 1 presents all estimated pesticide usage in three formats, area and weight of formulations by crop and area and weight of active substances grouped by their mode of action. The area and weight of active substances by crop data, which were previously published in this report, are now published as supplementary data in Excel format. 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 indication of the precision of estimates, the report includes relative standard errors. A full explanation of standard errors can be found in Appendix 5.

## **General trends**

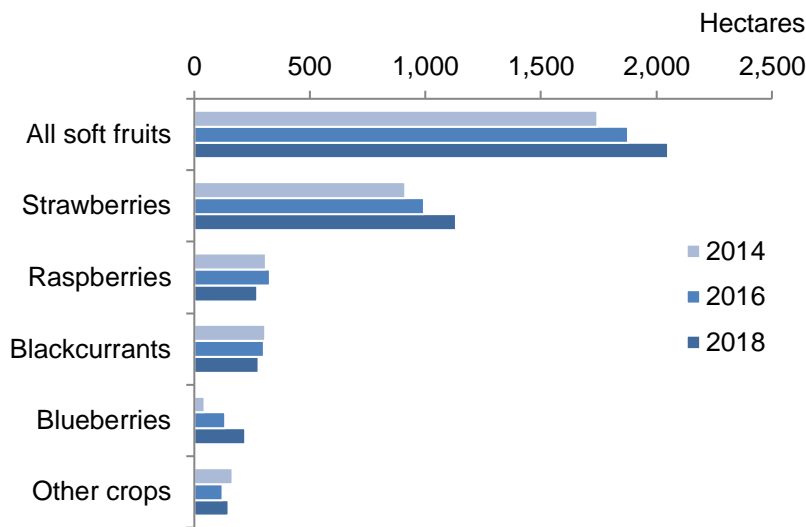
### **Crop area**

The census area of soft fruit crops grown in 2018 was 2,050 hectares (Table 24). This represents a nine per cent increase from 2016<sup>(3)</sup> and an 18 per cent increase from 2014<sup>(4)</sup>. Since the last survey, the areas of blueberries, mixed/other soft fruits and strawberries have increased (65, 21 and 14 per cent respectively); while the areas of raspberries and blackcurrants have decreased by 17 and eight per cent respectively (Figure 1).

In 2018, strawberries accounted for 56 per cent of the soft fruit area, raspberries 13 per cent, blackcurrants 14 per cent and other soft fruit crops (blueberries, blackberries, gooseberries, redcurrants and other minor crops) 17 per cent (Figure 2).

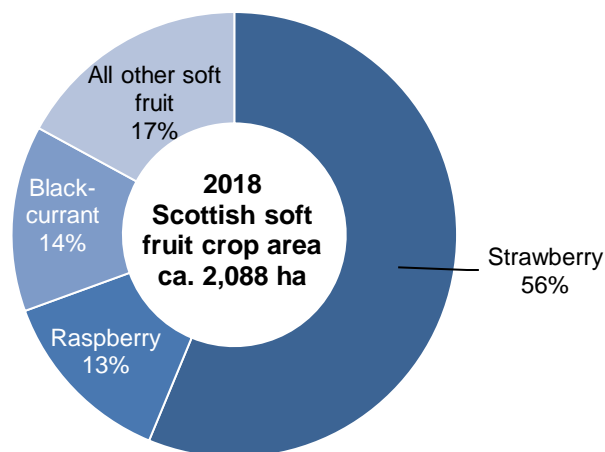


**Figure 1 Census area of soft fruit crops grown in Scotland 2014-2018**



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

**Figure 2 Soft fruit crop areas 2018 (percentage of total area)**



Note: areas include multi-cropping

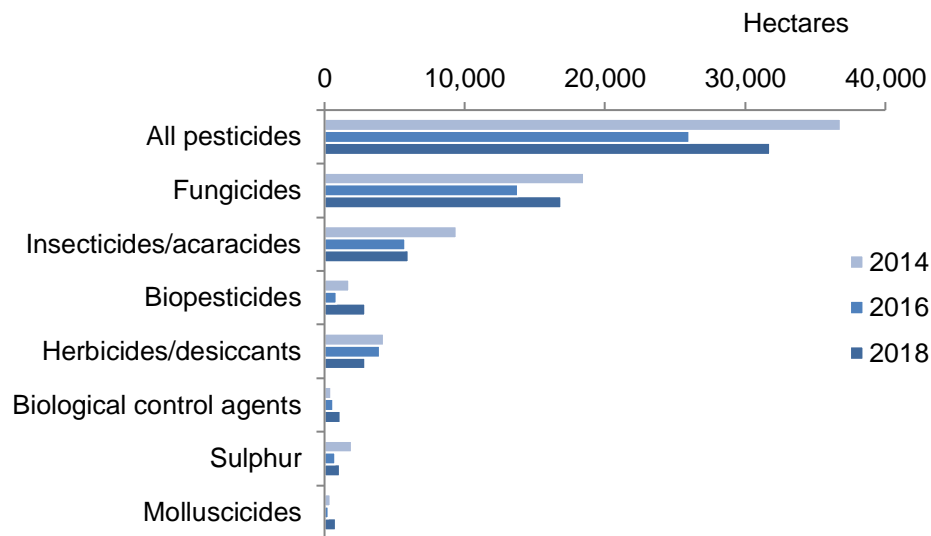
### Pesticide usage

The majority of soft fruit crops (93 per cent) received a pesticide treatment in 2018. Strawberries and blackcurrants had the highest overall proportion of crop treated with a pesticide (99 per cent, Table 1). Other soft fruit crops and raspberries were estimated to have lower proportions of treated crop (78 and 77 per cent respectively). In relation to the average number of pesticide applications, the treated area of soft fruit crops received on average 11.2 sprays, compared with 9.3 sprays in the previous survey. Strawberries received the highest number of applications with an average 14.5 sprays. In

contrast the all other soft fruit category received the lowest number of sprays, 5.3 on average (Table 1).

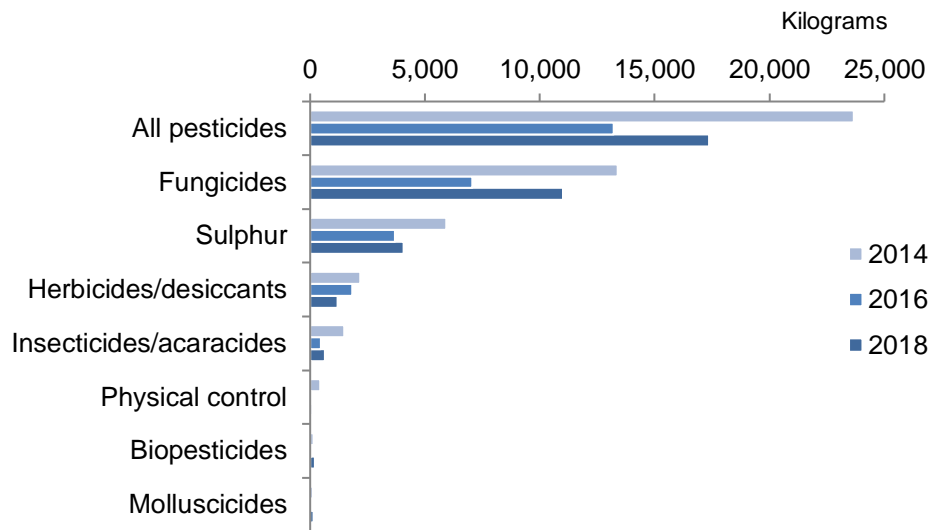
It is estimated that the area of soft fruit crops treated with a pesticide formulation in 2018 was ca. 31,800 hectares compared with 26,000 hectares in 2016 and ca. 36,800 hectares in 2014 (Table 23, Figure 3). This represents an increase of 22 per cent since 2016 and a decrease of 14 per cent since 2014.

**Figure 3 Area of soft fruit crops treated with the major pesticide groups in Scotland 2014-2018**



In terms of weight of pesticide applied, ca. 17.4 tonnes were applied in 2018, compared with ca. 13.2 tonnes in 2016 and ca. 23.7 tonnes in 2014 (Figure 4). This represents an increase of 31 per cent from 2016 and a decrease of 27 per cent from 2014.

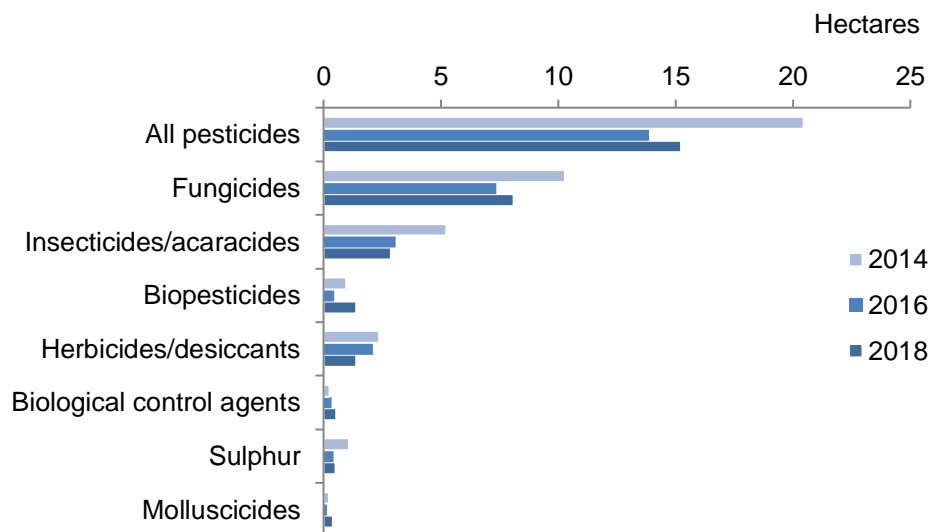
**Figure 4 Weight of the major pesticide groups applied to soft fruit crops in Scotland 2014-2018**



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

In order to make accurate comparisons between the 2018 data and that reported in previous surveys, it is important to take into account differences in crop areas between 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. In 2018, for each hectare of crop grown, around 15 treated hectares were recorded (Figure 5). This represents an increase of 10 per cent from 2016 and a decrease of 26 per cent from 2014.

**Figure 5 Number of pesticide treated hectares (formulations) per each hectare of crop grown**

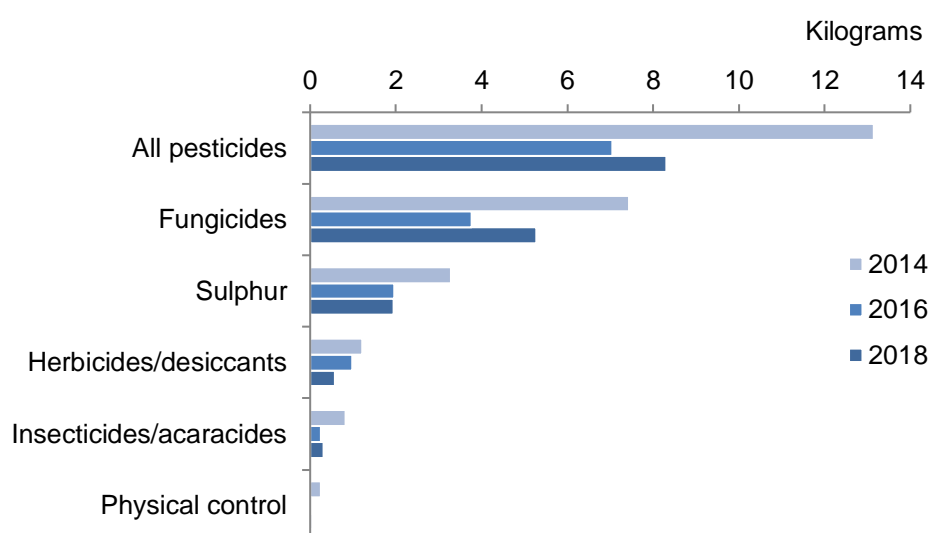


Note: physical control has been excluded as their use represents <0.1 treated hectares per hectare of crop grown.

The estimated weight of pesticide applied per hectare of crop grown was approximately eight kilograms (Figure 6). This represents an increase of 18 per cent from 2016 and a decrease of 37 per cent from 2014.

The lower pesticide use reported in 2016, mainly driven by lower fungicide use was atypical in this data series. The reduction in overall pesticide use in 2016 was influenced by the cool climatic conditions that year, leading to a lower pest pressure. However, as acknowledged in the 2016 report, it may also have been influenced by a low survey response rate in 2016, which affected sample size and distribution<sup>(3)</sup>. Therefore, although pesticide use in 2018 is greater than reported in 2016, overall it is lower than encountered in 2014 and 2012.

**Figure 6 Weight of pesticides applied per hectare of crop grown**



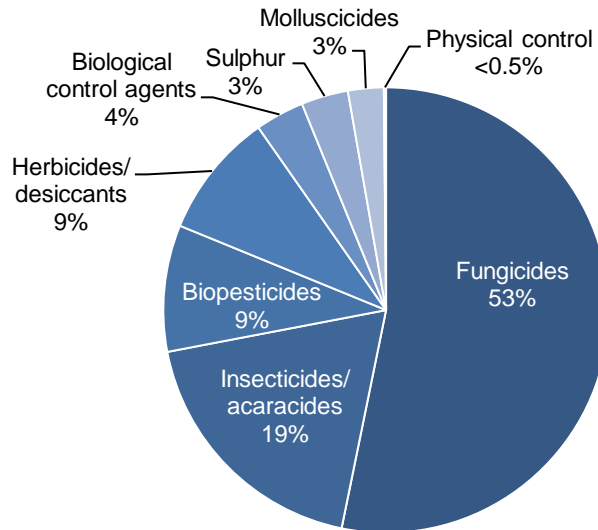
Note: molluscicides and biopesticides have been excluded as their use represents <0.1 kg per hectare of crop grown.

In 2018, fungicides were the most frequently used pesticides by area treated on soft fruit crops, followed by insecticides/acaricides, biopesticides and herbicides (Figure 7). Fungicides accounted for 53 per cent of the total pesticide treated area and 63 per cent of the total weight of pesticides applied (Figures 7 & 8). When changes in crop area are taken into account, the area treated with fungicide formulations increased by 10 per cent from 2016 to 2018 and decreased by 21 per cent from 2014 to 2018 (Figure 5). From 2016 to 2018, there was an increase of 40 per cent in the weight of fungicides used per hectare of crop grown and a decrease of 29 per cent from 2014 to 2018 (Figure 6).

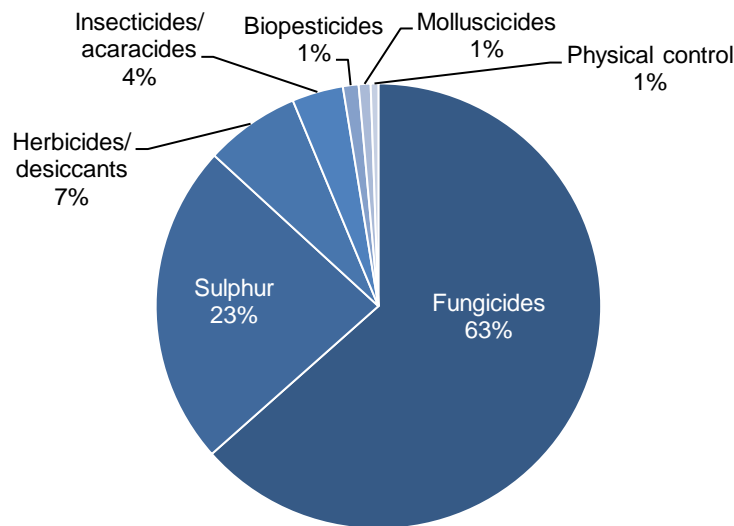
Sulphur accounted for three per cent of the total treated area and 23 per cent of the total weight of pesticides applied (Figures 7 & 8). When changes in area grown are taken into account, there was a 25 per cent increase in the use of sulphur between 2016 and 2018 and a 52 per cent decrease from 2014 to 2018 (Figure 5). The weight of sulphur applied per hectare of crop grown

decreased by one per cent from 2016 to 2018 and by 41 per cent from 2014 to 2018 (Figure 6). When crop area is taken into account, the mean applications of sulphur were 1.9 kg/ha in 2018, 2.0 kg/ha in 2016 and 3.3kg/ha in 2014. The majority of sulphur use encountered in the survey was on blackcurrants.

**Figure 7 Use of pesticides on soft fruit crops (percentage of total area treated with formulations) - 2018**



**Figure 8 Use of pesticides on soft fruit crops (percentage of total weight of pesticides applied) - 2018**



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

In 2018, insecticides and acaricides accounted for 19 per cent of the total pesticide treated area and four per cent of the total weight of pesticides

applied (Figures 7 & 8). When changes in crop area are taken into account, there is a seven per cent decrease from 2016 to 2018 and a 45 per cent decrease from 2014 to 2018 in the area treated with insecticide/acaricide formulations (Figure 5). In terms of weight of pesticide applied, when area of crop grown is taken into account, there is a 26 per cent increase from 2016 to 2018 and a 62 per cent decrease from 2014 to 2018 (Figure 6). This pattern of decreased treated area, but increased quantity applied from 2016 to 2018 may be explained by the use of fatty acids as an insecticide on protected strawberry crops in 2018. Fatty acids are applied at high rates and accounted for 36 per cent of the total weight of insecticides applied (Tables 2 & 23). No fatty acid use was recorded in 2016. The overall decrease in area treated with insecticides and acaricides may also have been influenced by increased use of alternative methods of insect control such as biological control agents.

Herbicides and desiccants accounted for nine per cent of the total pesticide treated area and seven per cent of the total weight of pesticides applied (Figures 7 & 8). When changes in crop area are taken into account, there is a decrease in area treated with herbicide and desiccant formulations of 34 per cent from 2016 and a decrease of 41 per cent from 2014 (Figure 5). In terms of weight of pesticide applied, when area of crop is taken into account, there is a decrease of 41 per cent from 2016 to 2018 and a decrease of 53 per cent from 2014 to 2018 (Figure 6). Decreases were recorded in key active substances. When corrected for area of crop grown, the glyphosate treated area decreased by 54 per cent from 2016 to 2018 and 16 per cent from 2014 to 2018. The area treated by diquat decreased by 35 per cent from 2016 to 2018 and by 56 per cent from 2014 to 2018. There was substantially less rainfall in winter, spring and summer of 2018 compared to 2016 and 2014, which may have resulted in reduced weed pressure<sup>(5)</sup>.

In 2018, biopesticides accounted for nine per cent of the total pesticide treated area and one per cent of the total weight of pesticides applied (Figures 7 & 8). When changes in crop area are taken into account, there is an increase of 208 per cent from 2016 to 2018 and an increase of 43 per cent from 2014 to 2018 in the area treated with biopesticide formulations (Figure 5). In terms of weight of pesticide applied, there is an increase of 153 per cent from 2016 to 2018 and an increase of 26 per cent from 2014 to 2018. Biopesticides were recorded on strawberry, raspberry and on other soft fruit crops. The majority of biopesticides were applied to strawberry crops for the control of mildew and botrytis.

Biological control agents accounted for four per cent of the total pesticide treated area. As biological control agents are applied by the number of organisms rather than the weight, no weight data are presented. When changes in crop area are taken into account, there is an increase of 63 per cent from 2016 to 2018 and an increase of 103 per cent from 2014 to 2018 in area treated. Biological control agents were used on strawberry, raspberry and other soft fruit crops. The largest proportion of biological control agent use was recorded on strawberry crops, targeting two-spotted spider mite. This represents a trend towards a significant increase in the use of

biopesticides and biological control agents for managing insect pests and disease in soft fruit crops as part of an integrated pest management system.

In 2018, molluscicides accounted for three per cent of the total pesticide treated area and one per cent of the total weight of pesticides applied (Figures 7 & 8). When changes in crop areas between years are taken into account, there is an increase in molluscicide applications per unit area of 152 per cent between 2016 and 2018 and an increase of 72 per cent between 2014 and 2018 (Figure 5). The weight of molluscicides applied per hectare of crop grown increased by 99 per cent from 2016 to 2018 and by 19 per cent from 2014 to 2018 (Figure 6). Molluscicide use varies significantly from year to year as slug populations are closely linked to climatic conditions.

Pesticides classified as physical control agents accounted for less than 0.5 per cent of the total pesticide treated area and one per cent of the total weight of pesticides applied (Figures 7 & 8). Physical control agents are substances that have a physical action against insect pests, for example by blocking insect spiracles and causing death by suffocation. Physical control was recorded on strawberry and raspberry crops and was mainly used for the control of aphids.

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. The use of the fungicide cyflufenamid has increased by 1,249 per cent in terms of area treated since 2016 (Table 21). The use of the biopesticide *Bacillus subtilis* strain QST 713 has increased by 129 per cent in terms of area treated and is now the second most commonly used active substance on soft fruit by area treated. The use of the fungicides fosetyl-aluminium, potassium hydrogen carbonate and pyrimethanil have increased by 266, 178 and 106 per cent respectively by quantity of active substance applied (Table 22). The fungicides trifloxystrobin, fluopyram, fenpyrazamine and proquinazid, the insecticide cyantranilprole and the herbicide clethodim were all recorded for the first time on soft fruit crops in 2018 (Table 17).



## 2018 Pesticide usage

### All strawberries (protected and non-protected crops)

- An estimated 1,175 hectares of strawberries were grown in Scotland in 2018. This consists of 30 ha of non-protected crops and 1,145 ha of protected crop
- 99 per cent of the crop was treated with a pesticide (see Figure 9 for types of pesticides used)
- Pesticide formulations were applied to 24,609 treated hectares with 11,671 kilograms of pesticide applied in total (see summary table)
- Strawberry crops received on average 14.5 applications (Table 1). These included 8.6 fungicide applications and 3.1 insecticide applications (applied to 99 and 97 per cent of the crop area) They also received on average 4.0 biological, 1.6 herbicide/desiccant, 1.7 molluscicide and 2.6 sulphur applications (applied to 68, 44, 39 and 18 per cent respectively)
- Timings of pesticide applications are shown in Figure 10
- Reasons for fungicide use were supplied for 59 per cent of total use; 29 per cent for control of mildew, 28 per cent for control of botrytis, one per cent for red core and root rot and under one per cent for general disease control, crown rot, brown rot, soft rot and rust. The only reasons specified for herbicide/desiccant use were general weed control (11 per cent) and annual meadow grass and crop destruction (under 0.5 per cent)
- Reasons were supplied for 70 per cent of insecticide use; 26 per cent for the control of aphids, 17 per cent for the control of two-spotted spider mites, 12 per cent for caterpillar control, seven per cent for thrips, three per cent for tarsonemid mites, two per cent for vine weevil and capsid control and one per cent for spotted wing drosophila control. Pollen beetle and whitefly control accounted for under 0.5 per cent of use
- Reasons for the use of biological control agents were supplied for 88 per cent of use; 52 per cent was for two-spotted spider mite, 22 per cent for aphids, 13 per cent for vine weevil and <0.5 per cent for thrips. Reasons for the use of biopesticides were supplied for 75 per cent of use; 36 per cent for the control of botrytis, 34 per cent for mildew control, three per cent for two-spotted spider mite and two per cent for thrips control. The only reasons supplied for the use of physical control were aphid and two-spotted spider mite control, each accounting for 12 per cent of use.
- The most common varieties encountered were Sonata and Malling Centenary, accounting for 39 and 20 per cent of the sample area respectively

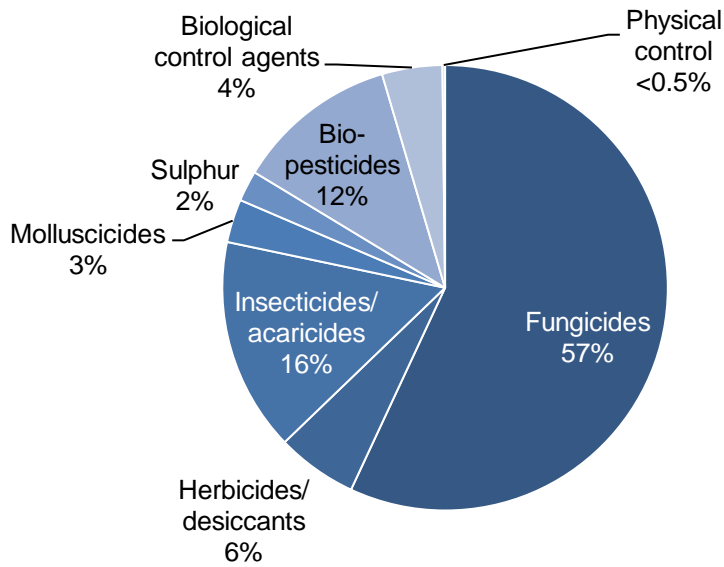
- 10 per cent of strawberries encountered in the sample were under one year old, 38 per cent were between one and two years old, 9 per cent were over two years old with the remainder unknown
- 73 per cent of the crop sampled was grown in a raised or table top system. 45 per cent of the crop sampled was grown in soil, with the remainder being grown in bags or troughs.
- 77 per cent of the crop sampled was grown using a ground mulch or straw
- 98 per cent of the crop sampled was grown under protection, of this 57 per cent was in permanent tunnels and 43 per cent was in temporary tunnels
- Pollinators were used on 94 per cent of the strawberry crop sampled; pollinators were not used on one per cent and the remainder was unknown. Of the sampled area using pollinators, 76 per cent used bumble bees, 21 per cent used honey bees, two per cent used both bumble bees and honey bees and the remainder used blow flies
- All of the strawberry crops surveyed were harvested in 2018. 98 per cent were for fresh market, one per cent for pick-your-own and one per cent for processing

Summary of pesticide use on all strawberries:

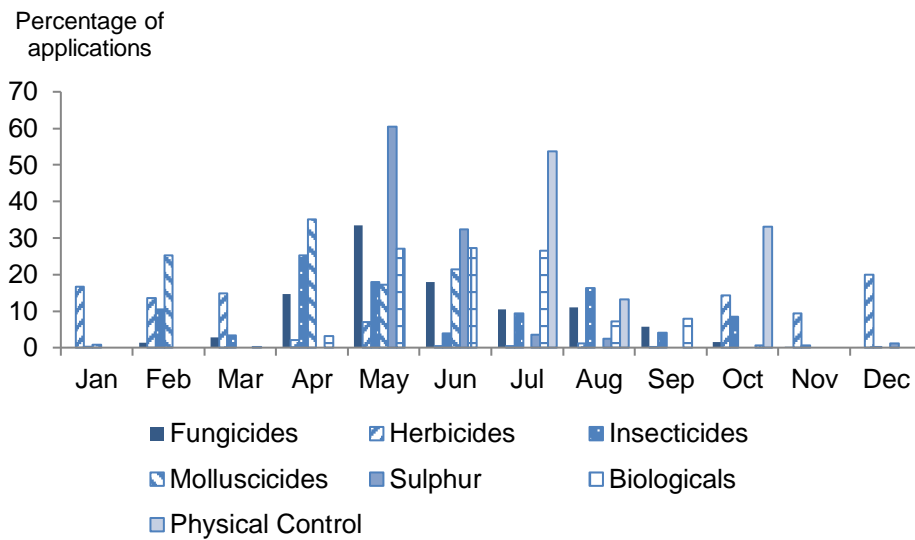
| Pesticide group           | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations                                |
|---------------------------|--------------------------|------------------------------|----------------------------|---|
|                           | ha                       | kg                           | %                          | ha  |
| Fungicides                | 14,012                   | 9,523                        | 99                         | Fenhexamid (1,905), Fluopyram/trifloxystrobin (1,714) |
| Herbicides/ desiccants    | 1,443                    | 573                          | 44                         | Diquat (625)  |
| Insecticides/ acaricides  | 3,814                    | 490                          | 97                         | Thiacloprid (823), Lambda-cyhalothrin (765)           |
| Molluscicides             | 773                      | 146                          | 39                         | Metaldehyde (412), Ferric phosphate (361)             |
| Sulphur                   | 549                      | 657                          | 18                         | N/A   |
| Biopesticides             | 2,895                    | 193                          |                            | <i>Bacillus subtilis</i> strain QST 713 (1,883)       |
| Biological control agents | 1,078                    | N/A                          |                            | <i>Phytoseiulus persimilis</i> (563)                  |
| Physical control          | 46                       | 90                           | 3                          | Carbonic acid diamide/urea (46)                       |
| <b>All pesticides</b>     | <b>24,609</b>            | <b>11,671</b>                | <b>99</b>                  |   |

N/A = not applicable

**Figure 9 Use of pesticides on all strawberry crops (percentage of total area treated with formulations) – 2018**



**Figure 10 Timings of pesticide applications on all strawberries – 2018**



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

## Non-protected strawberries

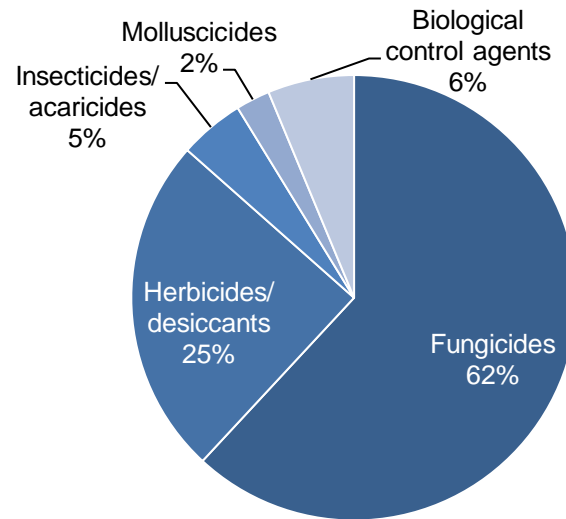
- An estimated 30 hectares of non-protected strawberry were grown in Scotland in 2018. This included an estimated three hectares recorded in the mixed and other soft fruit section of the census
- 72 per cent of the crop was treated with a pesticide (see Figure 11 for types of pesticides used)
- Pesticide formulations were applied to 237 treated hectares with 82 kilograms of pesticide applied in total (see summary table below)
- The 72 per cent of non-protected strawberry crop treated with a pesticide received on average 8.0 spray applications (Table 1). These included 4.7 fungicide applications, 2.8 herbicide/desiccant applications, 2.0 biological applications, one insecticide and one molluscicide application (applied to 71, 52, 25, 38 and 20 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 12
- The most common variety encountered was Symphony, accounting for 50 per cent of the sample area surveyed

Summary of pesticide use on non-protected strawberries:

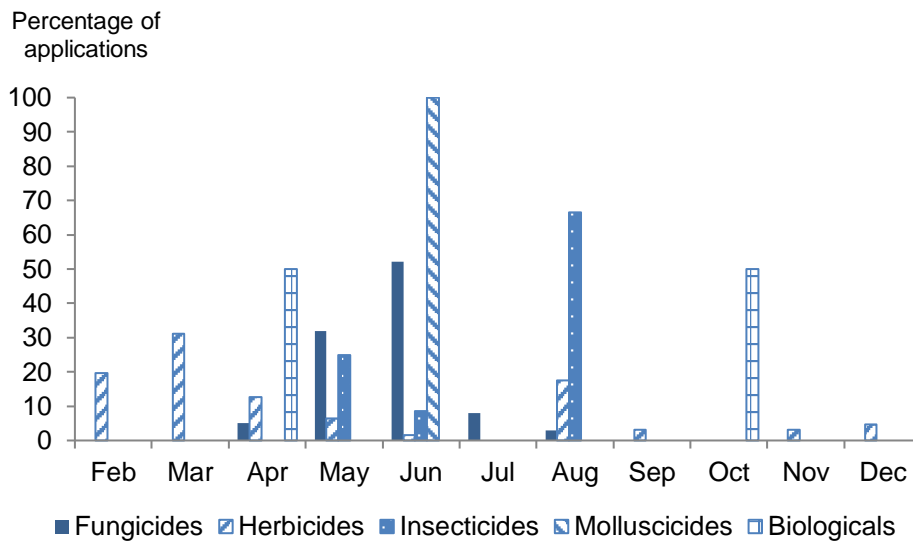
| Pesticide group           | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations          |
|---------------------------|--------------------------|------------------------------|----------------------------|---------------------------------|
|                           | ha                       | kg                           | %                          | ha                              |
| Fungicides                | 147                      | 59                           | 71                         | Fenhexamid (43)                 |
| Herbicides/desiccants     | 58                       | 21                           | 52                         | Diquat (21)                     |
| Insecticides/acaricides   | 11                       | <0.5                         | 38                         | Lambda-cyhalothrin (11)         |
| Molluscicides             | 6                        | 1                            | 20                         | Ferric phosphate (6)            |
| Biological control agents | 15                       | N/A                          |                            | <i>Steinernema feltiae</i> (15) |
| <b>All pesticides</b>     | <b>237</b>               | <b>82</b>                    | <b>72</b>                  |                                 |

N/A = not applicable

**Figure 11 Use of pesticides on non-protected strawberries (percentage of total area treated with formulations) – 2018**



**Figure 12 Timings of pesticide applications on non-protected strawberries – 2018**



Note: Insecticides include acaricides and herbicides include desiccants

## Protected strawberries

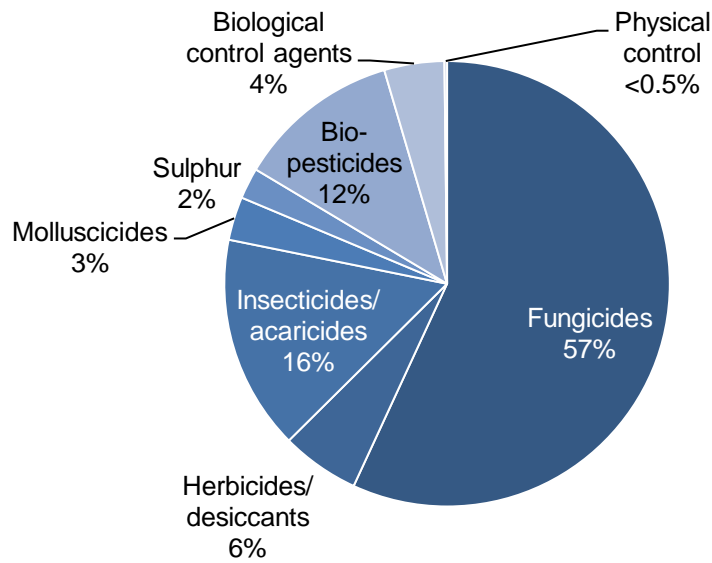
- An estimated 1,145 hectares of protected strawberry were grown in Scotland in 2018, including 39 hectares of multi-cropping. Based on the ratio encountered in the sample, it is estimated that 65 per cent of the crop was semi-protected (grown under temporary tunnels) and 35 per cent permanently protected (grown in permanent tunnels or glasshouses)
- All of the crop was treated with a pesticide (see Figure 13 for types of pesticides used)
- Pesticide formulations were applied to 24,372 treated hectares with 11,590 kilograms of pesticides applied in total (see summary table below)
- Protected strawberry crops received on average 14.6 pesticide applications (Table 1). These included 8.7 fungicide applications, 4.1 biological applications, 3.1 insecticide applications, 2.6 sulphur applications, 1.7 molluscicide applications and 1.5 herbicide/desiccant applications (applied to 100, 69, 99, 18, 39 and 44 per cent of the crop respectively)
- The timing of pesticide applications is shown in Figure 14
- The most common varieties encountered were Sonata and Malling Centenary, accounting for 39 per cent and 20 per cent of the sample area respectively

Summary of pesticide use on protected strawberries:

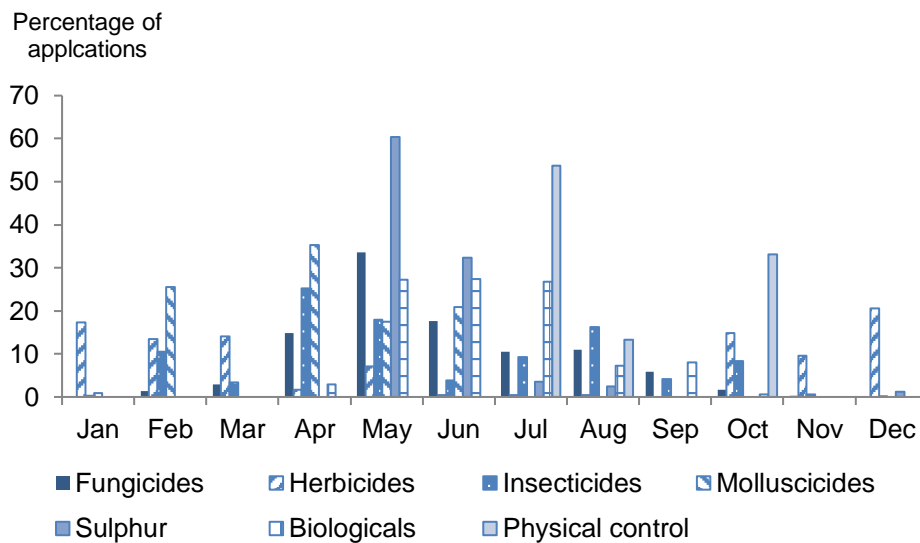
| Pesticide group           | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations                                |
|---------------------------|--------------------------|------------------------------|----------------------------|---|
|                           | ha                       | kg                           | %                          | ha  |
| Fungicides                | 13,865                   | 9,464                        | 100                        | Fenhexamid (1,862), Fluopyram/trifloxystrobin (1,714) |
| Herbicides/desiccants     | 1,385                    | 552                          | 44                         | Diquat (604)  |
| Insecticides/acaricides   | 3,803                    | 490                          | 99                         | Thiacloprid (823), Lambda-cyhalothrin (754)           |
| Molluscicides             | 767                      | 145                          | 39                         | Metaldehyde (412), Ferric phosphate (355)             |
| Sulphur                   | 549                      | 657                          | 18                         | N/A   |
| Biopesticides             | 2,895                    | 193                          |                            | <i>Bacillus subtilis</i> strain QST 713 (1,883)       |
| Biological control agents | 1,063                    | N/A                          |                            | <i>Phytoseiulus persimilis</i> (563)                  |
| Physical control          | 46                       | 90                           | 3                          | Carbonic acid diamide/urea (46)                       |
| <b>All pesticides</b>     | <b>24,372</b>            | <b>11,590</b>                | <b>100</b>                 |   |

N/A = not applicable

**Figure 13 Use of pesticides on protected strawberries (percentage of total area treated with formulations) – 2018**



**Figure 14 Timings of pesticide applications on protected strawberries – 2018**



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



## All raspberries (protected and non-protected crops)

- An estimated 276 hectares of raspberries were grown in Scotland in 2018. This consists of 113 hectares of non-protected crops and 162 hectares of protected crop
- 77 per cent of the crop was treated with a pesticide (See Figure 15 for the types of pesticides used)
- Pesticide formulations were applied to 2,005 treated hectares with 765 kilograms of pesticides applied in total (see summary table)
- The 77 per cent of raspberry crop treated with a pesticide received on average 7.1 pesticide sprays (Table 1). These included 4.4 fungicide applications, 2.6 insecticide applications, and 1.9 herbicide/desiccant applications (applied to 75, 68 and 48 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 16
- Reasons for fungicide applications were supplied for 57 per cent of total use; 41 per cent was for control of botrytis, five per cent for general disease control, four per cent for cane diseases, three per cent for mildew, two per cent for rust and one per cent for brown rot and root rot
- Reasons for herbicide/desiccant applications on raspberries were supplied for 39 per cent of use; 20 per cent was for general weed control and six per cent for annual grass weeds. Sucker control, annual meadow grass and annual broad-leaved weeds each accounted for four per cent of use; crop destruction accounted for one per cent of use
- Reasons were supplied for 57 per cent of insecticide use; 31 per cent was for aphid control, 11 per cent for two-spotted spider mite, five per cent for raspberry beetle, four per cent for raspberry cane midge, three per cent for caterpillars, two per cent for thrips and one per cent for leaf curling midge
- No reasons were supplied for the use of biological control agents. Reasons were supplied for 39 per cent of biopesticide use; 21 per cent was for two-spotted spider mite and 18 per cent for caterpillar control. All use of physical control was for the control of aphids
- The most common variety encountered was Driscoll Maravilla, accounting for 17 per cent of the sample area
- 28 per cent of the raspberries encountered in the sample were under two years old, 45 per cent were between two and five years old and seven per cent were over five years old. The age of the remainder was unknown
- 55 per cent of the crop sampled was grown in pots and 45 per cent was grown directly in the soil
- 37 per cent of the crop encountered was grown using a ground mulch

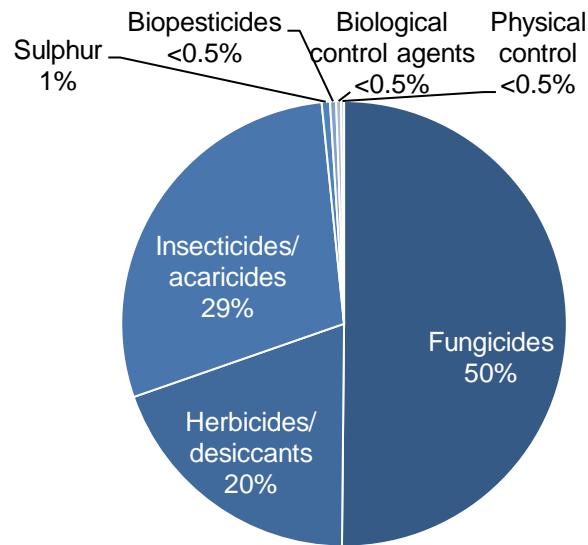
- 17 per cent of the raspberry crop sampled was grown outdoors, 39 per cent were in temporary tunnels and 43 per cent was grown under permanent tunnels
- Pollinators were used on 77 per cent of the raspberry crops surveyed; five per cent used no pollinators with the remainder unknown. Of the sampled area using pollinators, 74 per cent were bumble bees, eight per cent were honey bees and 18 per cent used both bumble bees and honey bees
- 98 per cent of the raspberry crops surveyed were harvested in 2018. 86 per cent were for fresh market, eight per cent for processing and six per cent for pick-your-own

Summary of pesticide use on all raspberries:

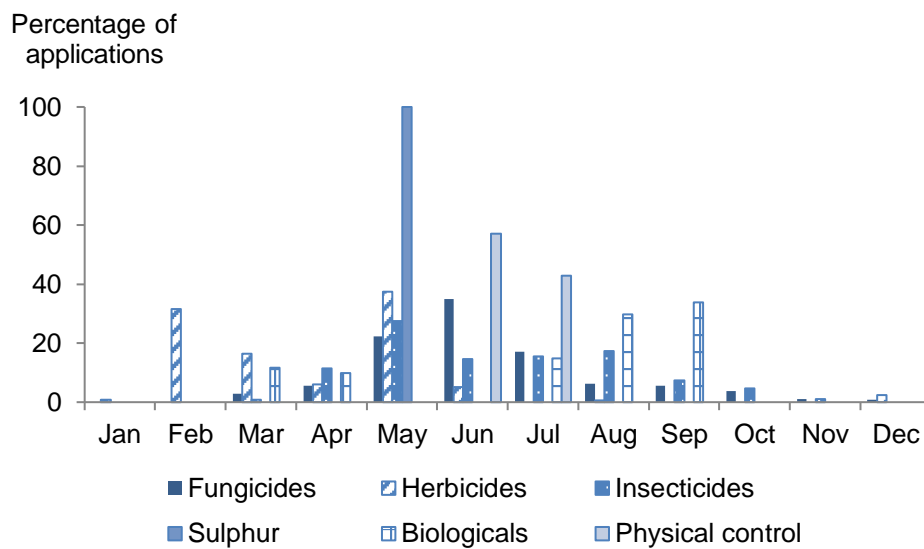
| Pesticide group              | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations                               |
|------------------------------|--------------------------|------------------------------|----------------------------|--|
|                              | ha                       | kg                           | %                          | ha   |
| Fungicides                   | 1,005                    | 566                          | 75                         | Fenhexamid (349)                                     |
| Herbicides/<br>desiccants    | 391                      | 107                          | 48                         | Diquat (136),<br>Carfentrazone-ethyl (107)           |
| Insecticides/<br>acaricides  | 576                      | 34                           | 68                         | Thiacloprid (197),<br>Abamectin (184)                |
| Sulphur                      | 12                       | 47                           | 4                          | N/A  |
| Biopesticides                | 9                        | 3                            |                            | <i>Bacillus amyloliquefaciens</i><br>strain D747 (5) |
| Biological<br>control agents | 7                        | N/A                          |                            | <i>Steinernema kraussei</i> (5)                      |
| Physical control             | 4                        | 7                            | 2                          | Carbonic acid<br>diamide/urea (4)                    |
| <b>All pesticides</b>        | <b>2,005</b>             | <b>765</b>                   | <b>77</b>                  |  |

N/A = not applicable

**Figure 15 Use of pesticides on all raspberries (percentage of total area treated with formulations) – 2018**



**Figure 16 Timings of pesticide applications on all raspberries – 2018**



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

## Non-protected raspberries

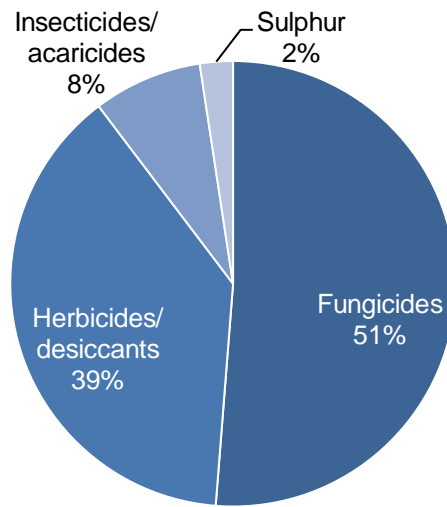
- An estimated 113 hectares of non-protected raspberries were grown in Scotland in 2018. This included an estimated four hectares recorded in the mixed and other crop category in the census
- 44 per cent of the crop was treated with a pesticide (see Figure 17 for types of pesticides used)
- Pesticide formulations were applied to 501 treated hectares with 199 kilograms of pesticide applied in total (see summary table below)
- The 44 per cent of the non-protected raspberry crop treated with a pesticide received on average 6.0 pesticide sprays (Table 1). These included 3.7 fungicide applications, 2.4 herbicide/desiccant applications, 1.3 insecticide applications and 1.0 sulphur applications (applied to 40, 44, 27 and 10 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 18
- Glen Ericht was the most common variety encountered, accounting for 40 per cent of the area sampled

Summary of pesticide use on non-protected raspberries:

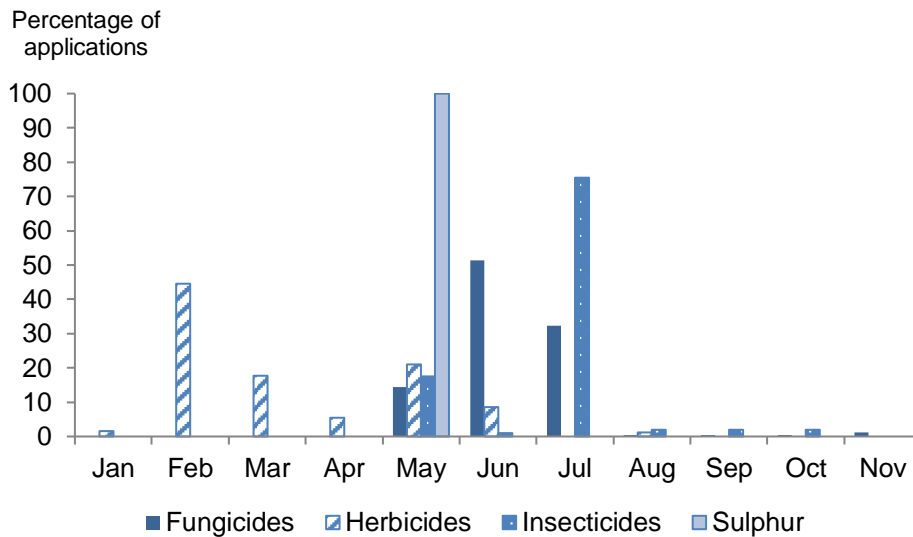
| Pesticide group         | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations     |
|-------------------------|--------------------------|------------------------------|----------------------------|----------------------------|
|                         | ha                       | kg                           | %                          | ha                         |
| Fungicides              | 257                      | 106                          | 40                         | Fenhexamid (119)           |
| Herbicides/desiccants   | 193                      | 43                           | 44                         | Diquat (59), Isoxaben (50) |
| Insecticides/acaricides | 40                       | 3                            | 27                         | Thiacloprid (23)           |
| Sulphur                 | 12                       | 47                           | 10                         | N/A                        |
| <b>All pesticides</b>   | <b>501</b>               | <b>199</b>                   | <b>44</b>                  |                            |

N/A = not applicable

**Figure 17 Use of pesticides on non-protected raspberries (percentage of total area treated with formulations) – 2018**



**Figure 18 Timings of pesticide applications on non-protected raspberries – 2018**



Note: Insecticides include acaricides and herbicides include desiccants

## Protected raspberries

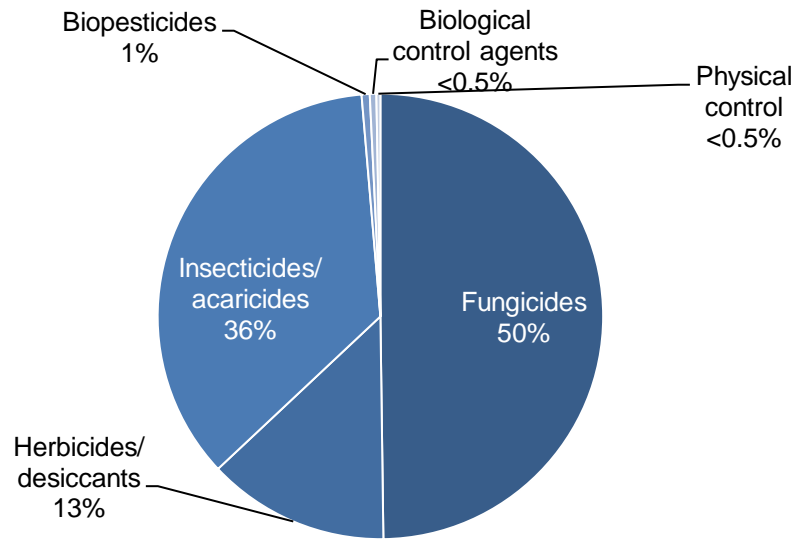
- An estimated 162 hectares of protected raspberries were grown in Scotland in 2018. Based on the ratio encountered in the sample, it is estimated that 47 per cent of the crop was semi-protected (grown under temporary tunnels) and 53 per cent was permanently protected (grown in permanent tunnels or glasshouses)
- All of the crop was treated with a pesticide (see Figure 19 for types of pesticides used)
- Pesticide formulations were applied to 1,504 treated hectares with 566 kilograms of pesticides applied in total (see summary table below)
- The protected raspberry crop received on average 7.4 pesticide applications (Table 1). These included 4.6 fungicide applications, 2.9 insecticide applications and 1.6 herbicide/desiccant applications (applied to 99, 96 and 51 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 20
- The most common variety encountered was Driscoll Maravilla, accounting for 20 per cent of the sample area

Summary of pesticide use on protected raspberries:

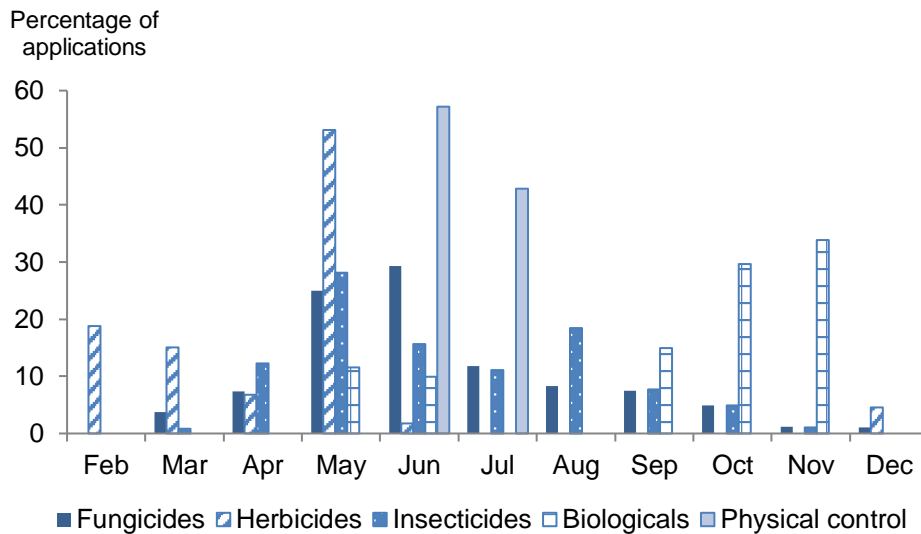
| Pesticide group           | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations                            |
|---------------------------|--------------------------|------------------------------|----------------------------|---|
|                           | ha                       | kg                           | %                          | ha  |
| Fungicides                | 749                      | 461                          | 99                         | Fenhexamid (231)                                  |
| Herbicides/desiccants     | 199                      | 64                           | 51                         | Carfentrazone-ethyl (83), Diquat (76)             |
| Insecticides/acaricides   | 536                      | 31                           | 96                         | Abamectin (184), Thiacloprid (174)                |
| Biopesticides             | 9                        | 3                            |                            | <i>Bacillus amyloliquefaciens</i> strain D747 (5) |
| Biological control agents | 7                        | N/A                          |                            | <i>Steinernema kraussei</i> (5)                   |
| Physical control          | 4                        | 7                            | 3                          | Carbonic acid diamide/urea (4)                    |
| <b>All pesticides</b>     | <b>1,504</b>             | <b>566</b>                   | <b>100</b>                 |   |

N/A = not applicable

**Figure 19 Use of pesticides on protected raspberries (percentage of total area treated with formulations) – 2018**



**Figure 20 Timings of pesticide applications on protected raspberries – 2018**



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



## Blackcurrants

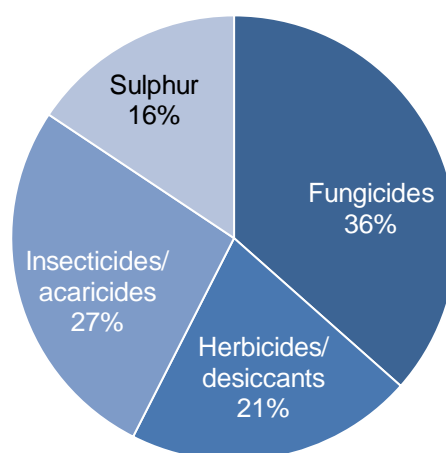
- The total estimated area of blackcurrants grown in Scotland in 2018 was 282 hectares. This includes three hectares which were included in the mixed and other soft fruit census category
- 99 per cent of the crop was treated with a pesticide (see Figure 21 for types of pesticides used)
- Pesticide formulations were applied to 3,335 treated hectares with 4,333 kilograms of pesticide applied in total (see summary table below)
- The 99 per cent of blackcurrant crop treated with a pesticide received on average 6.6 pesticide applications (Table 1). These included 3.9 fungicide applications, 2.6 insecticide applications, 2.0 sulphur applications and 1.5 herbicide/desiccant applications (applied to 97, 98, 91 and 63 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 22
- 40 per cent of herbicide/desiccant use was for general weed control, with the remainder unknown. Reasons were provided for less than one per cent of fungicide and insecticide use
- The most common variety encountered was Ben Kilbreck, accounting for 43 per cent of the area sampled
- 42 per cent of blackcurrants encountered were five years old or less, one per cent were between six and 10 years old and under one per cent were older than 10 years with the remainder unknown
- All of the blackcurrant crops sampled were grown in the soil without protection
- 99 per cent of the blackcurrant crops surveyed were harvested in 2018
- 99 per cent of the blackcurrant crops harvested were for processing, and under one per cent for fresh market and pick-your-own

Summary of pesticide use on blackcurrants:

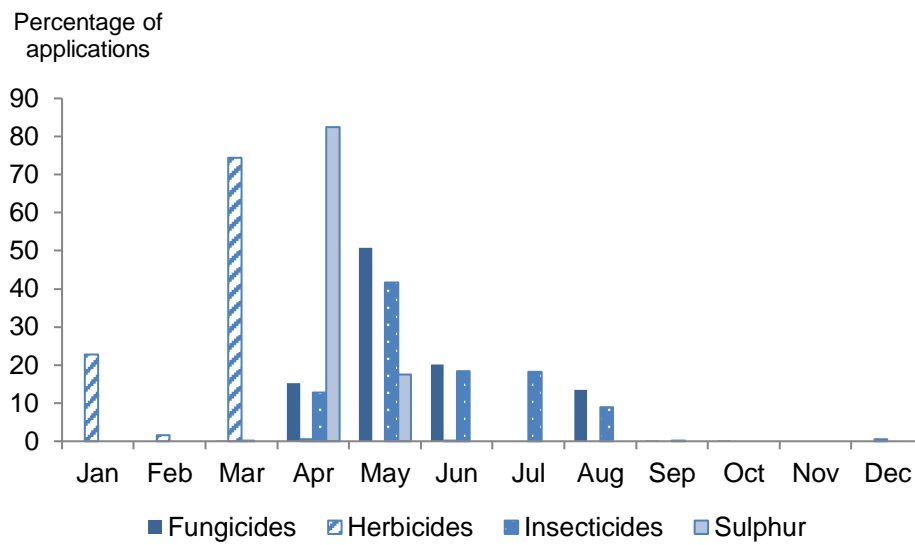
| Pesticide group             | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations  |
|-----------------------------|--------------------------|------------------------------|----------------------------|---|
|                             | ha                       | kg                           | %                          | ha  |
| Fungicides                  | 1,219                    | 585                          | 97                         | Kresoxim-methyl (178),<br>Cyprodinil/fludioxonil (172)                  |
| Herbicides/<br>desiccants   | 698                      | 326                          | 63                         | Pendimethalin (174),<br>Diquat (174),<br>Flufenacet/metribuzin<br>(171) |
| Insecticides/<br>acaricides | 896                      | 69                           | 98                         | Thiacloprid (529)   |
| Sulphur                     | 522                      | 3,353                        | 91                         | N/A   |
| <b>All pesticides</b>       | <b>3,335</b>             | <b>4,333</b>                 | <b>99</b>                  |   |

N/A = not applicable

**Figure 21 Use of pesticides on blackcurrants (percentage of total area treated with formulations) – 2018**



**Figure 22 Timings of pesticide applications on blackcurrants – 2018**



Note: insecticides include acaricides and herbicides include desiccants

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

- An estimated 356 hectares of other soft fruit was grown in Scotland in 2018. This consists of 139 hectares of non-protected crop and 218 hectares of protected crop
- The crops encountered in this category were blueberry, blackberry, gooseberry and redcurrant as well as minor crops; aronia, honeyberry, japanese wineberry, jostaberry, loganberry, tayberry, tummelberry, whitecurrant and worcesterberry
- 78 per cent of the other soft fruit crop was treated with a pesticide (see Figure 23 for types of pesticides used)
- Pesticide formulations were applied to 1,838 treated hectares with 594 kilograms of pesticide applied in total (see summary table below)
- The 78 per cent of the crop treated with a pesticide received on average 5.3 pesticide applications (Table 1) These included 2.9 insecticide applications, 2.8 fungicide applications, 1.5 herbicide/desiccant applications and one molluscicide application (applied to 62, 66, 29 and 14 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 24
- Reasons were supplied for 45 per cent of fungicide use; 25 per cent was for botrytis control, 10 per cent was for mildew, six per cent was for general disease control, two per cent for rust and one per cent for cane blight
- Reasons were provided for 43 per cent of herbicide/desiccant use; 40 per cent was for general weed control and three per cent for annual grass weeds
- Reasons were supplied for 82 per cent of insecticide use; 39 per cent was for aphid control, 21 per cent for caterpillar control, nine per cent for capsids, four per cent for gall midge, two per cent each for blackberry mite, two-spotted spider mite, raspberry leaf and bud mite and sawfly, one per cent for general pests
- All biopesticide use was for botrytis, 18 per cent of the use of biological control agents was for vine weevil and 18 per cent was for raspberry leaf and bud mite
- 48 per cent of other soft fruit crops sampled were five years old or less, 30 per cent were six to 10 years old, two per cent were over 10 years old and 20 per cent of the crop were an unknown age
- 53 per cent of the other soft fruit crops surveyed was grown in the soil and 47 per cent was grown in pots
- 11 per cent of the crop was grown outdoors, 56 per cent was grown under temporary tunnels and 33 per cent was grown under permanent protection
- 56 per cent of the sampled crop was grown using a ground mulch

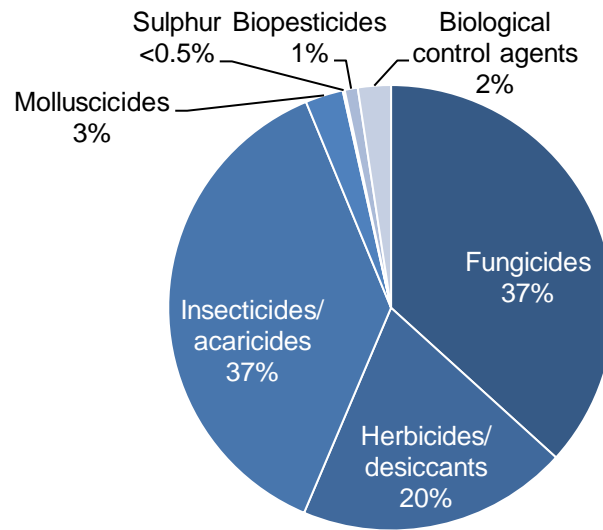
- Pollinators were used on 83 per cent of the other soft fruit crops sampled, 12 per cent had no pollinators and the remainder was unknown. Of the sampled area using pollinators, 93 per cent were bumble bees, seven per cent were both bumble bees and honey bees and under one per cent were honey bees
- 98 per cent of the crops surveyed were harvested in 2018. Of the crops harvested, 97 per cent was for fresh market, two per cent was for processing and one per cent was for pick-your-own

Summary of pesticide use on all other soft fruits:

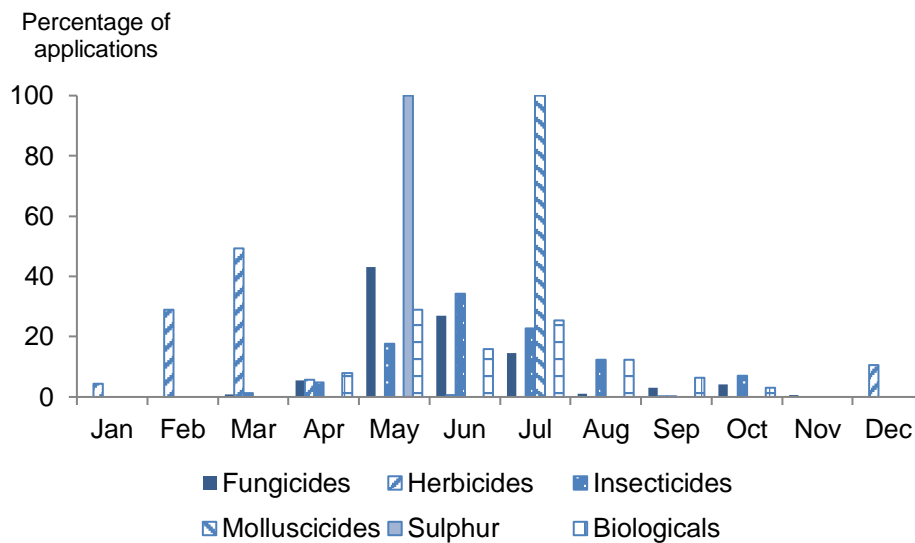
| Pesticide group           | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations  |
|---------------------------|--------------------------|------------------------------|----------------------------|---|
|                           | ha                       | kg                           | %                          | ha  |
| Fungicides                | 675                      | 342                          | 66                         | Cyprodinil/fludioxonil (186), Fenhexamid (152)                    |
| Herbicides/ desiccants    | 361                      | 192                          | 29                         | Diquat (75)   |
| Insecticides/ acaricides  | 687                      | 53                           | 62                         | Thiacloprid (257)   |
| Molluscicides             | 50                       | 4                            | 14                         | Metaldehyde (50)  |
| Sulphur                   | 3                        | 2                            | 1                          | N/A   |
| Biopesticides             | 17                       | 2                            |                            | <i>Bacillus subtilis</i> strain QST 713 (17)                      |
| Biological control agents | 44                       | N/A                          |                            | <i>Steinernema kraussei</i> (19), <i>Steinernema feltiae</i> (15) |
| <b>All pesticides</b>     | <b>1,838</b>             | <b>594</b>                   | <b>78</b>                  |   |

N/A = not applicable

**Figure 23 Use of pesticides on all other soft fruit crops (percentage of total area treated with formulations) – 2018**



**Figure 24 Timings of pesticide applications on all other soft fruit crops – 2018**



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

## Non-protected other soft fruit crops

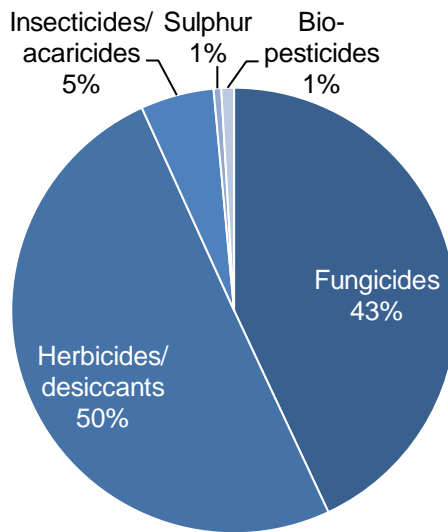
- An estimated area of 139 hectares of non-protected other soft fruit crops were grown in Scotland in 2018
- The crops encountered in this category were blueberry, blackberry, gooseberry and redcurrant as well as the minor crops aronia, honeyberry, japanese wineberry, jostaberry, loganberry, tayberry, tummelberry, whitecurrant and worcesterberry
- 44 per cent of the crop was treated with a pesticide (see Figure 25 for the types of pesticides used)
- Pesticide formulations were applied to 485 treated hectares with 191 kilograms of pesticide applied in total (see summary table below)
- The 44 per cent of the non-protected other soft fruit crop received on average 5.2 pesticide applications (Table 1). These applications included 3.9 fungicide applications, 1.7 herbicide/desiccant applications and 1,1 insecticide applications (applied to 38, 43 and 17 per cent of the crop area)
- The timings of pesticide applications are shown in Figure 26)

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

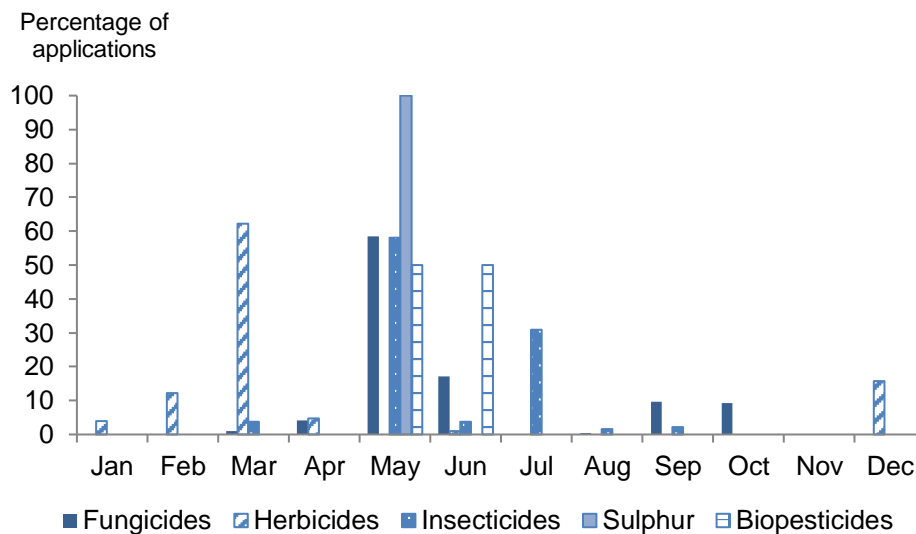
| Pesticide group         | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations                         |
|-------------------------|--------------------------|------------------------------|----------------------------|--|
|                         | ha                       | kg                           | %                          | ha   |
| Fungicides              | 209                      | 69                           | 38                         | Fenpropimorph (63)                             |
| Herbicides/desiccants   | 243                      | 117                          | 43                         | Isoxaben (49), Pendimethalin (48), Diquat (41) |
| Insecticides/acaricides | 26                       | 3                            | 17                         | Thiacloprid (10)                               |
| Sulphur                 | 3                        | 2                            | 2                          | N/A  |
| Biopesticides           | 4                        | <0.5                         |                            | <i>Bacillus subtilis</i> strain QST 713 (4)    |
| <b>All pesticides</b>   | <b>485</b>               | <b>191</b>                   | <b>44</b>                  |  |

N/A = not applicable

**Figure 25 Use of pesticides on non-protected other soft fruit crops (percentage of total area treated with formulations) – 2018**



**Figure 26 Timings of pesticide applications on non-protected other soft fruit crops – 2018**



Note: Insecticides include acaricides and herbicides include desiccants



## Protected other soft fruit crops

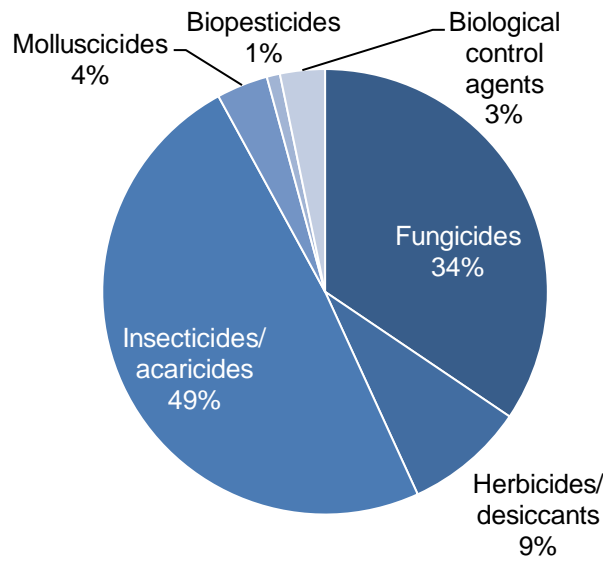
- The total estimated area of protected other soft fruit crops in 2018 was 218 hectares. It is estimated that 71 per cent of the crop was semi-protected (grown under temporary tunnels) with 29 per cent grown under permanent tunnels or glasshouses
- The crops encountered in this category were blueberry, blackberry, gooseberry and redcurrant
- All of the crop area was treated with a pesticide (see Figure 27 for types of pesticides used)
- Pesticide formulations were applied to 1,352 treated hectares with 403 kilograms of pesticide applied in total (see summary table below)
- The protected other soft fruit crop received on average 5.3 pesticide applications (Table 1). These applications included 3.2 insecticide applications, 2.5 fungicide applications, 1.8 biological applications, 1.2 herbicide/desiccant applications and one molluscicide applications (applied to 91, 85, 14, 20 and 23 per cent of the crop)
- The timings of pesticide applications are shown in Figure 28

Summary of pesticide use on protected other soft fruits:

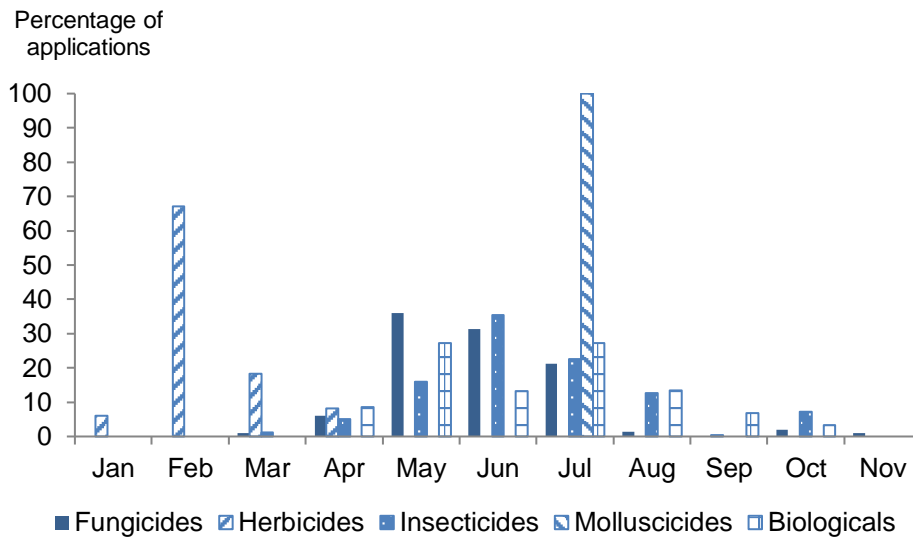
| Pesticide group           | Formulation area treated | Weight of pesticides applied | Percentage of crop treated | Most used formulations  |
|---------------------------|--------------------------|------------------------------|----------------------------|---|
|                           | ha                       | kg                           | %                          | ha  |
| Fungicides                | 466                      | 274                          | 85                         | Cyprodinil/fludioxonil (169)                                      |
| Herbicides/desiccants     | 118                      | 75                           | 20                         | Diquat (34), Napropamide (33)                                     |
| Insecticides/acaricides   | 661                      | 49                           | 91                         | Thiacloprid (247)   |
| Molluscicides             | 50                       | 4                            | 23                         | Metaldehyde (50)  |
| Biopesticides             | 13                       | 1                            |                            | <i>Bacillus subtilis</i> strain QST 713 (13)                      |
| Biological control agents | 44                       | N/A                          |                            | <i>Steinernema kraussei</i> (19), <i>Steinernema feltiae</i> (15) |
| <b>All pesticides</b>     | <b>1,352</b>             | <b>403</b>                   | <b>100</b>                 |   |

N/A = not applicable

**Figure 27 Use of pesticides on protected other soft fruit crops (percentage of total area treated with formulations) – 2018**



**Figure 28 Timings of pesticide applications on protected other soft fruit crops – 2018**



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

## Appendix 1 – Estimated application tables

**Table 1 Percentage of each crop treated with pesticides and mean number of spray applications - 2018**

| Crop                              | Fungicides |               | Herbicides/<br>desiccants |               | Insecticides/<br>acaricides |               | Molluscicides |               | Sulphur   |               | Biologicals <sup>(1)</sup> |               | Physical<br>control |               | Any pesticide |               |
|-----------------------------------|------------|---------------|---------------------------|---------------|-----------------------------|---------------|---------------|---------------|-----------|---------------|----------------------------|---------------|---------------------|---------------|---------------|---------------|
|                                   | %          | spray<br>apps | %                         | spray<br>apps | %                           | spray<br>apps | %             | spray<br>apps | %         | spray<br>apps | %                          | spray<br>apps | %                   | spray<br>apps | %             | spray<br>apps |
| Non-protected<br>strawberry       | 71         | 4.7           | 52                        | 2.8           | 38                          | 1.0           | 20            | 1.0           | 0         | 0.0           | 25                         | 2.0           | 0                   | 0.0           | <b>72</b>     | <b>8.0</b>    |
| Protected<br>strawberry           | 100        | 8.7           | 44                        | 1.5           | 99                          | 3.1           | 39            | 1.7           | 18        | 2.6           | 69                         | 4.1           | 3                   | 1.5           | <b>100</b>    | <b>14.6</b>   |
| <b>All strawberry</b>             | <b>99</b>  | <b>8.6</b>    | <b>44</b>                 | <b>1.6</b>    | <b>97</b>                   | <b>3.1</b>    | <b>39</b>     | <b>1.7</b>    | <b>18</b> | <b>2.6</b>    | <b>68</b>                  | <b>4.0</b>    | <b>3</b>            | <b>1.5</b>    | <b>99</b>     | <b>14.5</b>   |
| Non-protected<br>raspberry        | 40         | 3.7           | 44                        | 2.4           | 27                          | 1.3           | 0             | 0.0           | 10        | 1.0           | 0                          | 0.0           | 0                   | 0.0           | <b>44</b>     | <b>6.0</b>    |
| Protected raspberry               | 99         | 4.6           | 51                        | 1.6           | 96                          | 2.9           | 0             | 0.0           | 0         | 0.0           | 8                          | 1.2           | 3                   | 1.0           | <b>100</b>    | <b>7.4</b>    |
| <b>All raspberry</b>              | <b>75</b>  | <b>4.4</b>    | <b>48</b>                 | <b>1.9</b>    | <b>68</b>                   | <b>2.6</b>    | <b>0</b>      | <b>0.0</b>    | <b>4</b>  | <b>1.0</b>    | <b>5</b>                   | <b>1.2</b>    | <b>2</b>            | <b>1.0</b>    | <b>77</b>     | <b>7.1</b>    |
| <b>All blackcurrant</b>           | <b>97</b>  | <b>3.9</b>    | <b>63</b>                 | <b>1.5</b>    | <b>98</b>                   | <b>2.6</b>    | <b>0</b>      | <b>0.0</b>    | <b>91</b> | <b>2.0</b>    | <b>0</b>                   | <b>0.0</b>    | <b>0</b>            | <b>0.0</b>    | <b>99</b>     | <b>6.6</b>    |
| Non-protected<br>other soft fruit | 38         | 3.9           | 43                        | 1.7           | 17                          | 1.1           | 0             | 0.0           | 2         | 1.0           | 2                          | 2.0           | 0                   | 0.0           | <b>44</b>     | <b>5.2</b>    |
| Protected other soft<br>fruit     | 85         | 2.5           | 20                        | 1.2           | 91                          | 3.2           | 23            | 1.0           | 0         | 0.0           | 14                         | 1.8           | 0                   | 0.0           | <b>100</b>    | <b>5.3</b>    |
| <b>All other soft fruit</b>       | <b>66</b>  | <b>2.8</b>    | <b>29</b>                 | <b>1.5</b>    | <b>62</b>                   | <b>2.9</b>    | <b>14</b>     | <b>1.0</b>    | <b>1</b>  | <b>1.0</b>    | <b>9</b>                   | <b>1.9</b>    | <b>0</b>            | <b>0.0</b>    | <b>78</b>     | <b>5.3</b>    |
| <b>All soft fruit crops</b>       | <b>90</b>  | <b>6.7</b>    | <b>45</b>                 | <b>1.6</b>    | <b>88</b>                   | <b>2.9</b>    | <b>24</b>     | <b>1.6</b>    | <b>23</b> | <b>2.3</b>    | <b>40</b>                  | <b>3.9</b>    | <b>2</b>            | <b>1.4</b>    | <b>93</b>     | <b>11.2</b>   |

(1) Biologicals include biological control agents and biopesticides

Note: The average number of spray applications is calculated only on the areas receiving each pesticide group and therefore the minimum number of applications is always one (see appendix 3 – definitions and notes for details)

**Table 2 Strawberry insecticide and acaricide formulations - 2018**

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

| Insecticides/acaricides            | Non-protected strawberry |           | Protected strawberry |           | All strawberry 2018 |            | All strawberry 2016 <sup>(1)</sup> |            |
|------------------------------------|--------------------------|-----------|----------------------|-----------|---------------------|------------|------------------------------------|------------|
|                                    | ha                       | %         | ha                   | %         | ha                  | kg         | ha                                 | kg         |
| Abamectin                          | 0                        | 0         | 449                  | 37        | 449                 | 4          | 858                                | 6          |
| Bifenazate                         | 0                        | 0         | 310                  | 20        | 310                 | 36         | 0                                  | 0          |
| Clofentezine                       | 0                        | 0         | 160                  | 14        | 160                 | 32         | 595                                | 76         |
| Cyantraniliprole                   | 0                        | 0         | 50                   | 4         | 50                  | 4          | 0                                  | 0          |
| Deltamethrin                       | 0                        | 0         | 167                  | 15        | 167                 | 1          | 165                                | 1          |
| Etoxazole                          | 0                        | 0         | 233                  | 14        | 233                 | 8          | 162                                | 5          |
| Fatty acids                        | 0                        | 0         | 30                   | 2         | 30                  | 230        | 0                                  | 0          |
| Indoxacarb                         | 0                        | 0         | 66                   | 6         | 66                  | 3          | 0                                  | 0          |
| Lambda-cyhalothrin                 | 11                       | 38        | 754                  | 57        | 765                 | 8          | 886                                | 8          |
| Pirimicarb                         | 0                        | 0         | 5                    | <0.5      | 5                   | 0          | 88                                 | 25         |
| Pymetrozine                        | 0                        | 0         | 49                   | 4         | 49                  | 10         | 284                                | 57         |
| Pyrethrins                         | 0                        | 0         | 251                  | 21        | 251                 | 15         | 60                                 | 3          |
| Spinosad                           | 0                        | 0         | 250                  | 19        | 250                 | 18         | 51                                 | 4          |
| Spirodiclofen                      | 0                        | 0         | 18                   | 2         | 18                  | 2          | 37                                 | 1          |
| Spirotetramat                      | 0                        | 0         | 149                  | 13        | 149                 | 15         | 0                                  | 0          |
| Tebufenpyrad                       | 0                        | 0         | 41                   | 3         | 41                  | 6          | 72                                 | 9          |
| Thiacloprid                        | 0                        | 0         | 823                  | 64        | 823                 | 99         | 433                                | 52         |
| <b>All insecticides/acaricides</b> | <b>11</b>                | <b>38</b> | <b>3,803</b>         | <b>99</b> | <b>3,814</b>        | <b>490</b> | <b>3,858</b>                       | <b>322</b> |
| Area grown                         | 30                       |           | 1,145                |           | 1,175               |            | 995                                |            |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 3 Strawberry biological, molluscicide and physical control formulations - 2018**

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

| Biological control agents                   | Non-protected strawberry |           | Protected strawberry |           | All strawberry 2018 |            | All strawberry 2016 <sup>(1)</sup> |            |
|---|--------------------------|-----------|----------------------|-----------|---------------------|------------|------------------------------------|------------|
|   | ha                       | %         | ha                   | %         | ha                  | kg         | ha                                 | kg         |
| <i>Amblyseius spp.</i>                      | 0                        | 0         | 1                    | <0.5      | 1                   | N/A        | 0                                  | N/A        |
| <i>Heterorhabditis bacteriophora</i>        | 0                        | 0         | 9                    | 1         | 9                   | N/A        | 113                                | N/A        |
| <i>Neoseiulus cucumeris</i>                 | 0                        | 0         | 71                   | 6         | 71                  | N/A        | 70                                 | N/A        |
| Parasitic wasps                             | 0                        | 0         | 240                  | 10        | 240                 | N/A        | 0                                  | N/A        |
| <i>Phytoseiulus persimilis</i>              | 0                        | 0         | 563                  | 14        | 563                 | N/A        | 68                                 | N/A        |
| <i>Steinernema feltiae</i>                  | 15                       | 25        | 148                  | 12        | 162                 | N/A        | 0                                  | N/A        |
| <i>Steinernema kraussei</i>                 | 0                        | 0         | 31                   | 3         | 31                  | N/A        | 114                                | N/A        |
| <b>All biological control agents</b>        | <b>15</b>                |           | <b>1,063</b>         |           | <b>1,078</b>        | <b>N/A</b> | <b>374</b>                         | <b>N/A</b> |
| <b>Biopesticides</b>                        |                          |           |                      |           |                     |            |                                    |            |
| <i>Ampelomyces quisqualis</i> strain AQ 10  | 0                        | 0         | 773                  | 12        | 773                 | 31         | 0                                  | 0          |
| <i>Bacillus subtilis</i> strain QST 713     | 0                        | 0         | 1,883                | 58        | 1,883               | 114        | 767                                | 62         |
| <i>Bacillus thuringiensis</i> var. kurstaki | 0                        | 0         | 98                   | 2         | 98                  | 32         | 0                                  | 0          |
| <i>Beauveria bassiana</i> ATCC - 74040      | 0                        | 0         | 113                  | 10        | 113                 | 12         | 6                                  | 1          |
| <i>Beauveria bassiana</i> GHA               | 0                        | 0         | 28                   | 1         | 28                  | 4          | 7                                  | 1          |
| <b>All biopesticides</b>                    | <b>0</b>                 |           | <b>2,895</b>         |           | <b>2,895</b>        | <b>193</b> | <b>780</b>                         | <b>64</b>  |
| <b>All biologicals<sup>(2)</sup></b>        | <b>15</b>                | <b>25</b> | <b>3,958</b>         | <b>69</b> | <b>3,973</b>        | <b>193</b> | <b>1,154</b>                       | <b>64</b>  |

Cont...

**Table 3 Strawberry biological, molluscicide and physical control formulations – 2018 continued**

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

| Molluscicides              | Non-protected strawberry |           | Protected strawberry |           | All strawberry 2018 |            | All strawberry 2016 <sup>(1)</sup> |           |
|----------------------------|--------------------------|-----------|----------------------|-----------|---------------------|------------|------------------------------------|-----------|
|                            | ha                       | %         | ha                   | %         | ha                  | kg         | ha                                 | kg        |
| Ferric phosphate           | 6                        | 20        | 355                  | 25        | <b>361</b>          | <b>75</b>  | 59                                 | 12        |
| Metaldehyde                | 0                        | 0         | 412                  | 25        | <b>412</b>          | <b>71</b>  | 194                                | 47        |
| <b>All molluscicides</b>   | <b>6</b>                 | <b>20</b> | <b>767</b>           | <b>39</b> | <b>773</b>          | <b>146</b> | <b>253</b>                         | <b>59</b> |
| <b>Physical control</b>    |                          |           |                      |           |                     |            |                                    |           |
| Carbonic acid diamide/urea | 0                        | 0         | 46                   | 3         | <b>46</b>           | <b>90</b>  | 24                                 | 47        |
| Area grown                 | 30                       |           | 1,145                |           | <b>1,175</b>        |            | 995                                |           |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

(2) All biologicals includes biological control agents and biopesticides

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

N/A = not applicable

**Table 4 Strawberry fungicide and sulphur formulations – 2018**

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

| Fungicides                   | Non-protected strawberry |    | Protected strawberry |    | All strawberry 2018 |              | All strawberry 2016 <sup>(1)</sup> |     |
|------------------------------|--------------------------|----|----------------------|----|---------------------|--------------|------------------------------------|-----|
|                              | ha                       | %  | ha                   | %  | ha                  | kg           | ha                                 | kg  |
| Azoxystrobin                 | 7                        | 13 | 874                  | 60 | <b>881</b>          | <b>220</b>   | 1,109                              | 276 |
| Azoxystrobin/difenoconazole  | 0                        | 0  | 29                   | 2  | <b>29</b>           | <b>9</b>     | 0                                  | 0   |
| Boscalid/pyraclostrobin      | 9                        | 29 | 431                  | 30 | <b>440</b>          | <b>227</b>   | 788                                | 333 |
| Bupirimate                   | 0                        | 0  | 1,233                | 70 | <b>1,233</b>        | <b>420</b>   | 857                                | 297 |
| Chlorothalonil               | 0                        | 0  | 82                   | 7  | <b>82</b>           | <b>82</b>    | 16                                 | 16  |
| Cyflufenamid                 | 0                        | 0  | 938                  | 63 | <b>938</b>          | <b>14</b>    | 70                                 | 1   |
| Cyprodinil/fludioxonil       | 23                       | 54 | 1,232                | 67 | <b>1,255</b>        | <b>777</b>   | 1,201                              | 747 |
| Difenoconazole/fluxapyroxad  | 12                       | 20 | 166                  | 12 | <b>178</b>          | <b>13</b>    | 0                                  | 0   |
| Dimethomorph                 | 1                        | 3  | 183                  | 16 | <b>184</b>          | <b>275</b>   | 104                                | 155 |
| Fenamidone/fosetyl-aluminium | 2                        | 6  | 579                  | 49 | <b>581</b>          | <b>1,462</b> | 155                                | 399 |
| Fenhexamid                   | 43                       | 67 | 1,862                | 95 | <b>1,905</b>        | <b>1,338</b> | 1,227                              | 891 |
| Fenpropimorph                | 9                        | 31 | 234                  | 14 | <b>243</b>          | <b>173</b>   | 346                                | 251 |
| Fenpyrazamine                | 4                        | 13 | 415                  | 28 | <b>419</b>          | <b>240</b>   | 0                                  | 0   |
| Fluopyram/trifloxystrobin    | 0                        | 0  | 1,714                | 94 | <b>1,714</b>        | <b>681</b>   | 0                                  | 0   |
| Iprodione                    | 0                        | 0  | 167                  | 13 | <b>167</b>          | <b>119</b>   | 1,078                              | 795 |
| Kresoxim-methyl              | 7                        | 25 | 225                  | 18 | <b>232</b>          | <b>34</b>    | 242                                | 36  |
| Mepanipyrim                  | 10                       | 35 | 458                  | 34 | <b>469</b>          | <b>182</b>   | 54                                 | 22  |

Cont...

**Table 4 Strawberry fungicide and sulphur formulations – 2018 continued**

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

| Fungicides                   | Non-protected strawberry |           | Protected strawberry |            | All strawberry 2018 |              | All strawberry 2016 <sup>(1)</sup> |              |
|------------------------------|--------------------------|-----------|----------------------|------------|---------------------|--------------|------------------------------------|--------------|
|                              | ha                       | %         | ha                   | %          | ha                  | kg           | ha                                 | kg           |
| Meptyldinocap                | 0                        | 0         | 87                   | 8          | <b>87</b>           | <b>18</b>    | 250                                | 52           |
| Penconazole                  | 17                       | 29        | 940                  | 73         | <b>957</b>          | <b>48</b>    | 177                                | 8            |
| Potassium hydrogen carbonate | 0                        | 0         | 434                  | 16         | <b>434</b>          | <b>2,573</b> | 217                                | 935          |
| Proquinazid                  | 0                        | 0         | 141                  | 12         | <b>141</b>          | <b>5</b>     | 0                                  | 0            |
| Pyrimethanil                 | 0                        | 0         | 689                  | 54         | <b>689</b>          | <b>517</b>   | 327                                | 238          |
| Quinoxifen                   | 3                        | 9         | 753                  | 38         | <b>756</b>          | <b>94</b>    | 768                                | 96           |
| <b>All fungicides</b>        | <b>147</b>               | <b>71</b> | <b>13,865</b>        | <b>100</b> | <b>14,012</b>       | <b>9,523</b> | <b>10,593</b>                      | <b>5,682</b> |
| Sulphur                      | 0                        | 0         | 549                  | 18         | <b>549</b>          | <b>657</b>   | 339                                | 185          |
| Area grown                   | 30                       |           | 1,145                |            | <b>1,175</b>        |              | 995                                |              |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>



**Table 5 Strawberry herbicide and desiccant formulations – 2018**

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

| Herbicides/desiccants            | Non-protected strawberry |           | Protected strawberry |           | All strawberry 2018 |            | All strawberry 2016 <sup>(1)</sup> |              |
|----------------------------------|--------------------------|-----------|----------------------|-----------|---------------------|------------|------------------------------------|--------------|
|                                  | ha                       | %         | ha                   | %         | ha                  | kg         | ha                                 | kg           |
| 2,4-D/Glyphosate                 | 1                        | 3         | 0                    | 0         | 1                   | 2          | 0                                  | 0            |
| Carfentrazone-ethyl              | 0                        | 0         | 150                  | 12        | 150                 | 2          | 103                                | 2            |
| Clopyralid                       | 2                        | 6         | 0                    | 0         | 2                   | <0.5       | 34                                 | 4            |
| Diquat                           | 21                       | 47        | 604                  | 42        | 625                 | 133        | 828                                | 244          |
| Glyphosate                       | <0.5                     | 2         | 33                   | 3         | 33                  | 36         | 85                                 | 110          |
| Isoxaben                         | 14                       | 47        | 76                   | 7         | 90                  | 8          | 341                                | 18           |
| Metamitron                       | 2                        | 6         | 66                   | 6         | 68                  | 50         | 29                                 | 43           |
| Napropamide                      | 0                        | 0         | 274                  | 24        | 274                 | 216        | 400                                | 452          |
| Pendimethalin                    | 12                       | 41        | 26                   | 2         | 38                  | 28         | 2                                  | 1            |
| Phenmedipham                     | 1                        | 3         | 0                    | 0         | 1                   | <0.5       | 5                                  | 2            |
| Propyzamide                      | 5                        | 9         | 157                  | 14        | 161                 | 99         | 96                                 | 76           |
| <b>All herbicides/desiccants</b> | <b>58</b>                | <b>52</b> | <b>1,385</b>         | <b>44</b> | <b>1,443</b>        | <b>573</b> | <b>2,001</b>                       | <b>1,000</b> |
| Area grown                       | 30                       |           | 1,145                |           | 1,175               |            | 995                                |              |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 6 Raspberry insecticide and acaricide formulations – 2018**

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

| Insecticides/acaricides            | Non-protected raspberry |           | Protected raspberry |           | All raspberry 2018 |                | All raspberry 2016 <sup>(1)</sup> |           |
|------------------------------------|-------------------------|-----------|---------------------|-----------|--------------------|----------------|-----------------------------------|-----------|
|                                    | ha                      | %         | ha                  | %         | ha                 | kg             | ha                                | kg        |
| Abamectin                          | 0                       | 0         | 184                 | 57        | <b>184</b>         | <b>2</b>       | 152                               | 1         |
| Clofentezine                       | 0                       | 0         | 2                   | 1         | <b>2</b>           | <b>&lt;0.5</b> | 6                                 | 1         |
| Cyantraniliprole                   | 0                       | 0         | 5                   | 3         | <b>5</b>           | <b>&lt;0.5</b> | 0                                 | 0         |
| Deltamethrin                       | 7                       | 7         | 69                  | 30        | <b>76</b>          | <b>1</b>       | 94                                | 1         |
| Etoxazole                          | 0                       | 0         | 7                   | 3         | <b>7</b>           | <b>&lt;0.5</b> | 0                                 | 0         |
| Lambda-cyhalothrin                 | 9                       | 7         | 21                  | 13        | <b>30</b>          | <b>&lt;0.5</b> | 31                                | <0.5      |
| Pirimicarb                         | 0                       | 0         | 3                   | 2         | <b>3</b>           | <b>&lt;0.5</b> | 0                                 | 0         |
| Pymetrozine                        | 0                       | 0         | 6                   | 4         | <b>6</b>           | <b>1</b>       | 0                                 | 0         |
| Pyrethrins                         | 0                       | 0         | 45                  | 23        | <b>45</b>          | <b>3</b>       | 5                                 | <0.5      |
| Spinosad                           | 0                       | 0         | 11                  | 3         | <b>11</b>          | <b>1</b>       | 0                                 | 0         |
| Tebufenpyrad                       | 0                       | 0         | 8                   | 5         | <b>8</b>           | <b>1</b>       | 6                                 | <0.5      |
| Thiacloprid                        | 23                      | 20        | 174                 | 67        | <b>197</b>         | <b>24</b>      | 116                               | 14        |
| <b>All insecticides/acaricides</b> | <b>40</b>               | <b>27</b> | <b>536</b>          | <b>96</b> | <b>576</b>         | <b>34</b>      | <b>446</b>                        | <b>36</b> |
| Area grown                         | 113                     |           | 162                 |           | <b>276</b>         |                | 329                               |           |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 7 Raspberry biological and physical control formulations – 2018**

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

| Biological control agents                          | Non-protected raspberry |          | Protected raspberry |          | All raspberry 2018 |            | All raspberry 2016 <sup>(1)</sup> |            |
|--|-------------------------|----------|---------------------|----------|--------------------|------------|-----------------------------------|------------|
|  | ha                      | %        | ha                  | %        | ha                 | kg         | ha                                | kg         |
| <i>Steinernema feltiae</i>                         | 0                       | 0        | 2                   | 1        | 2                  | N/A        | 0                                 | N/A        |
| <i>Steinernema kraussei</i>                        | 0                       | 0        | 5                   | 3        | 5                  | N/A        | 0                                 | N/A        |
| <b>All biological control agents</b>               | <b>0</b>                |          | <b>7</b>            |          | <b>7</b>           | <b>N/A</b> | <b>3</b>                          | <b>N/A</b> |
| <b>Biopesticides</b>                               |                         |          |                     |          |                    |            |                                   |            |
| <i>Bacillus amyloliquefaciens</i> strain D747      | 0                       | 0        | 5                   | 3        | 5                  | 2          | 0                                 | 0          |
| <i>Bacillus thuringiensis</i> var. <i>kurstaki</i> | 0                       | 0        | 2                   | 1        | 2                  | 1          | 7                                 | <0.5       |
| <i>Beauveria bassiana</i> ATCC - 74040             | 0                       | 0        | 2                   | 1        | 2                  | <0.5       | 0                                 | 0          |
| <b>All biopesticides</b>                           | <b>0</b>                | <b>0</b> | <b>9</b>            |          | <b>9</b>           | <b>3</b>   | <b>72</b>                         | <b>7</b>   |
| <b>All biologicals<sup>(2)</sup></b>               | <b>0</b>                | <b>0</b> | <b>16</b>           | <b>8</b> | <b>16</b>          | <b>3</b>   | <b>75</b>                         | <b>7</b>   |
| <b>Physical control</b>                            |                         |          |                     |          |                    |            |                                   |            |
| Carbonic acid diamide/urea                         | 0                       | 0        | 4                   | 3        | 4                  | 7          | 0                                 | 0          |
| Area grown   | 113                     |          | 162                 |          | 276                |            | 329                               |            |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

(2) All biologicals includes biological control agents and biopesticides

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

N/A = not applicable

**Table 8 Raspberry fungicide and sulphur formulations – 2018**

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

| Fungicides                   | Non-protected raspberry |           | Protected raspberry |           | All raspberry 2018 |            | All raspberry 2016 <sup>(1)</sup> |            |
|------------------------------|-------------------------|-----------|---------------------|-----------|--------------------|------------|-----------------------------------|------------|
|                              | ha                      | %         | ha                  | %         | ha                 | kg         | ha                                | kg         |
| Azoxystrobin                 | 26                      | 23        | 110                 | 51        | 136                | 34         | 57                                | 14         |
| Boscalid/pyraclostrobin      | 28                      | 18        | 120                 | 48        | 148                | 62         | 179                               | 76         |
| Bupirimate                   | 0                       | 0         | 0                   | 0         | 0                  | 0          | 29                                | 7          |
| Chlorothalonil               | 0                       | 0         | 4                   | 3         | 4                  | 5          | 0                                 | 0          |
| Cyprodinil/fludioxonil       | 15                      | 13        | 75                  | 40        | 90                 | 55         | 236                               | 137        |
| Dimethomorph                 | 0                       | 0         | 45                  | 28        | 45                 | 66         | 124                               | 157        |
| Fenhexamid                   | 119                     | 29        | 231                 | 75        | 349                | 228        | 351                               | 228        |
| Fenpropimorph                | 7                       | 3         | 0                   | 0         | 7                  | 5          | 7                                 | 5          |
| Iprodione                    | 0                       | 0         | 10                  | 6         | 10                 | 8          | 109                               | 81         |
| Metalaxyl-M                  | 3                       | 3         | 3                   | 2         | 6                  | 2          | 0                                 | 0          |
| Potassium hydrogen carbonate | 0                       | 0         | 4                   | 3         | 4                  | 31         | 0                                 | 0          |
| Pyrimethanil                 | 14                      | 6         | 130                 | 73        | 143                | 58         | 80                                | 28         |
| Tebuconazole                 | 46                      | 20        | 17                  | 6         | 62                 | 12         | 48                                | 8          |
| <b>All fungicides</b>        | <b>257</b>              | <b>40</b> | <b>749</b>          | <b>99</b> | <b>1,005</b>       | <b>566</b> | <b>1,322</b>                      | <b>772</b> |
| Sulphur                      | 12                      | 10        | 0                   | 0         | 12                 | 47         | 34                                | 270        |
| Area grown                   | 113                     |           | 162                 |           | 276                |            | 329                               |            |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 9 Raspberry herbicide and desiccant formulations – 2018**

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

| Herbicides/desiccants            | Non-protected raspberry |           | Protected raspberry |           | All raspberry 2018 |            | All raspberry 2016 <sup>(1)</sup> |            |
|----------------------------------|-------------------------|-----------|---------------------|-----------|--------------------|------------|-----------------------------------|------------|
|                                  | ha                      | %         | ha                  | %         | ha                 | kg         | ha                                | kg         |
| 2,4-D/Glyphosate                 | 2                       | 2         | 0                   | 0         | 2                  | 4          | 0                                 | 0          |
| Carfentrazone-ethyl              | 24                      | 21        | 83                  | 43        | 107                | 1          | 115                               | 2          |
| Clethodim                        | 0                       | 0         | 2                   | 1         | 2                  | <0.5       | 0                                 | 0          |
| Diquat                           | 59                      | 38        | 76                  | 45        | 136                | 32         | 201                               | 42         |
| Fluazifop-p-butyl                | 23                      | 20        | 3                   | 2         | 26                 | 8          | 34                                | 4          |
| Glyphosate                       | 1                       | 1         | 0                   | 0         | 1                  | 1          | 15                                | 19         |
| Isoxaben                         | 50                      | 44        | 6                   | 4         | 56                 | 5          | 112                               | 12         |
| Lenacil                          | 0                       | 0         | 2                   | 1         | 2                  | 3          | 5                                 | 6          |
| Napropamide                      | 0                       | 0         | 16                  | 10        | 16                 | 30         | 94                                | 118        |
| Pendimethalin                    | 31                      | 27        | 4                   | 3         | 35                 | 16         | 68                                | 62         |
| Propyzamide                      | 3                       | 3         | 6                   | 4         | 9                  | 6          | 76                                | 35         |
| <b>All herbicides/desiccants</b> | <b>193</b>              | <b>44</b> | <b>199</b>          | <b>51</b> | <b>391</b>         | <b>107</b> | <b>719</b>                        | <b>301</b> |
| Area grown                       | 113                     |           | 162                 |           | 276                |            | 329                               |            |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 10 Blackcurrant insecticide and acaricide formulations – 2018**

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

| Insecticides/acaricides            | All blackcurrant 2018 |           |           | All blackcurrant 2016 <sup>(1)</sup> |           |
|------------------------------------|-----------------------|-----------|-----------|--------------------------------------|-----------|
|                                    | ha                    | %         | kg        | ha                                   | kg        |
| Lambda-cyhalothrin                 | 331                   | 61        | 2         | 387                                  | 4         |
| Pirimicarb                         | 3                     | 1         | 1         | 0                                    | 0         |
| Spirotetramat                      | 31                    | 6         | 2         | 153                                  | 11        |
| Tebufenpyrad                       | 2                     | 1         | <0.5      | 0                                    | 0         |
| Thiacloprid                        | 529                   | 97        | 63        | 345                                  | 41        |
| <b>All insecticides/acaricides</b> | <b>896</b>            | <b>98</b> | <b>69</b> | <b>943</b>                           | <b>62</b> |
| Area grown                         | 282                   |           |           | 304                                  |           |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 11 Blackcurrant fungicide and sulphur formulations – 2018**

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

| Fungicides              | All blackcurrant 2018 |           |            | All blackcurrant 2016 <sup>(1)</sup> |            |
|-------------------------|-----------------------|-----------|------------|--------------------------------------|------------|
|                         | ha                    | %         | kg         | ha                                   | kg         |
| Boscalid/pyraclostrobin | 531                   | 96        | 261        | 200                                  | 100        |
| Bupirimate              | <0.5                  | <0.5      | <0.5       | 0                                    | 0          |
| Cyprodinil/fludioxonil  | 172                   | 61        | 107        | 198                                  | 124        |
| Fenhexamid              | 81                    | 28        | 60         | 84                                   | 62         |
| Fenpropimorph           | 84                    | 29        | 63         | 3                                    | 2          |
| Kresoxim-methyl         | 178                   | 63        | 18         | 397                                  | 40         |
| Myclobutanil            | 85                    | 30        | 8          | 518                                  | 40         |
| Pyrimethanil            | 85                    | 30        | 68         | 53                                   | 41         |
| Quinoxifen              | 4                     | 1         | <0.5       | 0                                    | 0          |
| <b>All fungicides</b>   | <b>1,219</b>          | <b>97</b> | <b>585</b> | <b>1,459</b>                         | <b>412</b> |
| Sulphur                 | 522                   | 91        | 3,353      | 402                                  | 3,207      |
| Area grown              | 282                   |           |            | 304                                  |            |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 12 Blackcurrant herbicide and desiccant formulations – 2018**

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

| Herbicides/desiccants            | All blackcurrant 2018 |           |            | All blackcurrant 2016 <sup>(1)</sup> |            |
|----------------------------------|-----------------------|-----------|------------|--------------------------------------|------------|
|                                  | ha                    | %         | kg         | ha                                   | kg         |
| Carfentrazone-ethyl              | 2                     | 1         | <0.5       | 0                                    | 0          |
| Diquat                           | 174                   | 62        | 30         | 268                                  | 46         |
| Flufenacet/metribuzin            | 171                   | 61        | 76         | 191                                  | 81         |
| Glyphosate                       | 85                    | 30        | 30         | 107                                  | 93         |
| Isoxaben                         | 4                     | 1         | <0.5       | 143                                  | 16         |
| Napropamide                      | 3                     | 1         | 4          | 1                                    | 1          |
| Pendimethalin                    | 174                   | 62        | 99         | 256                                  | 137        |
| Propyzamide                      | 85                    | 30        | 86         | 1                                    | 1          |
| <b>All herbicides/desiccants</b> | <b>698</b>            | <b>63</b> | <b>326</b> | <b>968</b>                           | <b>375</b> |
| Area grown                       | 282                   |           |            | 304                                  |            |

(1) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>



**Table 13 Other soft fruit insecticide and acaricide formulations – 2018**

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

| Insecticides/acaricides            | Non-protected other soft fruit |           | Protected other soft fruit |           | All other soft fruit 2018 <sup>(1)</sup> |           | All other soft fruit 2016 <sup>(2)</sup> |           |
|------------------------------------|--------------------------------|-----------|----------------------------|-----------|--|-----------|--|-----------|
|                                    | ha                             | %         | ha                         | %         | ha                                       | kg        | ha                                       | kg        |
| Abamectin                          | 0                              | 0         | 19                         | 7         | 19                                       | <0.5      | 25                                       | <0.5      |
| Chlorantraniliprole                | 0                              | 0         | 9                          | 4         | 9  | <0.5      | 0  | 0         |
| Etoxazole                          | 0                              | 0         | 1                          | 1         | 1  | <0.5      | 0  | 0         |
| Indoxacarb                         | 0                              | 0         | 9                          | 4         | 9  | <0.5      | 0  | 0         |
| Lambda-cyhalothrin                 | 8                              | 5         | 82                         | 32        | 90                                       | 1         | 57                                       | <0.5      |
| Pirimicarb                         | 8                              | 6         | 0                          | 0         | 8  | 2         | 0  | 0         |
| Pymetrozine                        | 0                              | 0         | 7                          | 3         | 7  | 1         | 0  | 0         |
| Pyrethrins                         | 0                              | 0         | 197                        | 51        | 197                                      | 10        | 125                                      | 8         |
| Spinosad                           | 0                              | 0         | 85                         | 28        | 85                                       | 8         | 7  | 1         |
| Tebufenpyrad                       | 0                              | 0         | 4                          | 2         | 4  | <0.5      | 0  | 0         |
| Thiacloprid                        | 10                             | 7         | 247                        | 74        | 257                                      | 30        | 268                                      | 32        |
| <b>All insecticides/acaricides</b> | <b>26</b>                      | <b>17</b> | <b>661</b>                 | <b>91</b> | <b>687</b>                               | <b>53</b> | <b>494</b>                               | <b>42</b> |
| Area grown                         | 139                            |           | 218                        |           | 356                                      |           | 248                                      |           |

(1) In 2018 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, aronia, honeyberry, japanese wineberry, jostaberry, loganberry, tayberry, tummelberry, whitecurrant and worcesterberry

(2) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 14 Other soft fruit biological and molluscicide formulations – 2018**

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

| Biological control agents               | Non-protected other soft fruit |          | Protected other soft fruit |           | All other soft fruit 2018 <sup>(1)</sup> |            | All other soft fruit 2016 <sup>(2)</sup> |            |
|---|--------------------------------|----------|----------------------------|-----------|--|------------|--|------------|
|   | ha                             | %        | ha                         | %         | ha                                       | kg         | ha                                       | kg         |
| <i>Heterorhabditis bacteriophora</i>    | 0                              | 0        | 2                          | 1         | 2  | N/A        | 136                                      | N/A        |
| <i>Neoseiulus cucumeris</i>             | 0                              | 0        | 4                          | 2         | 4  | N/A        | 0  | N/A        |
| Parasitic wasps                         | 0                              | 0        | 3                          | 1         | 3  | N/A        | 25                                       | N/A        |
| <i>Steinernema feltiae</i>              | 0                              | 0        | 15                         | 4         | 15                                       | N/A        | 0  | N/A        |
| <i>Steinernema kraussei</i>             | 0                              | 0        | 19                         | 3         | 19                                       | N/A        | 61                                       | N/A        |
| <b>All biological control agents</b>    | <b>0</b>                       |          | <b>44</b>                  |           | <b>44</b>                                | <b>N/A</b> | <b>245</b>                               | <b>N/A</b> |
| <b>Biopesticides</b>                    |                                |          |                            |           |  |            |  |            |
| <i>Bacillus subtilis</i> strain QST 713 | 4                              | 2        | 13                         | 6         | 17                                       | 2          | 0  | 0          |
| <b>All biologicals<sup>(3)</sup></b>    | <b>4</b>                       | <b>2</b> | <b>57</b>                  | <b>14</b> | <b>61</b>                                | <b>2</b>   | <b>245</b>                               | <b>N/A</b> |
| <b>Molluscicides</b>                    |                                |          |                            |           |  |            |  |            |
| Metaldehyde                             | 0                              | 0        | 50                         | 23        | 50                                       | 4          | 0  | 0          |
| Area grown                              | 139                            |          | 218                        |           | 356                                      |            | 248                                      |            |

(1) In 2018 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, aronia, honeyberry, japanese wineberry, jostaberry, loganberry, tayberry, tummelberry, whitecurrant and worcesterberry

(2) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

(3) All biologicals includes biological control agents and biopesticides

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

N/A = not applicable

**Table 15 Other soft fruit fungicide and sulphur formulations – 2018**

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

| Fungicides              | Non-protected other soft fruit |           | Protected other soft fruit |           | All other soft fruit 2018 <sup>(1)</sup> |            | All other soft fruit 2016 <sup>(2)</sup> |            |
|-------------------------|--------------------------------|-----------|----------------------------|-----------|--|------------|--|------------|
|                         | ha                             | %         | ha                         | %         | ha                                       | kg         | ha                                       | kg         |
| Azoxystrobin            | 0                              | 0         | 11                         | 5         | 11                                       | 3          | 28                                       | 7          |
| Boscalid/pyraclostrobin | 11                             | 8         | 46                         | 15        | 57                                       | 19         | 42                                       | 16         |
| Bupirimate              | 11                             | 8         | 0                          | 0         | 11                                       | 3          | 4  | 2          |
| Cyprodinil/fludioxonil  | 18                             | 5         | 169                        | 62        | 186                                      | 94         | 155                                      | 69         |
| Fenhexamid              | 24                             | 7         | 127                        | 52        | 152                                      | 93         | 42                                       | 29         |
| Fenpropimorph           | 63                             | 24        | 2                          | 1         | 64                                       | 42         | 23                                       | 14         |
| Kresoxim-methyl         | 30                             | 22        | 0                          | 0         | 30                                       | 3          | 0  | 0          |
| Myclobutanil            | 5                              | 4         | 0                          | 0         | 5  | <0.5       | 26                                       | 1          |
| Pyrimethanil            | 0                              | 0         | 111                        | 51        | 111                                      | 79         | 64                                       | 43         |
| Quinoxifen              | 47                             | 20        | 0                          | 0         | 47                                       | 6          | 9  | 1          |
| <b>All fungicides</b>   | <b>209</b>                     | <b>38</b> | <b>466</b>                 | <b>85</b> | <b>675</b>                               | <b>342</b> | <b>414</b>                               | <b>189</b> |
| Sulphur                 | 3                              | 2         | 0                          | 0         | 3  | 2          | 6  | 25         |
| Area grown              | 139                            |           | 218                        |           | 356                                      |            | 248                                      |            |

(1) In 2018 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, aronia, honeyberry, japanese wineberry, jostaberry, loganberry, tayberry, tummelberry, whitecurrant and worcesterberry

(2) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 16 Other soft fruit herbicide and desiccant formulations – 2018**

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

| Herbicides/desiccants            | Non-protected other soft fruit |           | Protected other soft fruit |           | All other soft fruit 2018 <sup>(1)</sup> |            | All other soft fruit 2016 <sup>(2)</sup> |            |
|----------------------------------|--------------------------------|-----------|----------------------------|-----------|--|------------|--|------------|
|                                  | ha                             | %         | ha                         | %         | ha                                       | kg         | ha                                       | kg         |
| Carfentrazone-ethyl              | 23                             | 17        | 0                          | 0         | 23                                       | <0.5       | 0  | 0          |
| Clethodim                        | 0                              | 0         | 9                          | 4         | 9  | 2          | 0  | 0          |
| Diquat                           | 41                             | 30        | 34                         | 16        | 75                                       | 27         | 107                                      | 19         |
| Fluazifop-p-butyl                | 19                             | 14        | 0                          | 0         | 19                                       | 4          | 0  | 0          |
| Flufenacet/metribuzin            | 9                              | 6         | 21                         | 10        | 30                                       | 16         | 15                                       | 9          |
| Glyphosate                       | 10                             | 8         | 1                          | <0.5      | 11                                       | 11         | 55                                       | 55         |
| Isoxaben                         | 49                             | 35        | 7                          | 3         | 55                                       | 7          | 13                                       | 2          |
| Napropamide                      | 8                              | 6         | 33                         | 15        | 41                                       | 53         | 60                                       | 68         |
| Pendimethalin                    | 48                             | 34        | 7                          | 3         | 54                                       | 39         | 10                                       | 5          |
| Propyzamide                      | 37                             | 26        | 7                          | 3         | 43                                       | 32         | 10                                       | 4          |
| <b>All herbicides/desiccants</b> | <b>243</b>                     | <b>43</b> | <b>118</b>                 | <b>20</b> | <b>361</b>                               | <b>192</b> | <b>270</b>                               | <b>162</b> |
| Area grown                       | 139                            |           | 218                        |           | 356                                      |            | 248                                      |            |

(1) In 2018 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, aronia, honeyberry, japanese wineberry, jostaberry, loganberry, tayberry, tummelberry, whitecurrant and worcesterberry

(2) For a full list of formulations recorded in 2016 please refer to the 2016 report<sup>(3)</sup>

**Table 17** Compounds encountered in the soft fruit survey for the first time in 2018

| <b>Active substance</b> | <b>Type<sup>(1)</sup></b> | <b>Area (ha)</b> | <b>Weight (kg)</b> |
|-------------------------|---------------------------|------------------|--------------------|
| Trifloxystrobin         | F                         | 1,714            | 341                |
| Fluopyram               | F                         | 1,714            | 341                |
| Fenpyrazamine           | F                         | 419              | 240                |
| Proquinazid             | F                         | 141              | 5                  |
| Cyantraniliprole        | I                         | 55               | 4                  |
| Clethodim               | H                         | 11               | 2                  |

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

**Table 18 Mode of action/chemical group of insecticide active substances - 2018**

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

| Mode of Action  | Active Substance   | Chemical Group                  | IRAC Group | Total Soft Fruit | Total Soft Fruit |
|---|--------------------|---------------------------------|------------|------------------|------------------|
|   |                    |                                 |            | ha               | kg               |
| Acetylcholinesterase (Ache) inhibitors                                      | Pirimicarb         | Carbamate                       | 1A         | 19               | 4                |
| <b>All acetylcholinesterase (Ache) inhibitors</b>                           |                    |                                 |            | <b>19</b>        | <b>4</b>         |
| Sodium channel modulators   | Deltamethrin       | Pyrethroid                      | 3A         | 243              | 2                |
|   | Lambda-cyhalothrin | Pyrethroid                      | 3A         | 1,216            | 11               |
|   | Pyrethrins         | Pyrethrin                       | 3A         | 494              | 28               |
| <b>All sodium channel modulators</b>  |                    |                                 |            | <b>1,953</b>     | <b>40</b>        |
| Nicotinic acetylcholine receptor (naAChR) competitive modulators            | Thiacloprid        | Neonicotinoid                   | 4A         | 1,807            | 216              |
| <b>All nicotinic acetylcholine receptor (naAChR) competitive modulators</b> |                    |                                 |            | <b>1,807</b>     | <b>216</b>       |
| Nicotinic acetylcholine receptor (naAChR) allosteric modulators             | Spinosad           | Spinosyns                       | 5          | 345              | 27               |
| <b>All icotinic acetylcholine receptor (naAChR) allosteric modulators</b>   |                    |                                 |            | <b>345</b>       | <b>27</b>        |
| Glutamate-gated chloride channel (GluCl) allosteric modulators              | Abamectin          | Avermectins                     | 6          | 652              | 6                |
| <b>All glutamate-gated chloride channel (GluCl) allosteric modulators</b>   |                    |                                 |            | <b>652</b>       | <b>6</b>         |
| Chordotonal organ TRPV channel modulators                                   | Pymetrozine        | Pyridine azomethine derivatives | 9B         | 62               | 12               |
| <b>All Chordotonal organ TRPV channel modulators</b>                        |                    |                                 |            | <b>62</b>        | <b>12</b>        |

Cont...

**Table 18 Mode of action/chemical group of insecticide active substances – 2018 continued**

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

| Mode of Action   | Active Substance | Chemical Group                 | IRAC Group | Total Soft Fruit | Total Soft Fruit |
|--|------------------|--------------------------------|------------|------------------|------------------|
|  |                  |                                |            | ha               | kg               |
| Mite growth inhibitors   | Clofentezine     | Tetrazine                      | 10A        | 162              | 32               |
|  | Etoxazole        | Etoxazole                      | 10B        | 241              | 8                |
| <b>All mite growth inhibitors</b>                                  |                  |                                |            | <b>403</b>       | <b>41</b>        |
| Mitochondrial complex III electron transport inhibitors            | Bifenazate       | Bifenazate                     | 20D        | 310              | 36               |
| <b>All mitochondrial complex III electron transport inhibitors</b> |                  |                                |            | <b>310</b>       | <b>36</b>        |
| Mitochondrial complex I electron transport inhibitors              | Tebufenpyrad     | METI acaricides & insecticides | 21A        | 55               | 7                |
| <b>All mitochondrial complex I electron transport inhibitors</b>   |                  |                                |            | <b>55</b>        | <b>7</b>         |
| Voltage-dependent sodium channel blockers                          | Indoxacarb       | Oxadiazines                    | 22A        | 75               | 4                |
| <b>All voltage-dependent sodium channel blockers</b>               |                  |                                |            | <b>75</b>        | <b>4</b>         |
| Inhibitors of acetyl CoA carboxylase                               | Spirodiclofen    | Tetronic acid                  | 23         | 18               | 2                |
|  | Spirotetramat    | Tetronic acid                  | 23         | 180              | 17               |
| <b>All inhibitors of acetyl CoA carboxylase</b>                    |                  |                                |            | <b>198</b>       | <b>19</b>        |

Cont...

**Table 18 Mode of action/chemical group of insecticide active substances – 2018 continued**

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

| Mode of Action                           | Active Substance    | Chemical Group | IRAC Group | Total Soft Fruit | Total Soft Fruit |
|--|---------------------|----------------|------------|------------------|------------------|
|  |                     |                |            | ha               | kg               |
| Ryanodine receptor modulators            | Chlorantraniliprole | Diamides       | 28         | 9                | <0.5             |
|  | Cyantraniliprole    | Diamides       | 28         | 55               | 4                |
| <b>All ryanodine receptor modulators</b> |                     |                |            | <b>64</b>        | <b>4</b>         |
| Unclassified                             | Fatty Acids         |                |            | 30               | 230              |
| <b>All unclassified</b>                  |                     |                |            | <b>30</b>        | <b>230</b>       |
| <b>All insecticides</b>                  |                     |                |            | <b>5,973</b>     | <b>645</b>       |
| Area grown <sup>(1)</sup>                |                     |                |            | 2,088            |                  |

(1) Includes multi-cropping

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<sup>(6)</sup>



**Table 19 Mode of action/chemical group of fungicide active substances - 2018**

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

| Mode of Action                               | Active Substance | Group Name                     | Chemical Group                 | FRAC Group | Total Soft Fruit | Total Soft Fruit |
|--|------------------|--------------------------------|--------------------------------|------------|------------------|------------------|
|  |                  |                                |                                |            | ha               | kg               |
| Nucleic acid synthesis                       | Metalaxyl-M      | Phenylamide                    | Acylalanine                    | 4          | 6                | 2                |
|  | Bupirimate       | Hydroxy-(2-amino-) pyrimidines | Hydroxy-(2-amino-) pyrimidines | 8          | 1,245            | 423              |
| <b>All nucleic acid synthesis</b>            |                  |                                |                                |            | <b>1,250</b>     | <b>425</b>       |
| Respiration                                  | Boscalid         | SDHI                           | Pyridine-carboxamides          | 7          | 1,176            | 455              |
|  | Fluopyram        | SDHI                           | Pyridinyl-ethyl-benzamides     | 7          | 1,714            | 341              |
|  | Fluxapyroxad     | SDHI                           | Pyrazole-4-carboxamides        | 7          | 178              | 8                |
|  | Azoxystrobin     | Qo inhibitor                   | Methoxy-acrylates              | 11         | 1,056            | 262              |
|  | Fenamidone       | Qo inhibitor                   | Imidazolinones                 | 11         | 581              | 133              |
|  | Kresoxim-methyl  | Qo inhibitor                   | Oximino-acetates               | 11         | 440              | 55               |
|  | Pyraclostrobin   | Qo inhibitor                   | Methoxy-carbamates             | 11         | 1,176            | 114              |
|  | Trifloxystrobin  | Qo inhibitor                   | Strobilurin                    | 11         | 1,714            | 341              |
|  | Meptyldinocap    |                                | Dinitrophenyl crotonates       | 29         | 87               | 18               |
| <b>All respiration</b>                       |                  |                                |                                |            | <b>8,122</b>     | <b>1,727</b>     |
| Amino acids and protein synthesis            | Cyprodinil       | Anilino - pyrimidine           | Anilino - pyrimidine           | 9          | 1,703            | 621              |
|  | Mepanipyrim      | Anilino - pyrimidine           | Anilino - pyrimidine           | 9          | 469              | 182              |
|  | Pyrimethanil     | Anilino - pyrimidine           | Anilino - pyrimidine           | 9          | 1,028            | 723              |
| <b>All amino acids and protein synthesis</b> |                  |                                |                                |            | <b>3,200</b>     | <b>1,525</b>     |

Cont...

**Table 19 Mode of action/chemical group of fungicide active substances - 2018**

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

| Mode of Action                              | Active Substance | Group Name              | Chemical Group     | FRAC Group | Total Soft Fruit | Total Soft Fruit |
|---|------------------|-------------------------|--------------------|------------|------------------|------------------|
|   |                  |                         |                    |            | ha               | kg               |
| Signal transduction                         | Iprodione        | Dicarboximide           | Dicarboximide      | 2          | 177              | 127              |
|   | Fludioxonil      | Phenylpyrroles          | Phenylpyrroles     | 12         | 1,703            | 414              |
|   | Quinoxifen       | Phenylpyrroles          | Phenylpyrroles     | 13         | 807              | 100              |
|   | Proquinazid      | Aza-naphthalenes        | Quinazolinone      | 13         | 141              | 5                |
| <b>All signal transduction</b>              |                  |                         |                    |            | <b>2,828</b>     | <b>645</b>       |
| Sterol biosynthesis in membranes            | Difenoconazole   | DeMethylation inhibitor | Triazoles          | 3          | 206              | 9                |
|   | Myclobutanil     | DeMethylation inhibitor | Triazoles          | 3          | 90               | 8                |
|   | Penconazole      | DeMethylation inhibitor | Triazoles          | 3          | 957              | 48               |
|   | Tebuconazole     | DeMethylation inhibitor | Triazoles          | 3          | 62               | 12               |
|   | Fenpropimorph    | Morpholine              | Morpholines        | 5          | 398              | 282              |
|   | Fenhexamid       | KetoReductase Inhibitor | Hydroxyanilides    | 17         | 2,487            | 1,719            |
|   | Fenpyrazamine    | KetoReductase Inhibitor | Amino-pyrazolinone | 17         | 419              | 240              |
| <b>All sterol biosynthesis in membranes</b> |                  |                         |                    |            | <b>4,619</b>     | <b>2,318</b>     |

Cont...

**Table 19 Mode of action/chemical group of fungicide active substances - 2018**

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

| Mode of Action                                | Active Substance             | Group Name            | Chemical Group                 | FRAC Group | Total Soft Fruit | Total Soft Fruit |
|---|------------------------------|-----------------------|--------------------------------|------------|------------------|------------------|
|   |                              |                       |                                |            | ha               | kg               |
| Cell wall biosynthesis                        | Dimethomorph                 | Carboxylic acid amide | Morpholine/cinamic acid amides | 40         | 229              | 342              |
| <b>All cell wall biosynthesis</b>             |                              |                       |                                |            | <b>229</b>       | <b>342</b>       |
| Chemicals with multi-site activity            | Chlorothalonil               | Chloronitrile         | Chloronitrile                  | M 05       | 86               | 87               |
| <b>All chemicals with multi-site activity</b> |                              |                       |                                |            | <b>86</b>        | <b>87</b>        |
| Unknown mode of action                        | Cyflufenamid                 | Phenyl-acetamide      | Phenyl-acetamide               | U 06       | 938              | 14               |
|   | Fosetyl-aluminium            | Phosphonates          | Ethyl phosphonates             | 33         | 581              | 1,329            |
| <b>All unknown mode of action</b>             |                              |                       |                                |            | <b>1,519</b>     | <b>1,343</b>     |
| Not classified                                | Potassium hydrogen carbonate |                       |                                | NC         | 438              | 2,604            |
| <b>All not classified</b>                     |                              |                       |                                |            | <b>438</b>       | <b>2,604</b>     |
| <b>All fungicides</b>                         |                              |                       |                                |            | <b>22,291</b>    | <b>11,017</b>    |
| Sulphur                                       |                              |                       |                                |            | 1,085            | 4,058            |
| Area grown <sup>(1)</sup>                     |                              |                       |                                |            | 2,088            |                  |

(1) Includes multi-cropping

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<sup>(7)</sup>

**Table 20 Mode of action/chemical group of herbicide active substances - 2018**

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

| Mode of Action  | Active substance    | Chemical Group                   | HRAC Group | Total Soft Fruit | Total Soft Fruit |
|---|---------------------|----------------------------------|------------|------------------|------------------|
|   |                     |                                  |            | ha               | kg               |
| Inhibition of acetyl CoA carboxylase                      | Clethodim           | Cyclohexanedione 'DIMS'          | A          | 11               | 2                |
|   | Fluazifop-P-Butyl   | Aryloxyphenoxy-propionate 'FOPS' | A          | 45               | 12               |
| <b>All inhibition of acetyl CoA carboxylase</b>           |                     |                                  |            | <b>56</b>        | <b>14</b>        |
| Inhibition of photosynthesis at photosystem II            | Lenacil             | Uracil                           | C1         | 2                | 3                |
|   | Metamitron          | Triazinone                       | C1         | 68               | 50               |
|   | Metribuzin          | Triazinone                       | C1         | 201              | 39               |
|   | Phenmedipham        | Phenyl-carbamate                 | C1         | 1                | 0                |
| <b>All inhibition of photosynthesis at photosystem II</b> |                     |                                  |            | <b>272</b>       | <b>92</b>        |
| Photosystem-I-electron diversion                          | Diquat              | Bibyrilidium                     | D          | 1,010            | 223              |
| <b>All photosystem-I-electron diversion</b>               |                     |                                  |            | <b>1,010</b>     | <b>223</b>       |
| Inhibition of protoporphyrinogen oxidase                  | Carfentrazone-ethyl | Triazolinone                     | E          | 282              | 3                |
| <b>All inhibition of protoporphyrinogen oxidase</b>       |                     |                                  |            | <b>282</b>       | <b>3</b>         |
| Inhibition of EPSP synthase                               | Glyphosate          | Glycine                          | G          | 134              | 81               |
| <b>All inhibition of EPSP synthase</b>                    |                     |                                  |            | <b>134</b>       | <b>81</b>        |
| Microtubule assembly inhibition                           | Pendimethalin       | Dinitroaniline                   | K1         | 302              | 181              |
|   | Propyzamide         | Benzamide                        | K1         | 299              | 224              |
| <b>All microtubule assembly inhibition</b>                |                     |                                  |            | <b>601</b>       | <b>405</b>       |

Cont...

**Table 20 Mode of action/chemical group of herbicide active substances – 2018 continued**

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

| Mode of Action                               | Active substance | Chemical Group           | HRAC Group | Total Soft Fruit | Total Soft Fruit |
|--|------------------|--------------------------|------------|------------------|------------------|
|  |                  |                          |            | ha               | kg               |
| Inhibition of VLCFAs                         | Flufenacet       | Oxyacetamide             | K3         | 201              | 53               |
|  | Napropamide      | Acetamide                | K3         | 333              | 303              |
| <b>All inhibition of VLCFAs</b>              |                  |                          |            | <b>534</b>       | <b>357</b>       |
| Inhibition of cell wall synthesis            | Isoxaben         | Benzamide                | L          | 205              | 21               |
| <b>All inhibition of cell wall synthesis</b> |                  |                          |            | <b>205</b>       | <b>21</b>        |
| Action like indole acetic acid               | 2,4-D            | Phenoxy-carboxylic acid  | O          | 3                | 3                |
|  | Clopyralid       | Pyridine carboxylic acid | O          | 2                | 0                |
| <b>All action like indole acetic acid</b>    |                  |                          |            | <b>5</b>         | <b>3</b>         |
| <b>All herbicides</b>                        |                  |                          |            | <b>3,098</b>     | <b>1,199</b>     |
| Area grown <sup>(1)</sup>                    |                  |                          |            | 2,088            |                  |

(1) Includes multi-cropping

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<sup>(8)</sup>

**Table 21 Principal active substances by area treated**

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

|    | Active substance                           | Type <sup>(1)</sup> | 2018  | 2016  | % change |
|----|--|---------------------|-------|-------|----------|
| 1  | Fenhexamid                                 | F                   | 2,487 | 1,704 | 46       |
| 2  | <i>Bacillus subtilis</i> strain QST 713    | BP                  | 1,900 | 831   | 129      |
| 3  | Thiacloprid                                | I                   | 1,807 | 1,163 | 55       |
| 4  | Trifloxystrobin                            | F                   | 1,714 | 0     |          |
| 5  | Fluopyram                                  | F                   | 1,714 | 0     |          |
| 6  | Fludioxonil                                | F                   | 1,703 | 1,789 | -5       |
| 7  | Cyprodinil                                 | F                   | 1,703 | 1,789 | -5       |
| 8  | Bupirimate                                 | F                   | 1,245 | 891   | 40       |
| 9  | Lambda-cyhalothrin                         | I                   | 1,216 | 1,360 | -11      |
| 10 | Pyraclostrobin                             | F                   | 1,176 | 1,208 | -3       |
| 11 | Boscalid                                   | F                   | 1,176 | 1,208 | -3       |
| 12 | Sulphur                                    | SU                  | 1,085 | 781   | 39       |
| 13 | Azoxystrobin                               | F                   | 1,056 | 1,194 | -12      |
| 14 | Pyrimethanil                               | F                   | 1,028 | 524   | 96       |
| 15 | Diquat                                     | H                   | 1,010 | 1,404 | -28      |
| 16 | Penconazole                                | F                   | 957   | 193   | 395      |
| 17 | Cyflufenamid                               | F                   | 938   | 70    | 1,249    |
| 18 | Quinoxifen                                 | F                   | 807   | 777   | 4        |
| 19 | <i>Ampelomyces quisqualis</i> strain AQ 10 | BP                  | 773   | 0     |          |
| 20 | Abamectin                                  | I                   | 652   | 1,035 | -37      |

**Table 22 Principal active substances by weight**

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

|    | Active substance             | Type <sup>(1)</sup> | 2018  | 2016  | % change |
|----|------------------------------|---------------------|-------|-------|----------|
| 1  | Sulphur                      | SU                  | 4,058 | 3,687 | 10       |
| 2  | Potassium hydrogen carbonate | F                   | 2,604 | 935   | 178      |
| 3  | Fenhexamid                   | F                   | 1,719 | 1,211 | 42       |
| 4  | Fosetyl-aluminium            | F                   | 1,329 | 363   | 266      |
| 5  | Pyrimethanil                 | F                   | 723   | 350   | 106      |
| 6  | Cyprodinil                   | F                   | 621   | 646   | -4       |
| 7  | Boscalid                     | F                   | 455   | 419   | 9        |
| 8  | Bupirimate                   | F                   | 423   | 306   | 39       |
| 9  | Fludioxonil                  | F                   | 414   | 431   | -4       |
| 10 | Dimethomorph                 | F                   | 342   | 312   | 10       |
| 11 | Trifloxystrobin              | F                   | 341   | 0     |          |
| 12 | Fluopyram                    | F                   | 341   | 0     |          |
| 13 | Napropamide                  | H                   | 303   | 640   | -53      |
| 14 | Fenpropimorph                | F                   | 282   | 273   | 4        |
| 15 | Azoxystrobin                 | F                   | 262   | 297   | -12      |
| 16 | Fenpyrazamine                | F                   | 240   | 0     |          |
| 17 | Fatty Acids                  | I                   | 230   | 0     |          |
| 18 | Propyzamide                  | H                   | 224   | 115   | 94       |
| 19 | Diquat                       | H                   | 223   | 351   | -36      |
| 20 | Thiacloprid                  | I                   | 216   | 140   | 55       |

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

**Table 23 Total soft fruit crop, comparison with previous years**

Pesticide usage in 2014, 2016 and 2018, area treated with formulations and active substances (a.s.) and the weight (kg) applied

|   | 2014          |               |               | 2016          |               |               | 2018          |               |               |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
|   | Formulations  | a.s.          | Weight        | Formulations  | a.s.          | Weight        | Formulations  | a.s.          | Weight        |
|   | ha            | ha            | kg            | ha            | ha            | kg            | ha            | ha            | kg            |
| Insecticides/<br>acaracides                 | 9,435         | 9,435         | 1,480         | 5,741         | 5,741         | 461           | 5,973         | 5,973         | 645           |
| Molluscicides                               | 412           | 412           | 109           | 293           | 293           | 68            | 823           | 823           | 150           |
| Fungicides                                  | 18,505        | 21,498        | 13,392        | 13,788        | 16,940        | 7,055         | 16,911        | 22,291        | 11,017        |
| Sulphur                                     | 1,964         | 1,964         | 5,913         | 781           | 781           | 3,687         | 1,085         | 1,085         | 4,058         |
| Herbicides/<br>desiccants                   | 4,246         | 4,549         | 2,187         | 3,958         | 4,163         | 1,837         | 2,894         | 3,098         | 1,199         |
| Biological control<br>agents <sup>(1)</sup> | 466           | 466           | N/A           | 622           | 622           | N/A           | 1,129         | 1,129         | N/A           |
| Biopesticides                               | 1,759         | 1,759         | 136           | 852           | 852           | 70            | 2,921         | 2,921         | 198           |
| Physical control                            | 42            | 325           | 447           | 6             | 24            | 47            | 50            | 50            | 97            |
| <b>All pesticides</b>                       | <b>36,828</b> | <b>40,407</b> | <b>23,663</b> | <b>26,041</b> | <b>29,416</b> | <b>13,225</b> | <b>31,786</b> | <b>37,371</b> | <b>17,363</b> |
| Area grown (ha) <sup>(2)</sup>              | 1,800         |               |               | 1,876         |               |               | 2,088         |               |               |

(1) Invertebrate biological control agents are applied by number of organisms rather than weight therefore weight data are not presented

(2) Area grown includes multi-cropping

Note: the 2016 and 2014 herbicide/desiccant weights and therefore weight for all pesticides are lower than those published previously. The weights were previously overestimated and these have now been corrected in this report

N/A = not applicable

## Appendix 2 – Survey statistics

### Census and sample information

**Table 24 Census crop areas 2018**

Census area (ha) of soft fruit crops grown in Scotland

|                                | Scotland<br>2018 | Scotland<br>2016 | %<br>change |
|--------------------------------|------------------|------------------|-------------|
| Strawberry                     | 1,133            | 993              | 14          |
| Raspberry                      | 271              | 326              | -17         |
| Blackcurrant                   | 279              | 302              | -8          |
| Blueberry                      | 219              | 132              | 65          |
| Mixed and other soft<br>fruits | 147              | 122              | 21          |
| <b>All soft fruit</b>          | <b>2,050</b>     | <b>1,876</b>     | <b>9</b>    |

Note: Data taken from the 2018 and 2016 June Agricultural Census.

All areas exclude multi-cropping

It was estimated from the crops encountered in the 2018 sample, that 11 ha of the mixed and other soft fruit categories in the census were raspberry, strawberry, blueberry or blackcurrant

**Table 25 Distribution of soft fruit sample - 2018**

Number of holdings surveyed in each region and size group

| Size <sup>(1)</sup> (ha) | North     | Angus     | South     | Scotland  |
|--------------------------|-----------|-----------|-----------|-----------|
| 0.01 - 4.99              | 22        | 4         | 8         | <b>34</b> |
| 5.00 - 9.99              | 0         | 4         | 3         | <b>7</b>  |
| 10.00 - 19.99            | 2         | 10        | 1         | <b>13</b> |
| 20 +                     | 2         | 10        | 6         | <b>18</b> |
| <b>All sizes</b>         | <b>26</b> | <b>28</b> | <b>18</b> | <b>72</b> |

(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 26 Non-protected soft fruit sample areas - 2018**

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

| <b>Size<sup>(1)</sup> (ha)</b> | <b>Scotland<sup>(2)</sup></b> |
|--------------------------------|-------------------------------|
| 0.01 - 4.99                    | 11.49                         |
| 5.00 - 9.99                    | 15.71                         |
| 10.00 - 19.99                  | 22.97                         |
| 20 +                           | 139.45                        |
| <b>All sizes</b>               | <b>189.62</b>                 |

**Table 27 Non-protected soft fruit census areas - 2018**

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

| <b>Size<sup>(1)</sup> (ha)</b> | <b>Scotland<sup>(2)</sup></b> |
|--------------------------------|-------------------------------|
| 0.01 - 4.99                    | 102.19                        |
| 5.00 - 9.99                    | 56.51                         |
| 10.00 - 19.99                  | 112.10                        |
| 20 +                           | 292.31                        |
| <b>All sizes</b>               | <b>563.11</b>                 |

(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 28 Protected soft fruit sample areas - 2018**

Area (ha) of protected soft fruit crops in sample

| <b>Size<sup>(1)</sup> (ha)</b> | <b>Scotland<sup>(2)</sup></b> |
|--------------------------------|-------------------------------|
| 0.01 - 4.99                    | 11.77                         |
| 5.00 - 9.99                    | 23.54                         |
| 10.00 - 19.99                  | 124.80                        |
| 20 +                           | 556.95                        |
| <b>All sizes</b>               | <b>717.07</b>                 |

**Table 29 Protected soft fruit census areas - 2018**

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

| <b>Size<sup>(1)</sup> (ha)</b> | <b>Scotland<sup>(2)</sup></b> |
|--------------------------------|-------------------------------|
| 0.01 - 4.99                    | 50.84                         |
| 5.00 - 9.99                    | 85.28                         |
| 10.00 - 19.99                  | 252.74                        |
| 20 +                           | 1097.64                       |
| <b>All sizes</b>               | <b>1486.50</b>                |

(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 30 Non-protected soft fruit raising factors - 2018**

| Size <sup>(1)</sup> (ha) | North   | Angus   | South   |
|--------------------------|---------|---------|---------|
| 0.01 - 4.99              | 11.6241 | 5.5468  | 17.0472 |
| 5.00 - 9.99              |         | 38.0909 | 1.0000  |
| 10.00 - 19.99            | 1.7045  | 5.6327  |         |
| 20 +                     |         | 2.0027  |         |

**Table 31 Protected soft fruit raising factors - 2018**

| Size <sup>(1)</sup> (ha) | North  | Angus  | South   |
|--------------------------|--------|--------|---------|
| 0.01 - 4.99              | 1.9536 | 4.7853 | 7.0480  |
| 5.00 - 9.99              |        | 2.7976 | 12.5100 |
| 10.00 - 19.99            | 2.1216 | 1.5554 | 6.1829  |
| 20 +                     |        | 2.0851 | 2.7629  |

(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 32 Non-protected soft fruit first and second adjustment factors - 2018**

|                  | North<br>Adj. 1 | Angus<br>Adj. 1 | South<br>Adj. 1 | Adj 2  |
|------------------|-----------------|-----------------|-----------------|--------|
| Strawberries     | 6.0200          | 11.2300         | 9.2900          | 1.0000 |
| Raspberries      | 5.9600          | 95.4500         | 7.6300          | 1.0000 |
| Blackcurrants    | 3.7800          | 272.9300        | 2.3900          | 1.0000 |
| Other soft fruit | 26.8100         | 83.1900         | 38.4300         | 1.0000 |

**Table 33 Protected soft fruit first and second adjustment factors - 2018**

|                  | North<br>Adj. 1 | Angus<br>Adj. 1 | South<br>Adj. 1 | Adj 2  |
|------------------|-----------------|-----------------|-----------------|--------|
| Strawberries     | 25.6401         | 755.0211        | 325.6491        | 1.0000 |
| Raspberries      | 6.9678          | 136.8011        | 18.6500         | 1.0000 |
| Other soft fruit | 6.8539          | 180.1679        | 30.7500         | 0.9998 |

## Response rates

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

**Table 34**      **Response rate**

|   | <b>2018</b> | <b>% total</b> |
|---|-------------|----------------|
| Target sample                           | 82          | 100            |
|   |             |                |
| <b>Total achieved</b>                   | <b>72</b>   | <b>88</b>      |
|   |             |                |
| Total number of refusals/non-contact    | 46          |                |
| <b>Total number of farms approached</b> | <b>118</b>  |                |

## 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 2018 Soft Fruit Crop Survey placed on those providing the information, the surveyors recorded the time that 48 respondents spent providing the data during the surveys. This sample represents 67 per cent of growers surveyed. The median time taken to provide the information was 15 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 £14.38)<sup>(9)</sup>

The total financial burden to all growers resulting from participation in the 2018 Soft Fruit Crop survey was calculated to be £259.

## 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, biopesticides, 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 (before 2015) 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). A **desiccant** is a pesticide used to dry out unwanted plant material.

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

8) A **molluscicide** is a pesticide used to control unwanted 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 and 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 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 data are reported in two formats. For each pesticide formulation (mixture of active substances in a product) the area treated and weight applied is reported. Areas and weights for individual active substances are not included in this report but are published in Excel format as supplementary tables. These 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. In addition, both weight 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 weight 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 the crops.

17) The **June Agricultural Census**<sup>(10)</sup> 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 farmers growing the relevant crops to participate in the survey.

18) 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 – survey methodology 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.

19) 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**.

20) Where quoted in the text, 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 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 2016<sup>(3)</sup> and 2014<sup>(4)</sup> surveys are provided for comparison purposes in some of the tables, although 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 consider 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) The **average number of applications** indicated in the text for each crop is based on the occurrence of a pesticide group on at least ten per cent of the area grown. The average number of applications is calculated only on the areas receiving each pesticide group and therefore the minimum number of applications is always 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 pesticide group.

24) **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.

25) **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 the mulch.

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

27) 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 maturation of the crop allowing for a continuous supply of fruit.

28) The term **harvested** refers to plants that were harvested during 2018. This can include perennial crops planted the previous year and plants such as strawberries planted in early 2018. Some plants which are not harvested can include young plants such as raspberries which are normally harvested in their second year.

29) **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.

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

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



## Appendix 4 – Survey methodology

### Sampling and data collection

Using the June 2018 Agricultural Census<sup>(10)</sup>, 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 29). 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 2018. 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.

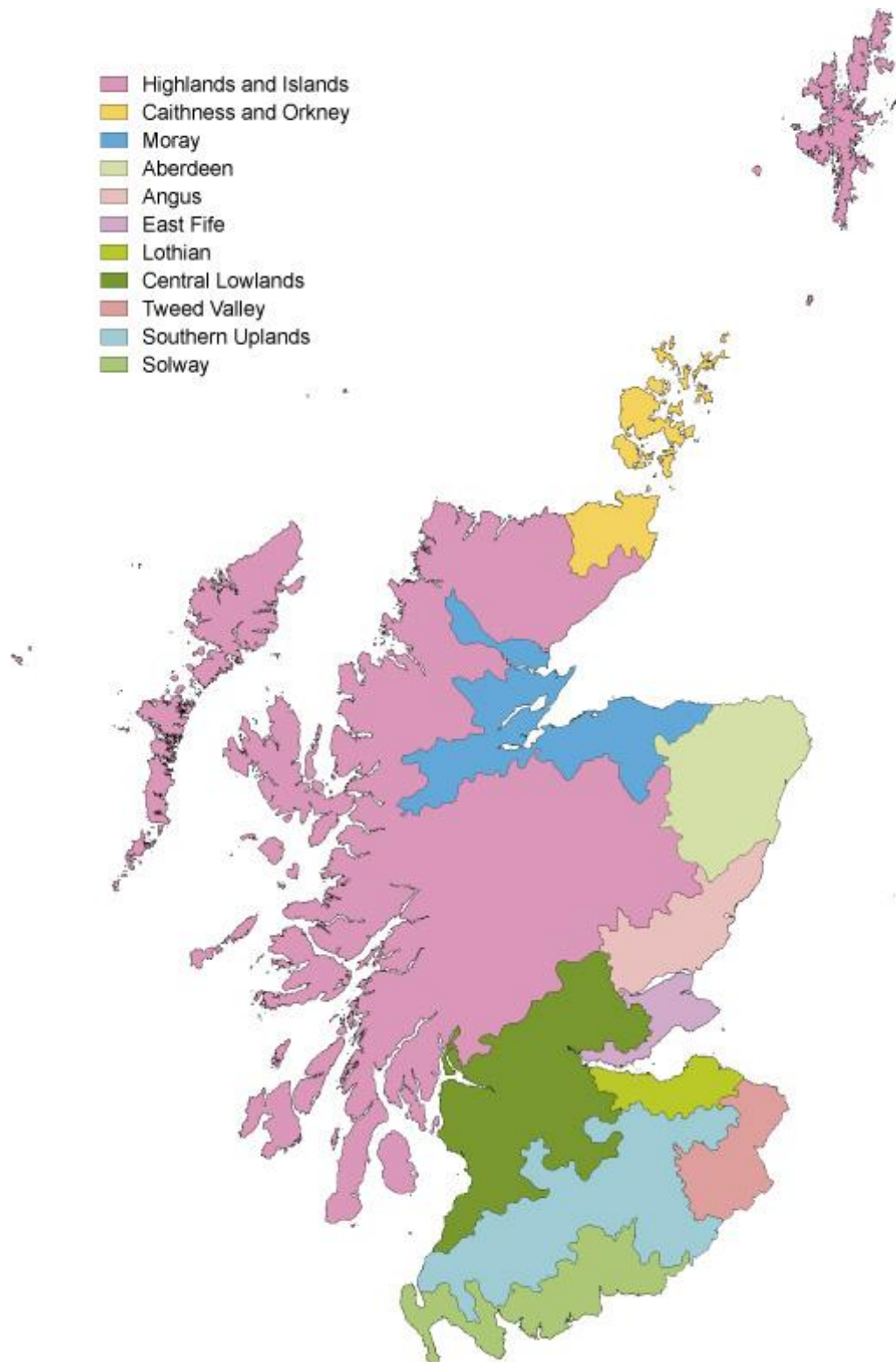
Following an introductory letter and phone call, data were collected by either personal interview during a visit to the holding or during a phone interview or by email. Where necessary, information was also collected from agronomists and contractors. In total, information was collected from 72 holdings growing soft fruit crops (Table 25). These holdings represent 44 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 30 & 31). 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 32 & 33) 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. Due to the distribution of soft fruit crops in Scotland the land use regions were amalgamated into three areas before raising; 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).

**Figure 29 Land use regions of Scotland<sup>(11)</sup>**



## **Changes from previous years**

There are a number of changes which should be noted when comparing the 2018 data with the previous survey.

The areas and weights treated with individual active substances are no longer included at crop level in this report. These data are now published separately as supplementary tables in Excel format to allow continued user access to the full dataset. In this report, the areas treated and weights of pesticide formulations (mixture of active substances in a product) by crop are presented in Tables 2-16 and summary active substance data are presented in Tables 17 to 23. The aim of this change is to focus on the key metrics at crop level and reduce the size of the published report. This approach is consistent with the output from the other UK pesticide survey teams.

The 2016 and 2014 herbicide and desiccant weights and therefore weight for all pesticides are lower than those published previously. The weights were previously overestimated and these have now been corrected in this report.

The previous report contained information about grower adoption of Integrated Pest Management (IPM). IPM data was not collected during the 2018 survey. It is anticipated that IPM data will be collected and published every 4 years. This allows IPM uptake to be monitored over time but reduces the burden on, growers and surveyors.

All farmers who participate in our surveys are now eligible to collect two BASIS and/or NRoSO CPD points. This may have contributed towards increased participation levels in our survey in 2018 compared to in 2016. In 2018 we achieved 88 per cent of the target sample, while in 2016 we achieved 57 per cent.

## **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 idea of the precision of estimates, the report includes relative standard errors (RSE) (Table 35). 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 (Table 35) 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 soft fruit crops (protected and non-protected) was 10 per cent for area and 13 per cent for quantity (Table 35)

The RSE for constituent protected and non-protected crop groups varied from 11 to 88 per cent for area and 13 to 52 per cent for weight (Table 36), 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 overall RSE values for protected and non-protected soft fruit crops should be treated with caution.

**Table 35 Relative standard errors for total soft fruit- 2018**

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

| Crops                       | Area SE (%) | Weight SE (%) |
|-----------------------------|-------------|---------------|
| Raspberry                   | 23          | 21            |
| Strawberry                  | 12          | 20            |
| Blackcurrant <sup>(1)</sup> | 14          | 17            |
| Other soft fruit            | 31          | 16            |
| <b>All soft fruit crops</b> | <b>10</b>   | <b>13</b>     |

**Table 36 Relative standard errors for protected and non-protected soft fruit crops - 2018**

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

| Crops   | Area SE (%) | Weight SE (%) |
|---|-------------|---------------|
| Protected raspberry <sup>(1)</sup>            | 15          | 17            |
| Protected strawberry                          | 11          | 18            |
| Protected other soft fruit                    | 16          | 13            |
| Non-protected raspberry <sup>(1)</sup>        | 88          | 73            |
| Non-protected strawberry <sup>(1)</sup>       | 37          | 43            |
| Non-protected blackcurrant <sup>(1)</sup>     | 15          | 17            |
| Non-protected other soft fruit <sup>(1)</sup> | 43          | 52            |
| <b>All non-protected crops<sup>(1)</sup></b>  | <b>21</b>   | <b>23</b>     |
| <b>All protected crops</b>                    | <b>11</b>   | <b>17</b>     |

(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 the overall RSE values should be treated with caution

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