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Pesticide Usage in Scotland

A National Statistics Publication for Scotland

Soft Fruit Crops 2020

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Executive summary

This report presents information from a survey of pesticide use on soft fruit crops grown in Scotland in 2020. The crops surveyed included strawberries, raspberries, blackcurrants and other minor soft fruit crops.

The estimated area of soft fruit crops grown in Scotland in 2020 was 2,193 hectares, including 25 hectares of multi-cropping. Strawberries accounted for 56 per cent of the soft fruit area, other soft fruit crops 19 per cent, blackcurrants 14 per cent and raspberries 11 per cent. Data were collected from a total of 64 holdings, collectively representing 36 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. 35,950 hectares (± 12 per cent Relative Standard Error, RSE) with a combined weight of ca. 17.2 tonnes (±13 per cent RSE). Overall, pesticides were applied to 90 per cent of the soft fruit crop area. Fungicides were applied to 86 per cent of the crop area, insecticides/acaricides to 83 per cent, herbicides to 34 per cent, biologicals to 47 per cent, molluscicides to 22 per cent and sulphur was applied to 32 per cent.

Taking into account changes in crop area, the 2020 total pesticide treated area was eight per cent higher than that reported in 2018 and 18 per cent higher than in 2016. The weight of pesticides applied to soft fruit crops in 2020 was six per cent lower than in 2018 and 11 per cent higher than in 2016. The application of physical controls, biological control agents, insecticides/ acaricides, sulphur and fungicides increased from the 2018 survey (544, 192, 27, 24 and four per cent increases in treated area respectively). The application of biopesticides, herbicides/desiccants and molluscicides decreased (61, 21 and 18 per cent decreases in treated area respectively).

Overall pesticide application to soft fruit crops was slightly higher in 2020 than reported in 2018 in terms of area treated but slightly lower in terms of weight applied. The different trends between these two metrics may have been influenced by the large increases in use of biological control agents which play an important part in growers Integrated Pest Management (IPM) programmes. Invertebrate biological control agents are applied by number of organisms rather than weight, therefore only the area treated is recorded, not the weight applied.

In terms of area treated, the fungicide fenhexamid was, as in 2016, the most commonly used active substance. *Neoseiulus cucumeris*, lambda-cyhalothrin and pendimethalin were the most used biological, insecticide/acaricide and herbicide/desiccant active substances respectively. Sulphur, which is used at high application rates, was the most commonly used pesticide by weight.

Data collected from growers about their Integrated Pest Management (IPM) activities showed that growers were using a variety of IPM methods in relation to risk management, pest monitoring and pest control. This dataset is the second in this series of surveys of IPM measures on soft fruit crops, allowing the adoption of IPM techniques to be monitored.

Introduction

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

This survey is part of a series of annual reports which are produced to detail pesticide usage in Scotland for arable, vegetable 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 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 2020. 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.

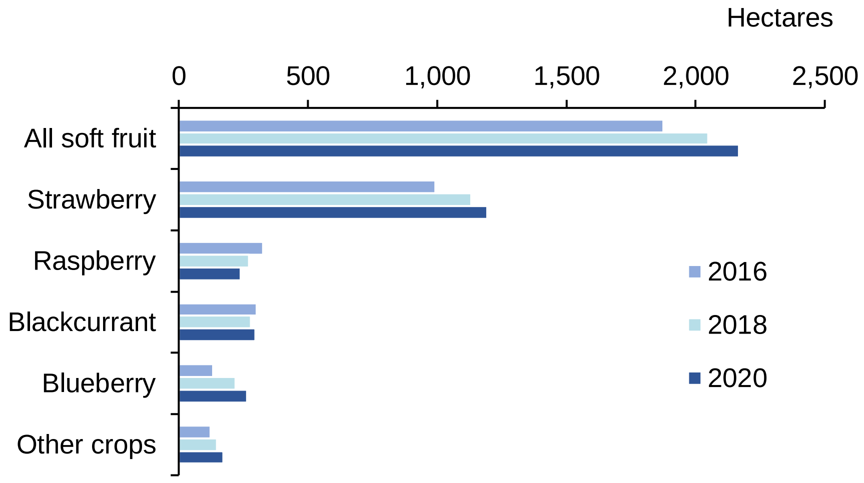
General trends

Crop area

In 2020 the census area of soft fruit crops grown was 2,168 hectares (Table 24). This represents a six per cent increase from 2018[3] and a 16 per cent increase from 2016[4]. Since the last survey, the areas of blueberries, mixed/ other soft fruits, blackcurrants and strawberries have increased (21,17, six and five per cent respectively); while the area of raspberries have decreased by 11 per cent (Figure 1).

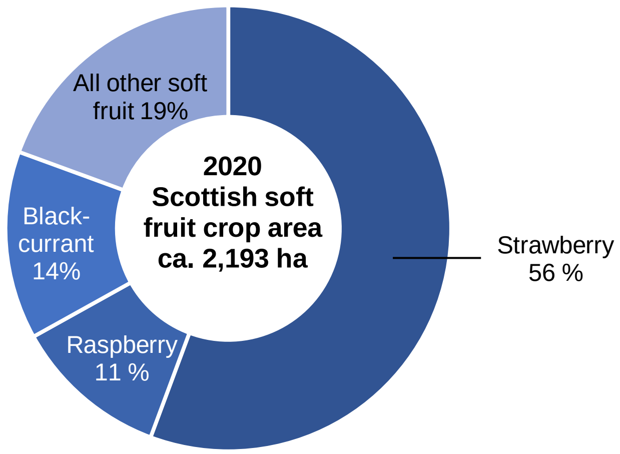
In 2020, strawberries accounted for 56 per cent of the soft fruit area, raspberries 11 per cent, blackcurrants 14 per cent and other soft fruit crops (blueberries, blackberries, gooseberries, redcurrants and other minor crops) 19 per cent (Figure 2).

Figure 1 Census area of soft fruit crops grown in Scotland 2016-2020



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

Figure 2 Soft fruit crop areas 2020 (percentage of total area)



Note: areas include multi-cropping

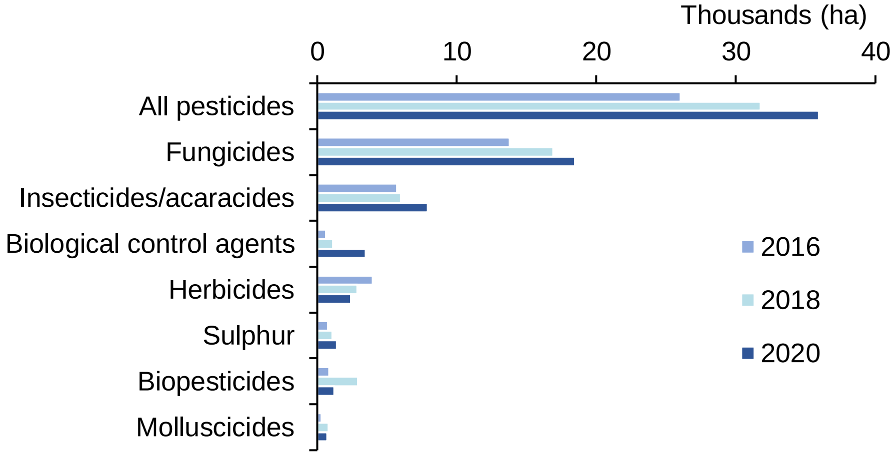
Pesticide usage

This section refers to pesticide usage patterns in overall soft fruit crops. For a description of usage on protected and unprotected crops please see the subsequent 2020 Pesticide Usage section.

The majority of soft fruit crops (90 per cent) received a pesticide treatment in 2020. Strawberries and blackcurrants had the highest overall proportion of crop treated with a pesticide (99 and 96 per cent respectively, Table 1). Other soft fruit crops and raspberries were estimated to have lower proportions of treated crop (73 and 70 per cent respectively). In relation to the average number of pesticide applications, the treated area of soft fruit crops received on average 12.4 sprays, compared with 11.2 sprays in the previous survey. Strawberries received the highest number of applications with an average 14.9 sprays. In contrast blackcurrants received the lowest number of sprays, 7.6 on average (Table 1).

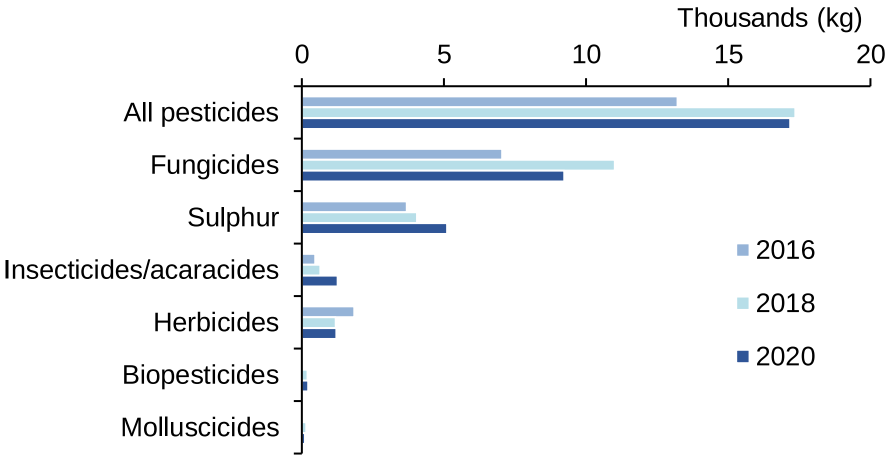
It is estimated that the area of soft fruit crops treated with a pesticide formulation (including biologicals) in 2020 was ca. 36,000 hectares compared with ca. 31,800 hectares in 2018 and ca. 26,000 hectares in 2016 (Table 23, Figure 3). This represents an increase of 38 per cent since 2016 and 13 per cent since 2018.

Figure 3 Area of soft fruit crops treated with the major pesticide groups in Scotland 2016-2020



In terms of weight of pesticide applied, ca. 17.2 tonnes were applied in 2020, compared with ca. 17.4 tonnes in 2018 and ca. 13.2 tonnes in 2016 (Figure 4). This represents an increase of 30 per cent from 2016 and a decrease of one per cent from 2018.

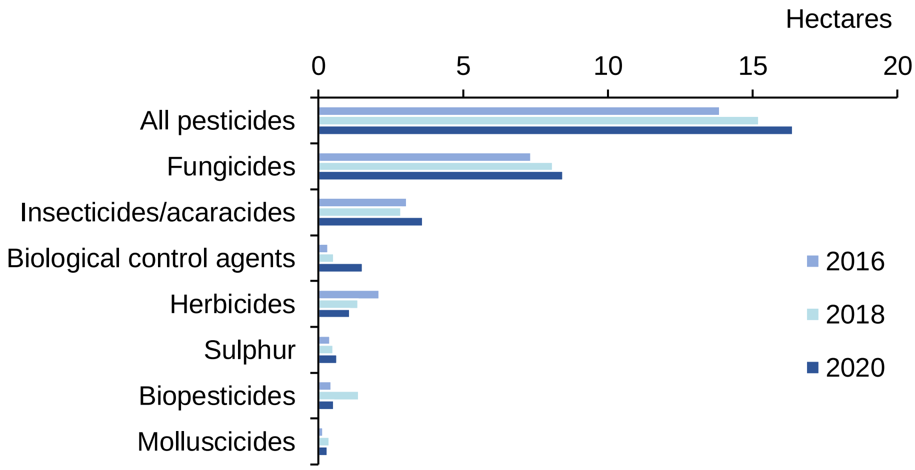
Figure 4 Weight of the major pesticide groups applied to the soft fruit crops in Scotland 2016-2020



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

In order to make accurate comparisons between the 2020 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 2020, for each hectare of crop grown, around 16 treated hectares were recorded (Figure 5). This represents an increase of eight per cent from 2018 and 18 per cent from 2016.

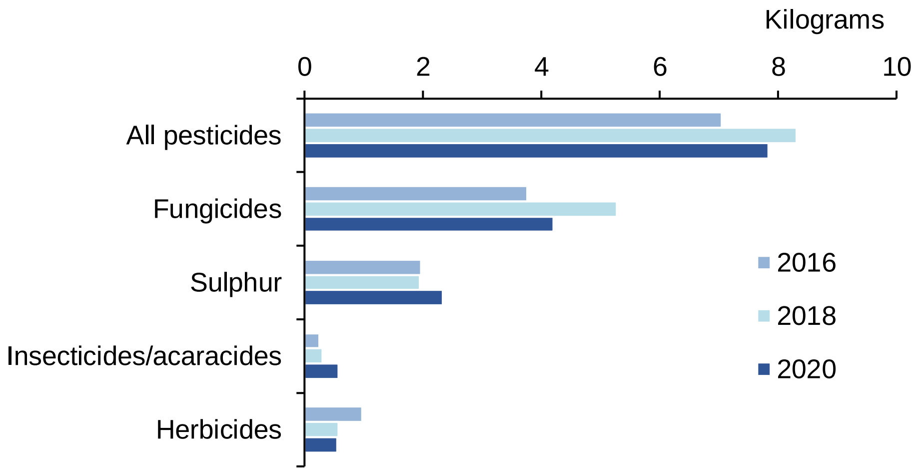
Figure 5 Number of pesticide treated hectares (formulations) per each hectare of crop grown 2016-2020



Note: Physical control has been excluded as its use represents < 0.2 treated hectares per hectare of crop grown

The estimated weight of pesticide applied per hectare of crop grown was almost eight kilograms (Figure 6). This represents a decrease of six per cent from 2018 and an increase of 11 per cent from 2016. The increase in treated area but decrease in weight applied compared with 2018 may have been influenced by large increases in the use of biological control agents which play an important part in growers Integrated Pest Management (IPM) programmes. Invertebrate biological control agents are applied by number of organisms rather than weight therefore weight data is not recorded. It was noted in previous reports that the lower pesticide use reported in 2016, influenced by cool climatic conditions, lower pest pressure and a low survey response rate, was atypical in this data series[4].

Figure 6 Weight of pesticides applied per each hectare of crop grown 2016-2020



Note: molluscicides, biopesticides and physical control have been excluded as their use represents 0.1 kg or less per hectare of crop grown

In 2020, fungicides were the most frequently used pesticides by area treated on soft fruit crops, followed by insecticides/acaricides, biological control agents and herbicides (Figure 7). Fungicides accounted for 51 per cent of the total pesticide treated area and 54 per cent of the total weight of pesticides applied (Figures 7 and 8). When changes in crop area are taken into account, the area treated with fungicide formulations increased by four per cent from 2018 to 2020 and by 15 per cent from 2016 to 2020 (Figure 5). From 2018 to 2020, there was a decrease of 20 per cent in the weight of fungicides used per hectare of crop grown and an increase of 12 per cent from 2016 to 2020 (Figure 6).

Sulphur can be applied as a fungicide but is also used as an insecticide on blackcurrants to control big bud mite. Sulphur accounted for four per cent of the total treated area and 30 per cent of the total weight of pesticides applied (Figures 7 and 8). When changes in area grown are taken into account, there was a 24 per cent increase in the use of sulphur between 2018 and 2020 and a 55 per cent increase from 2016 to 2020 (Figure 5). The weight of sulphur applied per hectare of crop grown increased by 20 per cent from 2018 to 2020 and by 19 per cent from 2016 to 2020 (Figure 6). When crop area is taken into account, the mean applications of sulphur were 2.3 kg/ha in 2020, 1.9 kg/ha in 2018 and 2.0 kg/ha in 2016. This increased use of sulphur in 2020 was primarily due to an increase in use of sulphur on blackcurrants for the control of big bud mite.

Figure 7 Use of pesticides on soft fruit crops - 2020 (percentage of total area treated with formulations)

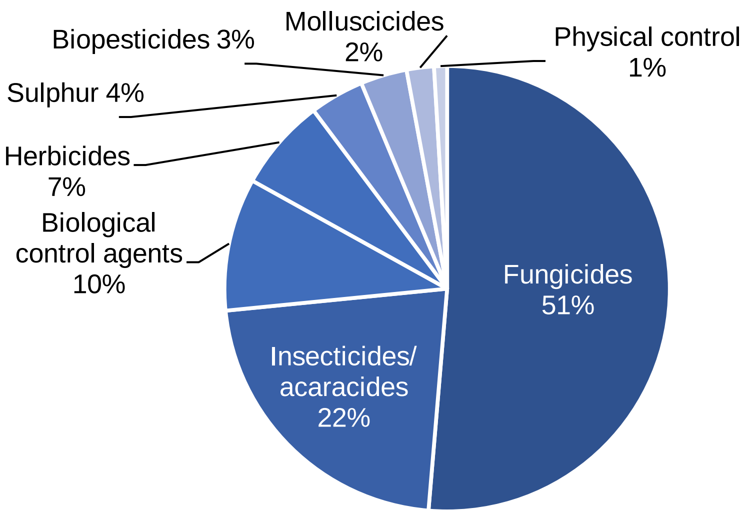
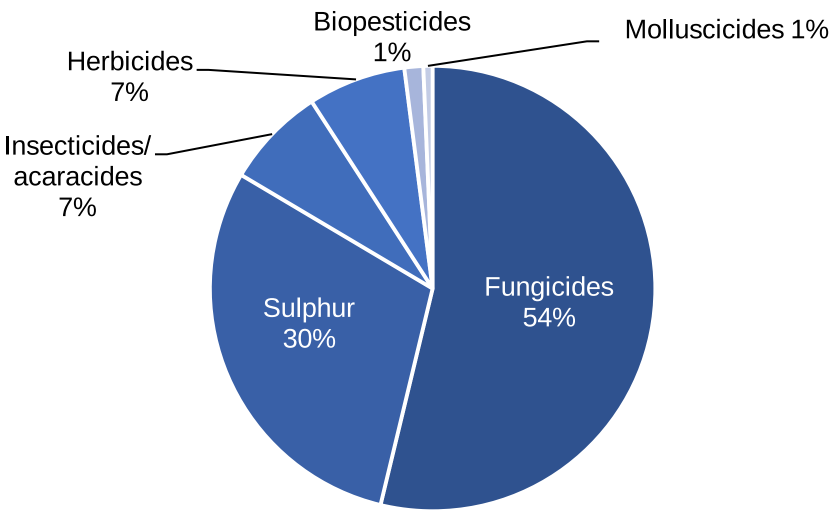


Figure 8 Use of pesticides on soft fruit crops - 2020 (percentage of total weight of pesticides applied)



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

In 2020, insecticides and acaricides accounted for 22 per cent of the total pesticide treated area and seven per cent of the total weight of pesticides applied (Figures 7 and 8). When changes in crop area are taken into account, there is a 27 per cent increase from 2018 to 2020 and an 18 per cent increase from 2016 to 2020 in the area treated with insecticide/acaricide formulations (Figure 5). In terms of weight of insecticide applied, when area of crop grown is taken into account, there is an 86 per cent increase from 2018 to 2020 and a 134 per cent increase from 2016 to 2020 (Figure 6). This increase in weight of insecticides applied is being driven by an increase in the use of fatty acids C7-C20 mainly on protected strawberries. Fatty acids C7-C20 are applied at high rates and accounted for 54 per cent of the total weight of insecticides applied in 2020 and 36 per cent in 2018. No fatty acid use was recorded in 2016. There has also been an increase in the use of spirotetramat mainly for the control of sucking pests such as aphids on protected strawberries. The use of spirotetramat in terms of weight applied has increased by 674 per cent since 2018 (Table 22). Unlike pyrethroids, which can have adverse effects on non-target insects, the use of fatty acids and spirotetramat are generally more compatible with IPM programmes. Spirotetramat is harmless or only slightly harmful to the main biological control agents and although the impact of fatty acid on IPM programmes has not been established, it has no residual activity so beneficials can be safely reintroduced after application[5].

Herbicides and desiccants accounted for seven per cent of both the total pesticide treated area and the total weight of pesticides applied (Figures 7 and 8). When changes in crop area are taken into account, there is a decrease in area treated with herbicide and desiccant formulations of 21 per cent from 2018 and a decrease of 48 per cent from 2016 (Figure 5). In terms of weight of pesticide applied, when area of crop is taken into account, there is a decrease of three per cent from 2018 to 2020 and a decrease of 43 per cent from 2016 to 2020 (Figure 6). Decreases were recorded in a number of key active substances. The principal herbicide active substances in 2018 in terms of weight applied were napropamide, propyzamide and diquat, these all decreased in 2020 (59, 40 and 94 per cent respectively). The authorisation for diquat has been withdrawn, with the final use for the product in February 2020, hence the large decrease reported in 2020

In 2020, biopesticides accounted for three per cent of the total pesticide treated area and one per cent of the total weight of pesticides applied (Figures 7 and 8). When changes in crop area are taken into account, there is a decrease of 61 per cent from 2018 to 2020 and an increase of 22 per cent from 2016 to 2020 in the area treated with biopesticide formulations (Figure 5). In terms of weight of pesticide applied, there is an increase of 13 per cent from 2018 to 2020 and an increase of 186 per cent from 2016 to 2020. 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 botrytis and powdery mildew.

Biological control agents accounted for 10 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 192 per cent from 2018 to 2020 and an increase of 377 per cent from 2016 to 2020 in area treated. Biological control agents were used on strawberry, raspberry and other soft fruit crops such as blueberry and blackberry. As in 2018, 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 biological control agents for managing insect pests and disease in soft fruit crops as part of an integrated pest management system.

In 2020, molluscicides accounted for two per cent of the total pesticide treated area and one per cent of the total weight of pesticides applied (Figures 7 and 8). When changes in crop areas between years are taken into account, there is a decrease in molluscicide applications per unit area of 18 per cent between 2018 and 2020 and an increase of 108 per cent between 2016 and 2020 (Figure 5). The weight of molluscicides applied per hectare of crop grown decreased by 27 per cent from 2018 to 2020 but increased by 46 per cent from 2016 to 2020 (Figure 6). Molluscicide use varies significantly from year to year as slug populations are closely linked to climatic conditions. In terms of area treated, ferric phosphate is now the principal molluscicide active substance (applied to 394 ha). The use of metaldehyde has declined as growers prepare for the withdrawal of metaldehyde, which has a final use date of March 2022, from the market.

Pesticides classified as physical control agents accounted for one per cent of the total pesticide treated area (Figures 7). When changes in crop areas between years are taken into account, there was an increase in physical control agent applications per unit area of 544 per cent between 2018 and 2020 and 4,551 per cent between 2016 and 2020. 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 predominately protected crops for the control of two-spotted spider mite and 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 myclobutanil has increased by 1,820 per cent in terms of area treated since 2018 (Table 21). However, usage was atypically low in 2018 and the use of myclobutanil has decreased by 22 per cent since 2016. The use of the biological control agent *Heterorhabditis bacteriophora* has increased by 7,737 per cent in terms of area treated and is appearing in the top twenty actives by area for the first time. The use of the herbicide glyphosate has increased by 137 per cent in terms of area treated since 2018 and by 21 per cent since 2016. This increase may be the result of growers using glyphosate as a replacement for diquat which has been withdrawn. The insecticide cyflumetofen, which was first authorised in February 2020 and the residual-acting herbicides dimethenamid-p and flazasulfuron were all recorded for the first time on soft fruit crops in 2020 (Table 17).

The biopesticide *Aureobasidium pullulans* was seen for the first time in this survey as well as biological control agents B*acillus pumilus strain* QST 2808, *Bacillus amyloliquefaciens* strain MBI600, *Amblyseius andersoni, Stratiolaelaps scimitus* and T*ranseius montdorensis.*

Integrated Pest Management

Information about the uptake of IPM measures by Scottish growers was collected alongside the 2020 soft fruit pesticide usage survey. This 2020 IPM survey represents the second in the series of surveys of IPM measures on soft fruit, allowing the adoption of IPM techniques to be monitored.

This is a summary of the data; please refer to Appendix 6 for the full dataset. Growers were asked a series of questions about the IPM activities that they implemented for soft fruit production. Unlike the other statistics in this report, the figures relating to IPM are not raised to produce national estimates but represent only the responses of those surveyed.

In total, IPM data was collected from 40 growers, collectively representing 50 holdings and 32 per cent of Scotland's 2020 soft fruit area. Of these growers, 48 per cent had an IPM plan (30 per cent completed their own IPM plan and 18 per cent had a plan completed by their agronomist) (Figure 30). This provides some evidence that the proportion of growers completing an IPM plan has increased from the 2016 survey where 18 per cent of growers had an IPM plan (p-value = 0.12). Since 2016, there has been a focus on the promotion of IPM and the introduction of mandatory completion of IPM plans within some key farm assurance schemes to help growers make the best possible and most sustainable use of all available methods of pest control. Growers were asked about their IPM activities in relation to three categories; risk management, pest monitoring and pest control.

In both 2020 and 2016, all growers sampled reported that they implemented at least one measure associated with an IPM risk management approach (Table 37). There were no statistically significant differences in the responses to summary risk management questions between 2016 and 2020. Although not statistically significant, there were increases in uptake in other risk management activities from 2016 including soil testing (54 per cent in 2016 to 63 per cent in 2020), cultivation at sowing (39 per cent in 2016 to 50 per cent in 2020), adoption of techniques to protect or enhance populations of beneficial organisms (82 per cent in 2016 to 93 per cent in 2020) and manipulation of environmental factors to reduce pest risk (32 per cent to 50 per cent in 2020).

In terms of the uptake of pest monitoring activities, there was very little change between 2016 and 2020. In both years, the majority of growers sampled reported they implemented at least one pest monitoring measure (89 per cent in 2016 and 85 per cent in 2020) (Table 38). There were some changes, however, in setting action thresholds for crops with an increase from 2016 (32 per cent to 53 per cent in 2020), use of specialist diagnostics (39 per cent in 2016 to 45 per cent in 2020) and regular monitoring of crop growth stage (71 per cent in 2016 to 80 per cent in 2020). There was a decrease in monitoring and identifying pests going from 86 per cent in 2016 to 78 per cent in 2020.

The overwhelming majority of the growers sampled in 2016 and 2020 adopted at least one IPM pest control activity (96 per cent and 95 per cent respectively). There was an increase in the use of targeted pesticide application (from 46 per cent of respondents in 2016 to 50 per cent in 2020), anti-resistance strategies (32 per cent in 2016 to 50 per cent in 2020). Finally, there was a small decrease in the proportion of respondents who stated that they regularly monitored the success of their crop protection measures (71 per cent in 2016 to 68 per cent in 2020) and use of non-chemical controls (96 per cent in 2016 to 95 per cent in 2020).

2020 Pesticide usage

All strawberries (protected and non-protected crops)

- An estimated 1,221 hectares of strawberries were grown in Scotland in 2020. This consists of 31 ha of non-protected crops and 1,190 ha of protected crop
- Ninety-nine per cent of the crop was treated with a pesticide (see Figure 9 for types of pesticides used)
- Pesticide formulations were applied to 27,091 treated hectares with 10,511 kilograms of pesticide applied in total (see summary table)
- Strawberry crops received on average 14.9 applications (Table 1). These included 9.8 fungicide applications and 3.8 insecticide applications (applied to 99 and 93 per cent of the crop area). They also received on average 3.8 biological, 2 herbicide/desiccant and 1.5 molluscicide and sulphur applications (applied to 59, 27, 39 and 36 per cent respectively
- Timings of pesticide applications are shown in Figure 10. The most common varieties encountered were Sonata and Malling Centenary, accounting for 28 and 24 per cent of the sample area respectively
- Reasons for fungicide use were supplied for 67 per cent of total use; 31 per cent for control of botrytis, 24 per cent for control of powdery mildew and 12 per cent for control of mildew. Three other reasons for fungicide use were all recorded at below one per cent
- Reasons for herbicide use were supplied for nine per cent of total use; slightly less than nine per cent for general weed control. Two other reasons accounted for less than one per cent each
- Reasons were supplied for 65 per cent of insecticide use; 22 per cent for the control of aphids, 15 per cent for spider mites, seven per cent for capsids, six per cent for thrips, three per cent each for two-spotted spider mite and general pests, two per cent for both tarsonemid mites and caterpillar control, and one per cent for control of flower thrips. Four other reasons accounted for less than one per cent in total
- Reasons for the use of biological control agents were supplied for 84 per cent of use; 22 per cent for two-spotted spider mite, 15 per cent for thrips, 12 per cent for vine weevil, 11 per cent for powdery mildew, eight per cent for aphids, six per cent for mildew, and four per cent for both spider mite and tarsonemid mite and two per cent for control of botrytis
- Reasons for the use of biopesticides were supplied for 61 per cent of use; 26 per cent for the control of botrytis, 16 per cent for mildew control, 14 per cent to control caterpillars and four per cent for powdery mildew. Two-spotted spider and thrips together accounted for approximately one per cent

- Reasons for physical control were provided for 99 per cent of total use; 23 per cent was for control of aphids and two-spotted spider mite and 18 per cent each for control of leaf hopper, spider mite and thrips.
- Nine per cent of strawberries encountered in the sample were under one year old, 47 per cent were between one and two years old, six per cent were over two years old with the remainder unknown
- Sixty-one per cent of the crop sampled was grown in a raised or tabletop system. 53 per cent of the crop sampled was grown in soil, with the remainder being grown in bags
- Sixty-seven per cent of the crop sampled was grown using a ground mulch or straw
- Ninety nine per cent of the crop sampled was grown under protection, of this 52 per cent was in permanent tunnels and 48 per cent was in temporary tunnels
- Pollinators were used on 98 per cent of the strawberry crop sampled;. Of the sampled area using pollinators, 58 per cent used bumble bees, 22 per cent used honey bees and 20 per cent used both bumble bees and honey bees
- All of the strawberry crops surveyed were harvested in 2020. Ninety-eight per cent were for fresh market, one per cent for pick-your-own and less than 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	15,465	7,784	99	Fenhexamid (1,978) Fluopyram/trifloxystrobin (1,766)
Herbicides	1,314	766	27	Carfentrazone-ethyl (252)
Insecticides/ acaricides	5,548	1,050	93	Spirotetramat (1,265), Lambda-cyhalothrin (798), Bifenazate (787)
Molluscicides	706	114	39	Ferric phosphate (388) Metaldehyde (318)
Sulphur	661	586	36	N/A
Biopesticides	1,065	211		*Bacillus subtilis strain* QST 713 (622)
Biological control agents	2,153	N/A		*Neoseiulus cucumeris* (881)
Physical control	180	N/A	10	Unspecified physical control agents (180)
All pesticides	**27,091**	**10,511**	**99**	

N/A = Not applicable

Figure 9 Use of pesticides on all strawberry crops (percentage of total area treated with formulations) - 2020

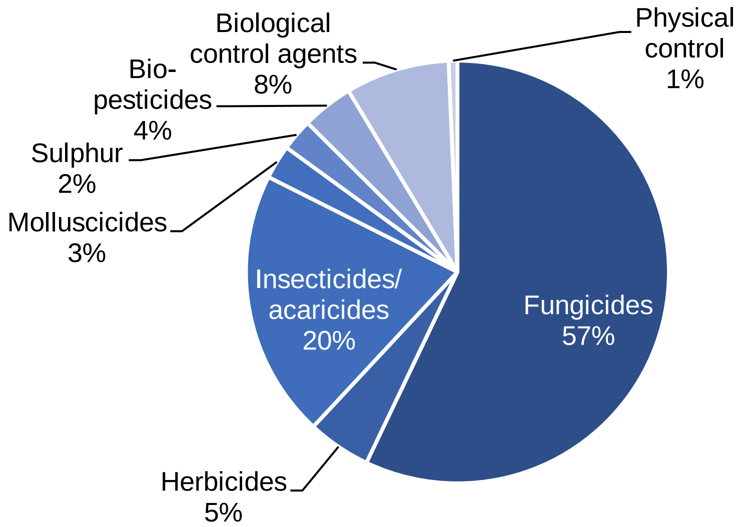
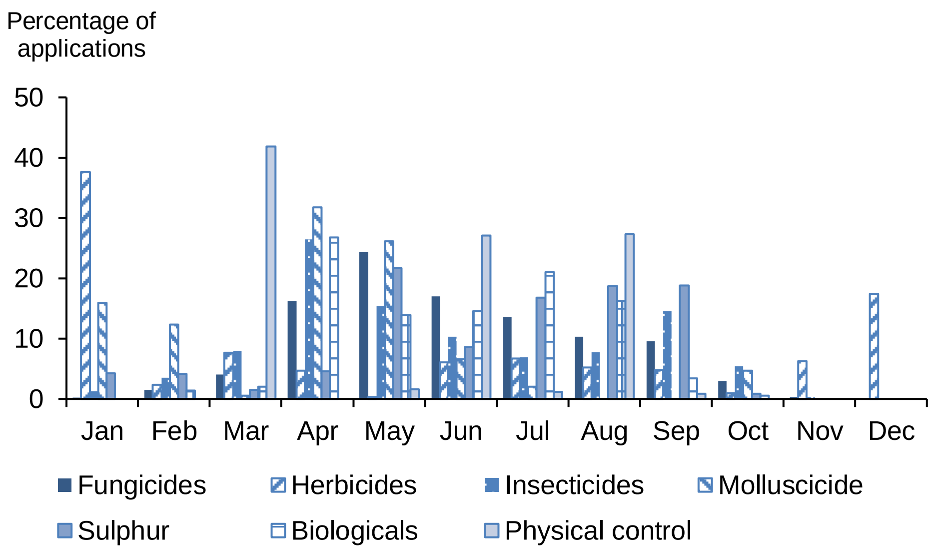


Figure 10 Timings of pesticide applications on all strawberries - 2020



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

Non-protected strawberries

- An estimated 31 hectares of non-protected strawberry were grown in Scotland in 2020. This included an estimated three hectares recorded in the mixed and other soft fruit section of the census
- Fifty-one per cent of the crop was treated with a pesticide (see Figure 11 for types of pesticides used)
- Pesticide formulations were applied to 263 treated hectares with 111 kilograms of pesticide applied in total (see summary table below)
- The 51 per cent of non-protected strawberry crop treated with a pesticide received on average 10.9 spray applications (Table 1). These included 5.6 fungicide applications, 5.9 herbicide/desiccant applications and one insecticide (applied to 48, 48 and 39 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 12
- The most common varieties encountered were Symphony and Eros, accounting for 69 and 17 per cent of the sample area surveyed respectively.

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	162	52	48	Myclobutanil (31)
Herbicides	89	58	48	Clopyralid (25)
Insecticides/ acaricides	12	1	39	Thiacloprid (12)
All pesticides	**263**	**111**	**51**	

Figure 11 Use of pesticides on non-protected strawberries (percentage of total area treated with formulations) - 2020

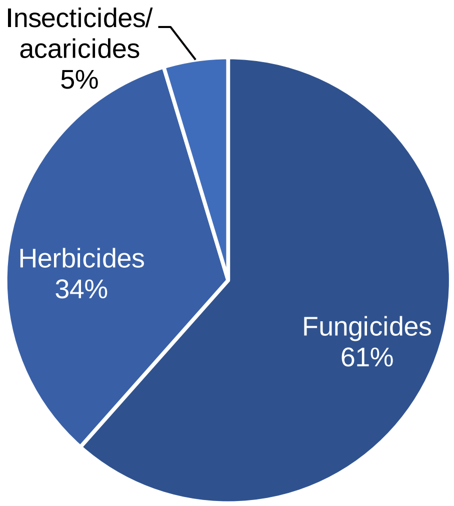
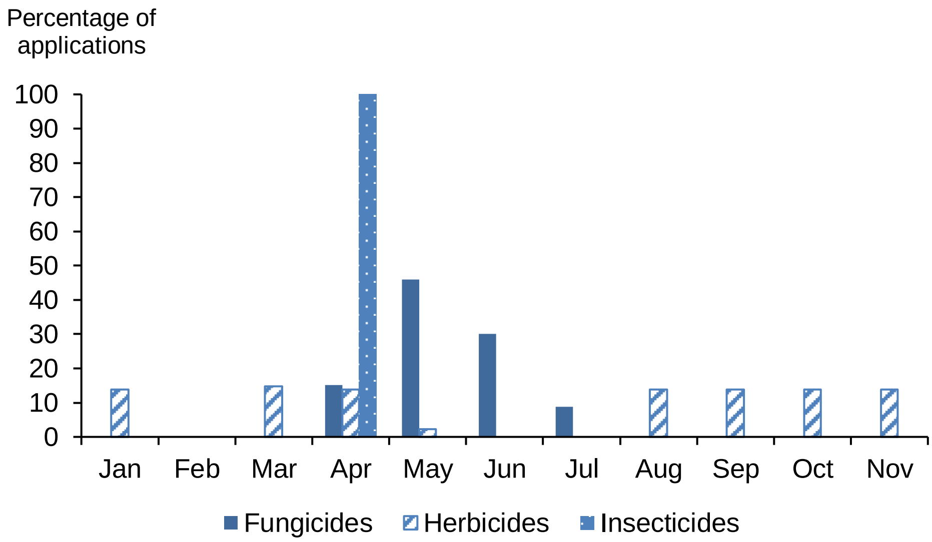


Figure 12 Timings of pesticide applications on non-protected strawberries – 2020



Note: Insecticides include acaricides and herbicides include desiccants

Protected strawberries

- An estimated 1,190 hectares of protected strawberry were grown in Scotland in 2020, including 25 hectares of multi-cropping. Based on the ratio encountered in the sample, it is estimated that 48 per cent of the crop was semi-protected (grown under temporary tunnels) and 52 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 26,828 treated hectares with 10,400 kilograms of pesticides applied in total (see summary table below)
- Protected strawberry crops received on average 15 pesticide applications (Table 1). These included 9.9 fungicide applications, 3.9 insecticide applications, 3.8 biological applications, 1.8 herbicide/desiccant, 1.5 sulphur applications, 1.5 molluscicide applications and 1.4 physical control applications (applied to 100, 94, 60, 27, 37, 40 and 11 per cent of the crop respectively)
- The timing of pesticide applications is shown in Figure 14
- The most common varieties encountered were Malling Centenary and Sonata, accounting for 29 and 24 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	15,303	7,732	100	Fenhexamid (1,954)
Herbicides	1,225	708	27	Carfentrazone-ethyl (252)
Insecticides/ acaricides	5,536	1,049	94	Spirotetramat (1,265)
Molluscicides	706	114	40	Ferric phosphate (388) Metaldehyde (318)
Sulphur	661	586	37	N/A
Biopesticides	1,065	211		*Bacillus subtilis* strain QST 713 (622)
Biological control agents	2,153	N/A		*Neoseiulus cucumeris* (881)
Physical control	180	N/A	11	Unspecified physical control agents (180)
All pesticides	**26,828**	**10,400**	**100**	

N/A = not applicable

Figure 13 **Use of pesticides on protected strawberries (percentage of total area treated with formulations) - 2020**

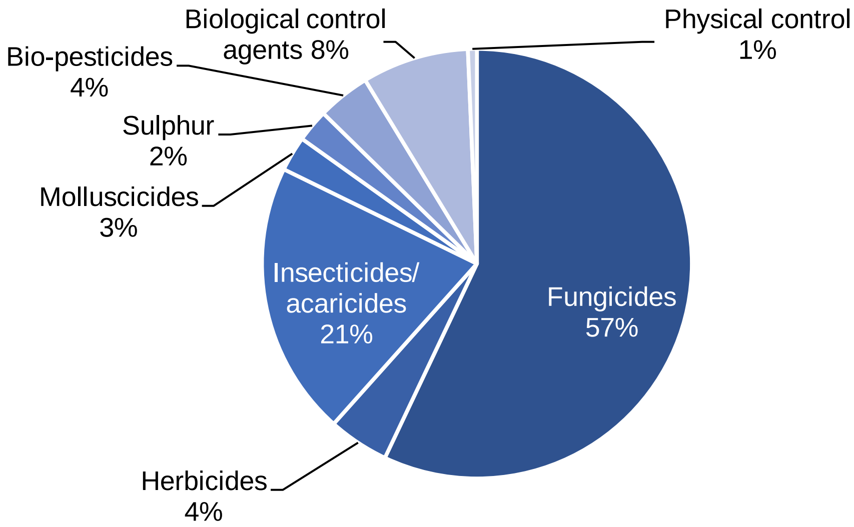
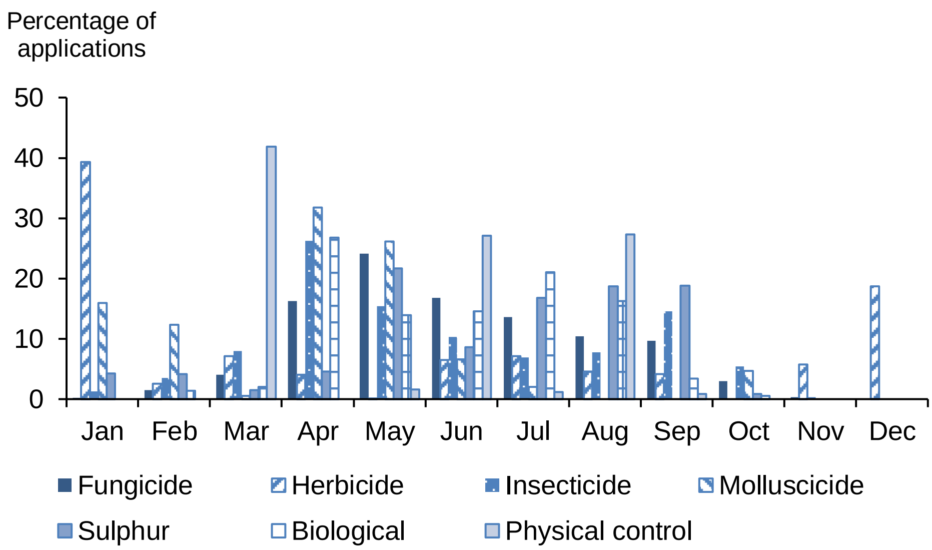


Figure 14 **Timings of pesticide applications on protected strawberries – 2020**



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

All raspberries (protected and non-protected crops)

- An estimated 247 hectares of raspberries were grown in Scotland in 2020. This consists of 77 hectares of non-protected crops and 169 hectares of protected crop
- Seventy-seven per cent of the crop was treated with a pesticide (See Figure 15 for the types of pesticides used)
- Pesticide formulations were applied to 1,652 treated hectares with 552 kilograms of pesticides applied in total (see summary table)
- The 70 per cent of raspberry crop treated with a pesticide received on average 8.5 pesticide sprays (Table 1). These included 4.1 fungicide applications, 3 insecticide applications, 2.2 biological applications, 2 physical control applications and 1.6 herbicide/desiccant applications (applied to 69, 51, 42, 19 and 37 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 16
- Reasons for fungicide applications were supplied for 53 per cent of total use; 36 per cent was for control of botrytis, four per cent for both cane blight and mildew, three per cent for rust, brown rot and root rot, and one per cent for disease control
- Reasons for herbicide/desiccant applications on raspberries were supplied for 76 per cent of use; 44 per cent was for general weed control, 31 per cent for sucker control, and less than one per cent for annual grass weeds
- Reasons were supplied for 41 per cent of insecticide use; 16 per cent was for aphid control, seven per cent for raspberry cane midge and raspberry beetle, four per cent for caterpillars, three per cent for both two-spotted spider mite and capsids, and less than one per cent for thrips
- Reasons for use of biological control agents were supplied for 85 per cent of total use; 69 per cent was for two-spotted spider mite control and 16 per cent for vine weevil.
- Reasons for the use of biopesticides were supplied for 18 per cent of use; 15 per cent for the control of two-spotted spider mite, and two per cent each for control of aphids and thrips
- Reasons for use of physical control were provided for 59 per cent of total use; 31, 15 and 13 per cent was for control of two-spotted spider mite, thrips and aphids respectively
- The most common variety encountered was Driscoll Maravilla, accounting for 43 per cent of the sample area
- 33 per cent of the raspberries encountered in the sample were under two years old, 33 per cent were between two and five years old. The age of the remainder was unknown
- 66 per cent of the crop sampled was grown in pots and 34 per cent was grown directly in the soil

- Fifty-one per cent of the crop encountered was grown using a ground mulch
- Six per cent of the raspberry crop sampled was grown outdoors, 43 per cent were in temporary tunnels and 52 per cent was grown under permanent tunnels
- Pollinators were used on 93 per cent of the raspberry crops surveyed. Of the sampled area using pollinators, 38 per cent were bumble bees, six per cent were honeybees and 56 per cent used both bumble bees and honey bees
- Ninety-seven per cent of the raspberry crops surveyed were harvested in 2020. Ninety-five per cent were for fresh market, three per cent for processing and two 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	722	427	69	Fenhexamid (191)
Herbicides	188	19	37	Carfentrazone-ethyl (107)
Insecticides/ acaricides	418	91	51	Thiacloprid (114)
Biopesticides	110	14		*Bacillus subtilis* strain QST 713 (79)
Biological control agents	120	N/A		*Phytoseiulus persimilis* (37)
Physical control	94	N/A	19	Unspecified physical control agents (94)
All pesticides	**1,652**	**552**	**70**	

N/A = not applicable

Figure 15 Use of pesticides on all raspberry crops (percentage of total area treated with formulations) - 2020

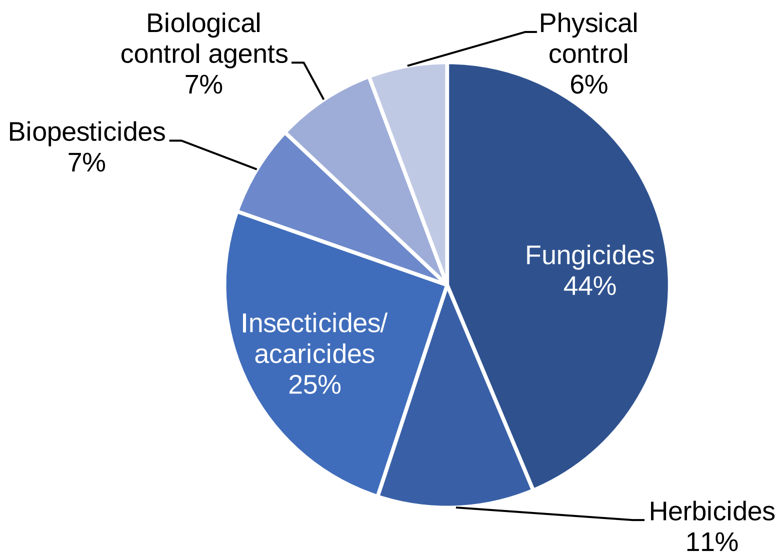
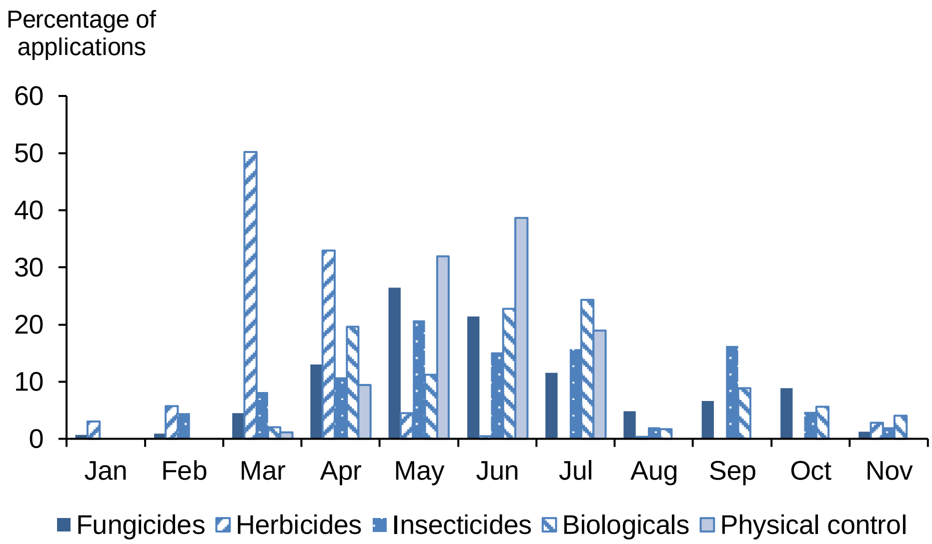


Figure 16 Timings of pesticide applications on all raspberries – 2020



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

Non-protected raspberries

- An estimated 77 hectares of non-protected raspberries were grown in Scotland in 2020. This included an estimated six hectares recorded in the mixed and other crop category in the census
- Six per cent of the crop was treated with a pesticide (see Figure 17 for types of pesticides used)
- Pesticide formulations were applied to 56 treated hectares with 20 kilograms of pesticide applied in total (see summary table below)
- Timings of pesticide applications are shown in Figure 18
- Glen Ample was the most common named variety encountered, accounting for 28 per cent of the area sampled. For 58 per cent of the sample variety names were not supplied

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	36	16	4	Azoxystrobin (10)
Herbicides	13	4	6	Isoxaben (5), Pendimethalin (5)
Insecticides/ acaricides	7	< 0.5	4	Lambda-cyhalothrin (3), Thiacloprid (3)
All pesticides	**56**	**20**	**6**	

Figure 17 Use of pesticides on non-protected raspberries (percentage of total area treated with formulations) – 2020

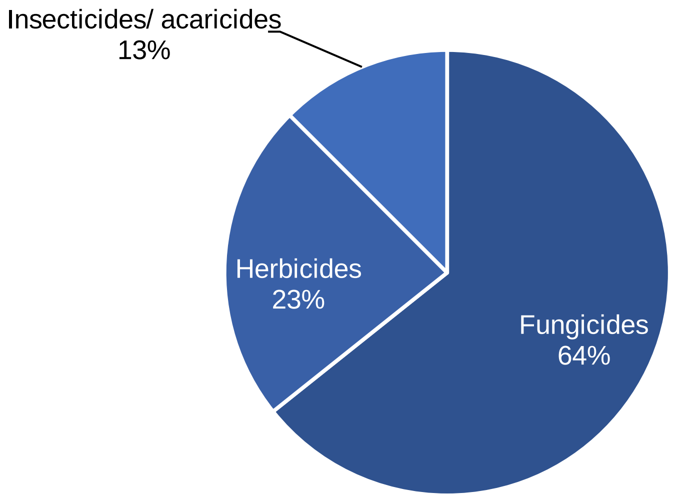
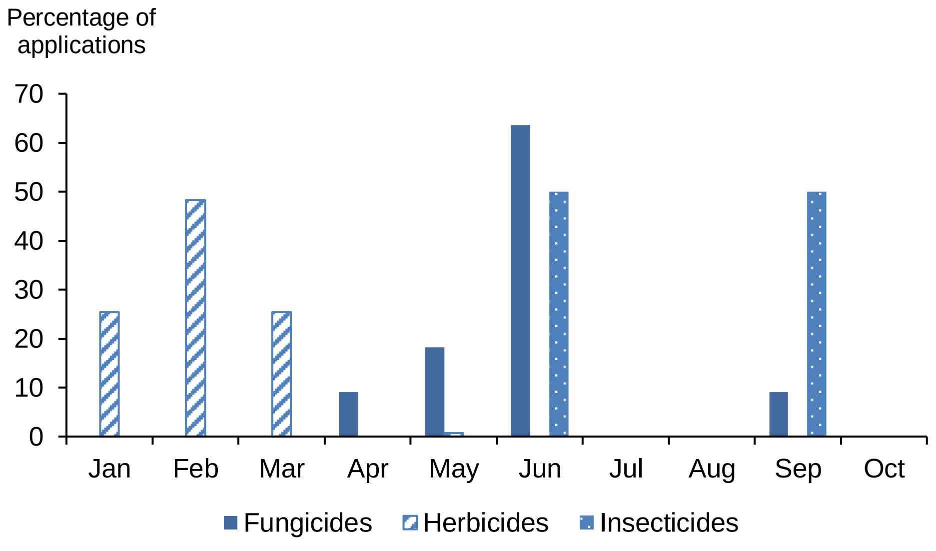


Figure 18 Timings of pesticide applications on non-protected raspberries – 2020



Note: Insecticides include acaricides and herbicides include desiccants

Protected raspberries

- An estimated 169 hectares of protected raspberries were grown in Scotland in 2020. Based on the ratio encountered in the sample, it is estimated that 45 per cent of the crop was semi-protected (grown under temporary tunnels) and 55 per cent was permanently protected (grown in permanent tunnels or glasshouses)
- All the crop was treated with a pesticide (see Figure 19 for types of pesticides used)
- Pesticide formulations were applied to 1,597 treated hectares with 531 kilograms of pesticides applied in total (see summary table below)
- The protected raspberry crop received on average 8.5 pesticide applications (Table 1). These included 4 fungicide applications, 3.1 insecticide applications, 2.2 biological applications, 2 physical control applications and 1.6 herbicide/desiccant applications (applied to 99, 72, 61, 28 and 50 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 45 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	686	411	99	Fenhexamid (188)
Herbicides	175	15	50	Carfentrazone-ethyl (106)
Insecticides/ acaricides	412	91	72	Thiacloprid (111), Lambda-cyhalothrin (107)
Biopesticides	110	14		*Bacillus subtilis* strain QST 713 (79)
Biological control agents	120	N/A		*Phytoseiulus persimilis* (37), *Neoseiulus cucumeris* (33)
Physical control	94	N/A	28	Unspecified physical control agents (94)
All pesticides	**1,597**	**531**	**100**	

N/A = not applicable

Figure 19 Use of pesticides on protected raspberries (percentage of total area treated with formulations) - 2020

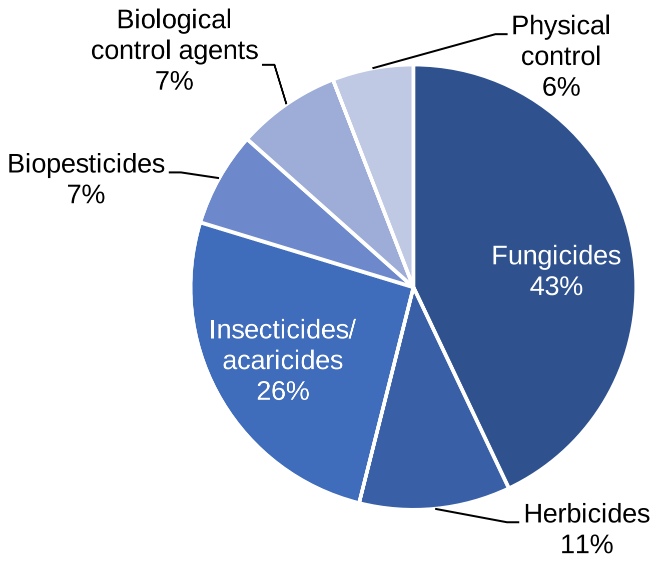
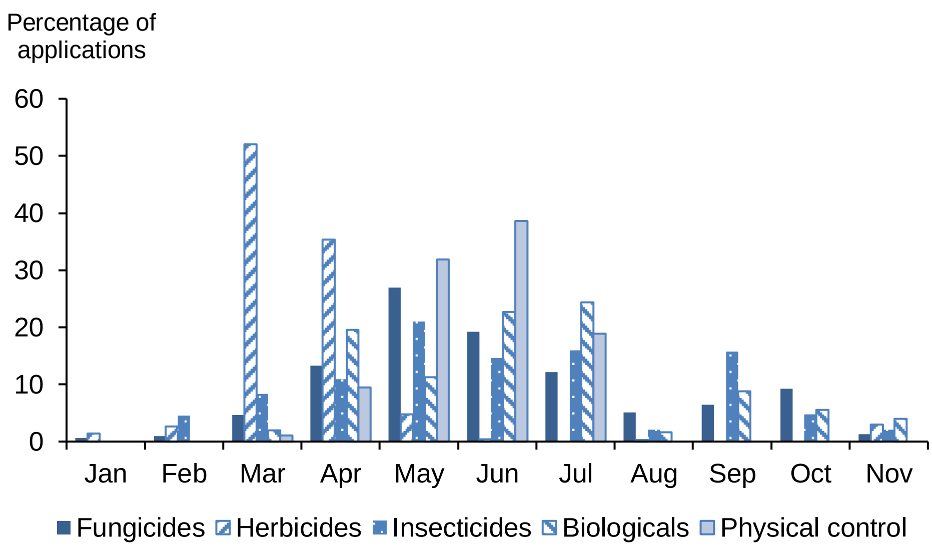


Figure 20 Timings of pesticide applications on protected raspberries – 2020



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 2020 was 299 hectares. This includes ten hectares which were included in the mixed and other soft fruit census category
- Ninety-six per cent of the cop was treated with a pesticide (see Figure 21 for types of pesticides used)
- Pesticide formulations were applied to 3,998 treated hectares with 5,414 kilograms of pesticide applied in total (see summary table below)
- The blackcurrant crop treated with a pesticide received on average 7.6 pesticide applications (Table 1). These included 3.9 fungicide applications, 2.9 sulphur applications, 2.8 insecticide applications and 1.4 herbicide/desiccant applications (applied to 95, 85, 95 and 82 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 22
- Reasons for fungicide applications were supplied for 49 per cent of total use; 17 per cent to control botrytis and slightly more than 10 per cent each for control of mildew, big bud mite and leaf spot
- Reasons for herbicide use were supplied for less than one per cent of total use.
- Reasons for insecticide applications were supplied for 32 per cent of total use, with control of aphids being the only reason given.
- The most common variety encountered was Ben Kilbreck, accounting for 53 per cent of the area sampled
- Fifty per cent of blackcurrants encountered were five years old or less, 40 per cent were between six and 10 years old and eight per cent were older than 10 years with the remainder unknown
- All blackcurrant crops sampled were grown in soil without protection
- Eighty-nine per cent of the blackcurrant crops surveyed were harvested in 2020
- Almost 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	1,457	591	95	Boscalid/pyraclostrobin (535)
Herbicides	687	315	82	Flufenacet/metribuzin (242), Pendimethalin (242)
Insecticides/ acaricides	1,110	44	95	Lambda-cyhalothrin (538)
Sulphur	742	4,465	85	N/A
Physical control	3	N/A	1	Unspecified physical control agents (3)
All pesticides	**3,998**	**5,414**	**96**	

N/A = not applicable

Figure 21 Use of pesticides on blackcurrants (percentage of total area treated with formulations) - 2020

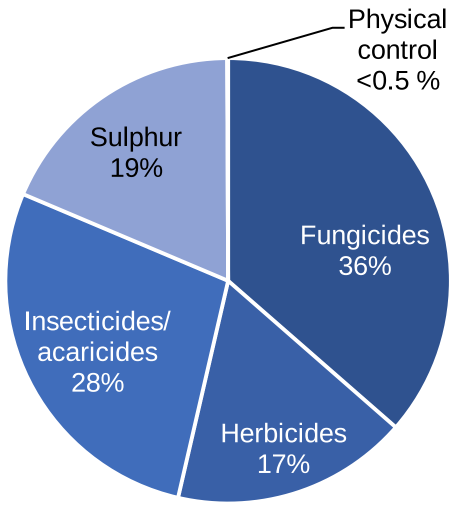
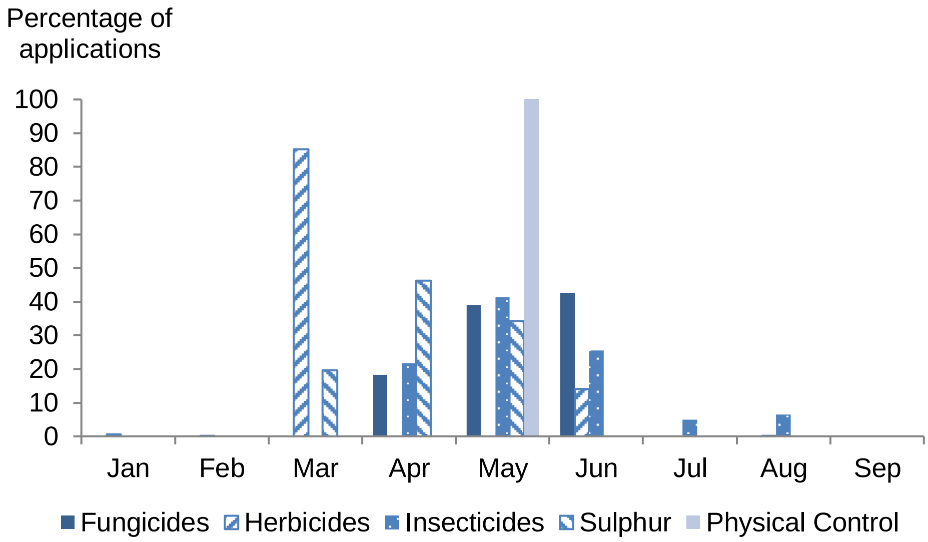


Figure 22 Timings of pesticide applications on blackcurrants - 2020



Note: Insecticides include acaricides and herbicides include desiccants

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

- An estimated 426 hectares of other soft fruit was grown in Scotland in 2020. This consists of 153 hectares of non-protected crop and 273 hectares of protected crop
- The crops encountered in this category were blueberry, blackberry, gooseberry and redcurrant as well as minor crops; honeyberry, jostaberry, loganberry, tayberry, tummelberry and whitecurrant
- Seventy-three 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 3,205 treated hectares with 697 kilograms of pesticide applied in total (see summary table below)
- The area of the crop treated with a pesticide received on average 9.3 pesticide applications (Table 1). These included 5.9 biological applications, 3.4 fungicide applications, 3.1 insecticide applications, 1.5 herbicide/desiccant applications and 1.4 physical control applications (applied to 48, 55, 66, 16 and 11 per cent of the crop respectively)
- Timings of pesticide applications are shown in Figure 24
- Reasons were supplied for 39 per cent of fungicide use; 30 per cent was for botrytis control, three per cent was for mildew, two per cent each for rust, purple blotch and cane blight and less than one per cent for powdery mildew
- Reasons were provided for 12 per cent of herbicide use; five per cent was for annual grass weeds, four per cent for general weed control and three per cent for willowherb
- Reasons were supplied for 65 per cent of insecticide use; 34 per cent was for aphid control, 13 per cent for caterpillar control, five per cent for blueberry midge capsids, four per cent for gall midge, two per cent each for blackberry mite, four per cent each for sawfly and capsid control, three per cent for control of spotted wing drosophila, with four other reasons provided for less than one per cent each.
- Reasons for the use of biological control agents were supplied for 41 per cent of use; 33 per cent for control of vine weevil, four per cent for two-spotted spider mite, two per cent for control of thrips and one per cent for aphids
- Reasons supplied for biopesticide use were supplied for 62 per cent of use; 27 per cent for control of botrytis and 23 per cent each for the control of thrips and two-spotted spider mite and 18 per cent for the control of powdery mildew
- Reasons for physical control were supplied for 100 per cent of use; 73 per cent for control of aphids, 14 and 12 per cent for control of spider mite and two-spotted spider mite respectively
- Thirty-five per cent of other soft fruit crops sampled were five years old or less, eight per cent were six to 10 years old, one per cent were over 10 years old and 56 per cent of the crop were an unknown age

- Thirty-six per cent of the other soft fruit crops surveyed was grown in the soil and 64 per cent was grown in pots
- Five per cent of the crop was grown outdoors, 20 per cent was grown under temporary tunnels and 75 per cent was grown under permanent protection
- Sixty-seven per cent of the sampled crop was grown using a ground mulch
- Pollinators were used on 96 per cent of the other soft fruit crops sampled, three per cent had no pollinators and the remainder was unknown. Of the sampled area using pollinators, 48 per cent were bumble bees, 50 per cent were both bumble bees and honey bees and under two per cent were honey bees
- Ninety-nine per cent of the crops surveyed were harvested in 2020. Of the crops harvested, 99 per cent was for fresh market, one per cent was for pick-your-own and the remainder was for processing

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	811	432	55	Fenhexamid (252)
Herbicides	221	120	16	Flufenacet/metribuzin (46)
Insecticides/ acaricides	865	75	66	Thiacloprid (514)
Molluscicides	6	1	1	Ferric phosphate (6)
Sulphur	15	60	3	N/A
Biopesticides	36	9		*Beauveria bassiana* ATCC - 74040 (15), *Bacillus subtilis* strain QST 713 (14)
Biological control agents	1,190	N/A		*Heterorhabditis bacteriophora* (826)
Physical control	61	N/A	11	Unspecified physical control agents (61)
All pesticides	**3,205**	**697**	**73**	

N/A = not applicable

Figure 23 Use of pesticides on all other soft fruit crops (percentage of total area treated with formulations) - 2020

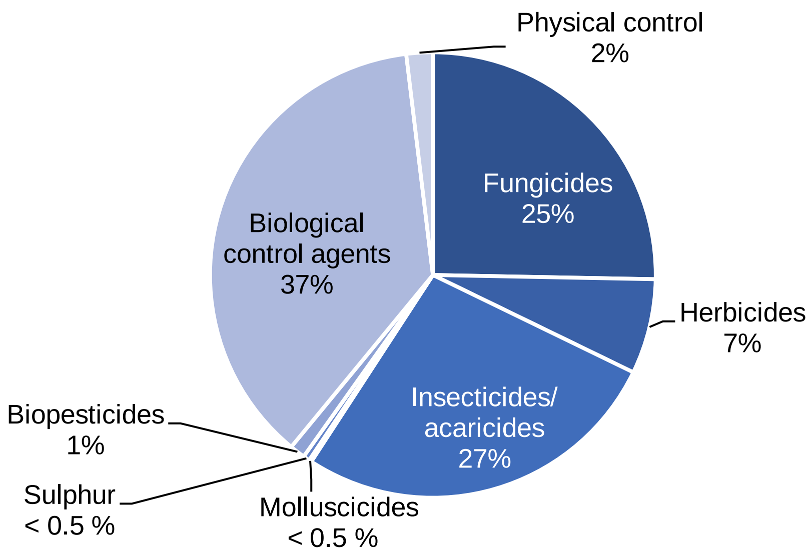
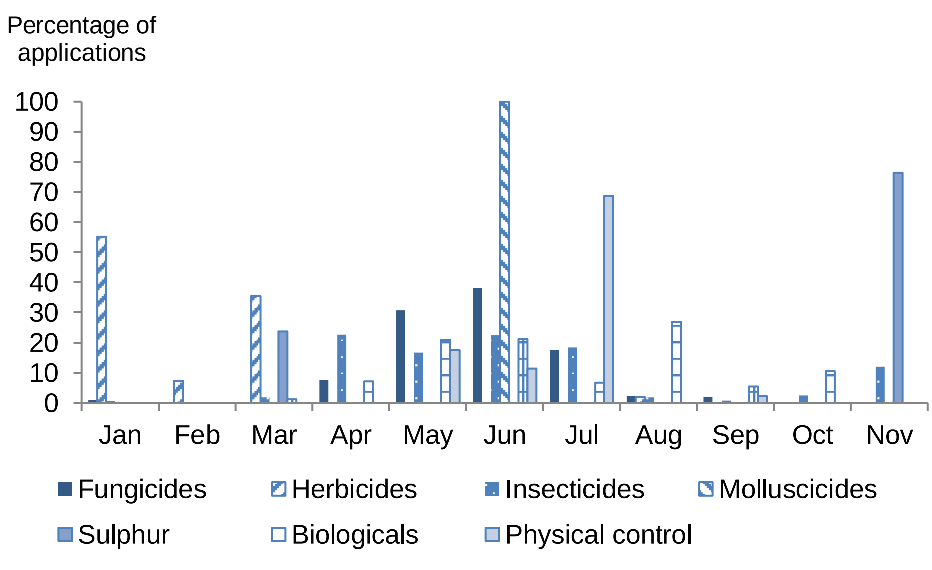


Figure 24 Timings of pesticide applications on all other soft fruit crops – 2020



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

Non-protected other soft fruit crops

- An estimated area of 153 hectares of non-protected other soft fruit crops were grown in Scotland in 2020
- The crops encountered in this category were blueberry, blackberry, gooseberry and redcurrant as well as minor crops; honeyberry, jostaberry, loganberry, tayberry, tummelberry and whitecurrant
- Twenty-six per cent of the crop was treated with a pesticide (see Figure 25 for the types of pesticides used)
- Pesticide formulations were applied to 288 treated hectares with 82 kilograms of pesticide applied in total (see summary table below)
- The treated area of the non-protected other soft fruit crop received on average 4.4 pesticide applications (Table 1). These applications included 3.6 fungicide applications, 2 insecticide applications and 1.8 herbicide/desiccant applications (applied to 16, 14 and 26 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	91	12	16	Myclobutanil (59)
Herbicides	139	68	26	Glyphosate (30), Pendimethalin (29)
Insecticides/ acaricides	44	3	14	Lambda-cyhalothrin (25), Thiacloprid (20)
Biological control agents	3	N/A		*Heterorhabditis bacteriophora* (3)
Physical control	11	N/A	7	Unspecified physical control agents (11)
All pesticides	**288**	**82**	**26**	

N/A = not applicable

Figure 25 Use of pesticides on non-protected other soft fruit crops (percentage of total area treated with formulations) - 2020

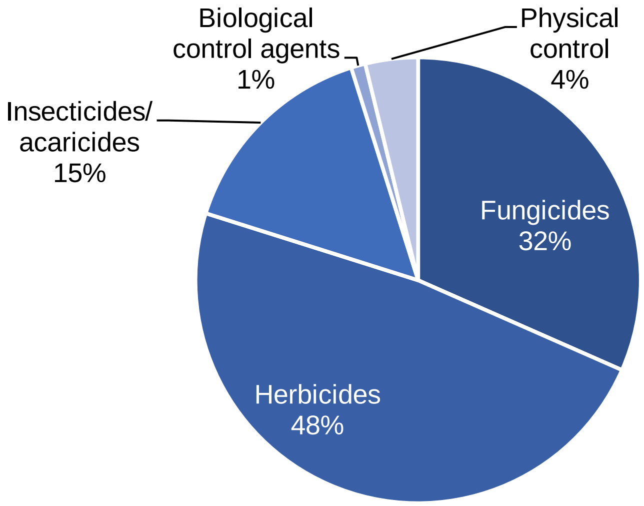
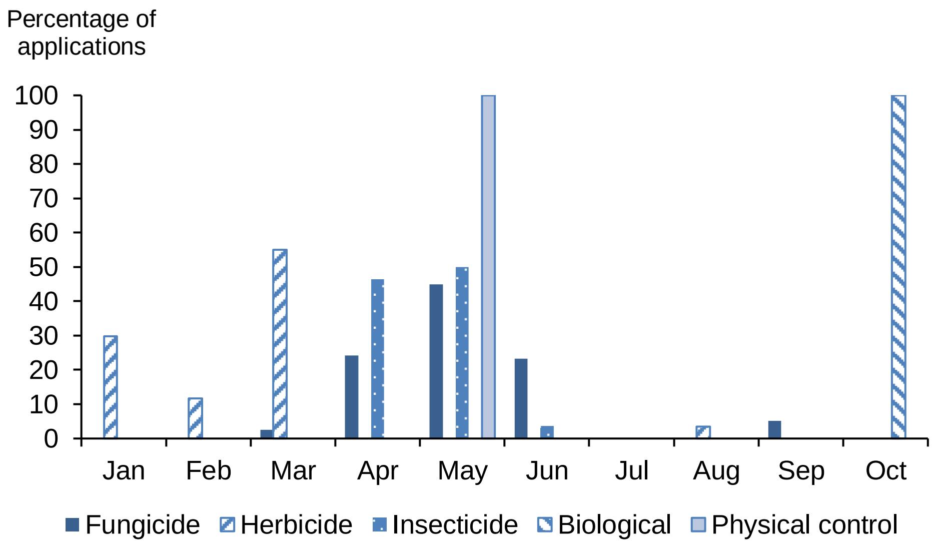


Figure 26 Timings of pesticide applications on non-protected other soft fruit crops – 2020



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

Protected other soft fruit crops

- The total estimated area of protected other soft fruit crops in 2020 was 273 hectares. It is estimated that 61 per cent of the crop was semi-protected (grown under temporary tunnels) with 39 per cent grown under permanent tunnels or glasshouses
- The crops encountered in this category were blueberry and blackberry
- All of the crop area was treated with a pesticide (see Figure 27 for types of pesticides used)
- Pesticide formulations were applied to 2,918 treated hectares with 616 kilograms of pesticide applied in total (see summary table below)
- The protected other soft fruit crop received on average 10.1 pesticide applications (Table 1). These applications included six biological applications, 3.4 fungicide applications, 3.1 insecticide applications, 1.5 physical control applications and one herbicide/desiccant application (applied to 74, 77, 95, 13 and 11 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	721	420	77	Fenhexamid (250)
Herbicides	83	52	11	Diquat, Flufenacet/metribuzin, Napropamide (all 27)
Insecticides/ acaricides	820	72	95	Thiacloprid (494)
Molluscicides	6	1	2	Ferric phosphate (6)
Sulphur	15	60	5	N/A
Biopesticides	36	9		*Beauveria bassiana* ATCC - 74040 (15)
Biological control agents	1,186	N/A		*Heterorhabditis bacteriophora* (822)
Physical control	51	N/A	13	Unspecified physical control agents (51)
All pesticides	**2,918**	**616**	**100**	

Figure 27 Use of pesticides on protected other soft fruit crops (percentage of total area treated with formulations) - 2020

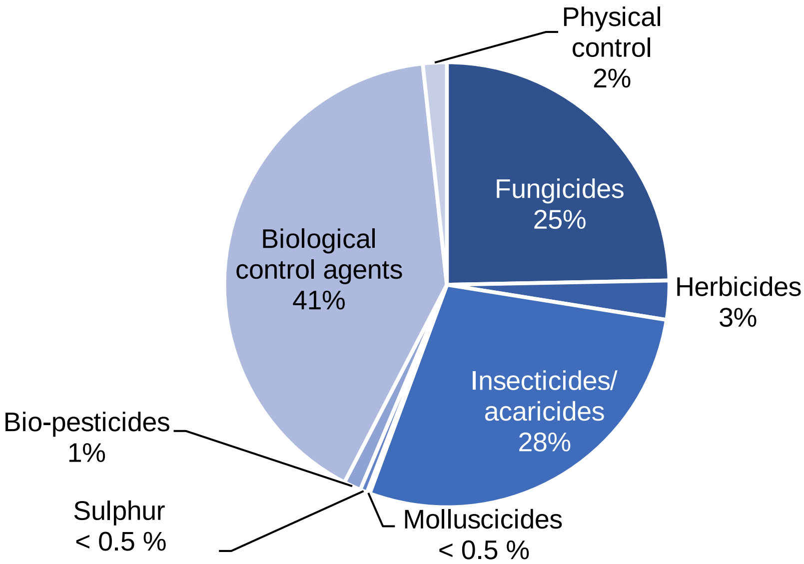
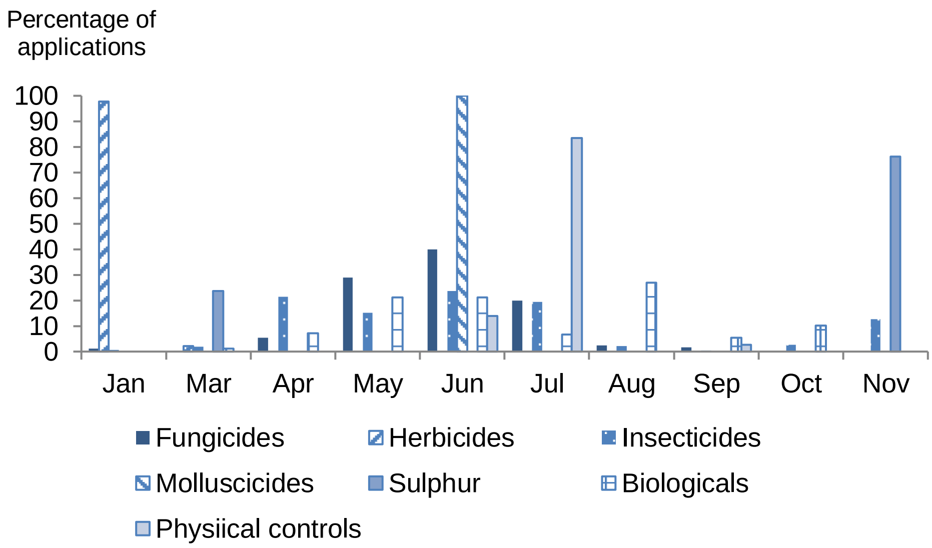


Figure 28 Timings of pesticide applications on protected other soft fruit crops – 2020



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 - 2020

Crop	Fungicides		Herbicides/ desiccants		Insecticides/ acaricides		Molluscicides		Sulphur		Biologicals[1]		Physical control		Any pesticide	
	%	spray apps	%	spray apps	%	spray apps	%	spray apps	%	spray apps	%	spray apps	%	spray apps	%	spray apps
Non-protected strawberry	48	5.6	48	5.9	39	1.0	0	0.0	0	0.0	0	0.0	0	0.0	**51**	**10.9**
Protected strawberry	100	9.9	27	1.8	94	3.9	40	1.5	37	1.5	60	3.8	11	1.4	**100**	**15.0**
All strawberry	**99**	**9.8**	**27**	**2.0**	**93**	**3.8**	**39**	**1.5**	**36**	**1.5**	**59**	**3.8**	**10**	**1.4**	**99**	**14.9**
Non-protected raspberry	4	7.0	6	2.4	4	2.0	0	0.0	0	0.0	0	0.0	0	0.0	**6**	**8.6**
Protected raspberry	99	4.0	50	1.6	72	3.1	0	0.0	0	0.0	61	2.2	28	2.0	**100**	**8.5**
All raspberry	**69**	**4.1**	**37**	**1.6**	**51**	**3.0**	**0**	**0.0**	**0**	**0.0**	**42**	**2.2**	**19**	**2.0**	**70**	**8.5**
All blackcurrant	**95**	**3.9**	**82**	**1.4**	**95**	**2.8**	**0**	**0.0**	**85**	**2.9**	**0**	**0.0**	**1**	**1.0**	**96**	**7.6**
Non-protected other soft fruit	16	3.6	26	1.8	14	2.0	0	0.0	0	0.0	2	1.0	7	1.0	**26**	**4.4**
Protected other soft fruit	77	3.4	11	1.0	95	3.1	2	1.0	5	1.1	74	6.0	13	1.5	**100**	**10.1**
All other soft fruit	**55**	**3.4**	**16**	**1.5**	**66**	**3.1**	**1**	**1.0**	**3**	**1.1**	**48**	**5.9**	**11**	**1.4**	**73**	**9.3**
All soft fruit crops	**86**	**7.6**	**34**	**1.7**	**83**	**3.5**	**22**	**1.5**	**32**	**2.0**	**47**	**4.0**	**10**	**1.5**	**90**	**12.4**

(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 - 2020

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

Insecticides/acaricides	Non-protected strawberry		Protected strawberry		All strawberry 2020		All strawberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Abamectin	0	0	75	5	**75**	**1**	449	4
Bifenazate	0	0	787	46	**787**	**68**	310	36
Clofentezine	0	0	444	37	**444**	**71**	160	32
Cyantraniliprole	0	0	19	2	**19**	**1**	50	4
Cyflumetofen	0	0	150	13	**150**	**30**	0	0
Deltamethrin	0	0	93	8	**93**	**1**	167	1
Etoxazole	0	0	271	23	**271**	**10**	233	8
Fatty acids C7-C20	0	0	126	11	**126**	**607**	30	230
Indoxacarb	0	0	126	11	**126**	**6**	66	3
Lambda-cyhalothrin	0	0	798	47	**798**	**7**	765	8
Pyrethrins	0	0	13	1	**13**	**1**	251	15
Spinosad	0	0	428	27	**428**	**29**	250	18
Spirodiclofen	0	0	196	16	**196**	**16**	18	2
Spirotetramat	0	0	1,265	83	**1,265**	**120**	149	15
Thiacloprid	12	39	744	58	**756**	**83**	823	99
All insecticides/acaricides	**12**	**39**	**5,536**	**94**	**5,548**	**1,050**	**3,814**	**490**
Area grown	31		1,190		**1,221**		1,175	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 3 Strawberry biological, molluscicide and physical control formulations - 2020

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

Biological control agents	Non-protected strawberry		Protected strawberry		All strawberry 2020		All strawberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Amblydromalus limonicus	0	0	4	< 0.5	**4**	**N/A**	0	N/A
Bacillus amyloliquefaciens strain MBI600	0	0	49	4	**49**	**N/A**	0	N/A
Bacillus pumilus strain QST 2808	0	0	428	14	**428**	**N/A**	0	N/A
Heterorhabditis bacteriophora	0	0	14	1	**14**	**N/A**	9	N/A
Neoseiulus cucumeris	0	0	881	34	**881**	**N/A**	71	N/A
Parasitic wasps (species not recorded)	0	0	49	4	**49**	**N/A**	240	N/A
Phytoseiulus persimilis	0	0	370	16	**370**	**N/A**	563	N/A
Steinernema feltiae	0	0	29	2	**29**	**N/A**	162	N/A
Steinernema kraussei	0	0	314	18	**314**	**N/A**	31	N/A
Stratiolaelaps scimitus	0	0	11	1	**11**	**N/A**	0	N/A
Transeius montdorensis	0	0	4	< 0.5	**4**	**N/A**	0	N/A
All biological control agents	**0**		**2,153**		**2,153**	**N/A**	**1,078**	N/A
Biopesticides								
Ampelomyces quisqualis strain AQ 10	0	0	47	2	**47**	**2**	773	31
Aureobasidium pullulans	0	0	18	1	**18**	**4**	0	0
Bacillus amyloliquefaciens strain D747	0	0	59	4	**59**	**34**	0	0

Cont…

Table 3 Strawberry biological, molluscicide and physical control formulations – 2020 continued

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

	Non-protected strawberry		Protected strawberry		All strawberry 2020		All strawberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Bacillus subtilis strain QST 713	0	0	622	31	622	50	1,883	114
Bacillus thuringiensis var. kurstaki	0	0	307	22	307	119	98	32
Beauveria bassiana ATCC - 74040	0	0	12	1	12	3	113	12
All biopesticides	**0**		**1,065**		**1,065**	**211**	**2,895**	**193**
All biologicals[2]	**0**	**0**	**3,217**	**60**	**3,217**	211	**3,973**	**193**
Molluscicides								
Ferric phosphate	0	0	388	27	388	78	361	75
Metaldehyde	0	0	318	17	318	36	412	71
All molluscicides	**0**	**0**	**706**	**40**	**706**	**114**	**773**	**146**
Physical control								
Unspecified physical control agents	0	0	180	11	180	N/A	0	0
All physical control	**0**	**0**	**180**	**11**	**180**	**N/A**	**46**	**90**
Area grown	31		1,190		1,221		1,175	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]
(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 – 2020

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

Fungicides	Non-protected strawberry		Protected strawberry		All strawberry 2020		All strawberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Azoxystrobin	12	39	910	63	**922**	**219**	881	220
Azoxystrobin/difenoconazole	0	0	17	1	**17**	**6**	29	9
Boscalid/pyraclostrobin	24	39	1,488	86	**1,512**	**749**	440	227
Bupirimate	2	6	188	9	**190**	**45**	1,233	420
Cyflufenamid	0	0	1,142	65	**1,142**	**16**	938	14
Cyprodinil/fludioxonil	22	46	1,323	69	**1,345**	**781**	1,255	777
Difenoconazole/fluxapyroxad	0	0	754	48	**754**	**57**	178	13
Dimethomorph	1	3	260	21	**261**	**384**	184	275
Fenhexamid	24	46	1,954	79	**1,978**	**1,302**	1,905	1,338
Fenpropimorph	0	0	9	1	**9**	**4**	243	173
Fenpyrazamine	12	39	593	36	**605**	**332**	419	240
Fluopyram/trifloxystrobin	0	0	1,766	89	**1,766**	**703**	1,714	681
Kresoxim-methyl	0	0	250	21	**250**	**31**	232	34
Mepanipyrim	10	26	327	27	**337**	**120**	469	182
Myclobutanil	31	39	1,279	73	**1,310**	**75**	0	0
Penconazole	22	46	1,263	63	**1,286**	**62**	957	48
Potassium hydrogen carbonate	0	0	458	25	**458**	**2,301**	434	2,573

Cont…

Table 4 Strawberry fungicide and sulphur formulations – 2020 continued

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

Fungicides	**Non-protected strawberry**		**Protected strawberry**		**All strawberry 2020**		**All strawberry 2018[1]**	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Proquinazid	0	0	497	42	**497**	**16**	141	5
Pyrimethanil	0	0	787	47	**787**	**577**	689	517
Quinoxyfen	0	0	36	3	**36**	**5**	756	94
All fungicides	**162**	**48**	**15,303**	**100**	**15,465**	**7,784**	**14,012**	**9,523**
Sulphur	0	0	661	37	**661**	**586**	549	657
Area grown	31		1,190		**1,221**		1,175	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 5 Strawberry herbicide and desiccant formulations – 2020

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

Herbicides/desiccants	Non-protected strawberry		Protected strawberry		All strawberry 2020		All strawberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Carfentrazone-ethyl	0	0	252	18	**252**	**3**	150	2
Clethodim	0	0	52	4	**52**	**6**	0	0
Clopyralid	25	39	26	2	**50**	**5**	2	< 0.5
Dimethenamid-P/pendimethalin	0	0	121	10	**121**	**105**	0	0
Diquat	0	0	23	2	**23**	**8**	625	133
Flazasulfuron	0	0	17	1	**17**	**< 0.5**	0	0
Glufosinate-ammonium	0	0	1	< 0.5	**1**	**1**	0	0
Glyphosate	13	42	166	8	**179**	**275**	33	36
Isoxaben	12	39	217	13	**229**	**17**	90	8
Metamitron	12	39	44	4	**56**	**78**	68	50
Napropamide	0	0	80	7	**80**	**90**	274	216
Pendimethalin	14	46	59	5	**73**	**62**	38	28
Propyzamide	12	39	168	14	**180**	**116**	161	99
All herbicides/desiccants	**89**	**48**	**1,225**	**27**	**1,314**	**766**	**1,443**	**573**
Area grown	31		1,190		**1,221**		1,175	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 6 Raspberry insecticide and acaricide formulations – 2020

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

Insecticides/acaricides	Non-protected raspberry		Protected raspberry		All raspberry 2020		All raspberry 2018(1)	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Abamectin	0	0	27	11	**27**	**< 0.5**	184	2
Clofentezine	0	0	21	12	**21**	**4**	2	< 0.5
Cyantraniliprole	0	0	< 0.5	< 0.5	**< 0.5**	**< 0.5**	5	< 0.5
Deltamethrin	0	0	87	33	**87**	**1**	76	1
Fatty acids C7-C20	0	0	21	6	**21**	**69**	0	0
Lambda-cyhalothrin	3	4	107	37	**111**	**1**	30	< 0.5
Pyrethrins	0	0	5	3	**5**	**< 0.5**	45	3
Spinosad	0	0	23	5	**23**	**2**	11	1
Spirotetramat	0	0	9	5	**9**	**1**	0	0
Thiacloprid	3	4	111	47	**114**	**14**	197	24
Total insecticides/acaricides	**7**	**4**	**412**	**72**	**418**	**91**	**576**	**34**
Area grown	77		169		**247**		276	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 7 Raspberry biological and physical control formulations – 2020

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

Biological control agents	Non-protected raspberry		Protected raspberry		All raspberry 2020		All raspberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Amblyseius andersoni	0	0	19	11	**19**	**N/A**	0	N/A
Heterorhabditis bacteriophora	0	0	19	11	**19**	**N/A**	0	N/A
Nematodes (species not recorded)	0	0	9	5	**9**	**N/A**	0	N/A
Neoseiulus cucumeris	0	0	33	7	**33**	**N/A**	0	N/A
Phytoseiulus persimilis	0	0	37	12	**37**	**N/A**	0	N/A
Steinernema kraussei	0	0	3	2	**3**	**N/A**	5	N/A
All biological control agents	**0**		**120**		**120**	**N/A**	**7**	N/A
Biopesticides								
Bacillus amyloliquefaciens strain D747	0	0	6	3	**6**	**3**	5	2
Bacillus subtilis strain QST 713	0	0	79	15	**79**	**6**	0	0
Beauveria bassiana ATCC - 74040	0	0	11	3	**11**	**2**	2	<0.5
Beauveria bassiana GHA	0	0	14	8	**14**	**2**	0	0
All biopesticides	**0**		**110**		**110**	**14**	**9**	**3**
All biologicals[2]	**0**	**0**	**230**	**61**	**230**		**16**	**3**
Physical control								
Unspecified physical control agents[3]	0	0	94	28	**94**	**N/A**	0	0
All physical control	**0**	**0**	**94**	**28**	**94**	**N/A**	**4**	**7**
Area grown	77		169		**247**		276	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]
(2) All biologicals includes biological control agents and biopesticides. (3) Refer to Appendix 3 for definitions. 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 formulations – 2020

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

Fungicides	Non-protected raspberry		Protected raspberry		All raspberry 2020		All raspberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Azoxystrobin	10	4	24	9	**34**	**8**	136	34
Boscalid/pyraclostrobin	7	4	142	65	**149**	**61**	148	62
Chlorothalonil	0	0	9	5	**9**	**9**	4	5
Cyprodinil/fludioxonil	7	4	97	46	**104**	**65**	90	55
Dimethomorph	0	0	90	38	**90**	**97**	45	66
Fenhexamid	3	4	188	77	**191**	**143**	349	228
Fluazinam	0	0	26	5	**26**	**2**	0	0
Metalaxyl-M	0	0	1	< 0.5	**1**	**< 0.5**	6	2
Myclobutanil	7	4	2	1	**9**	**1**	0	0
Pyrimethanil	3	4	93	41	**96**	**39**	143	58
Tebuconazole	0	0	15	8	**15**	**2**	62	12
All fungicides	**36**	**4**	**686**	**99**	**722**	**427**	**1,005**	**566**
Area grown	77		169		**247**		276	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report(3)

Table 9 Raspberry herbicide and desiccant formulations – 2020

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

Herbicides/desiccants	Non-protected raspberry		Protected raspberry		All raspberry 2020		All raspberry 2018[1]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Carfentrazone-ethyl	<0.5	<0.5	106	49	**107**	**1**	107	1
Clethodim	0	0	6	3	**6**	**< 0.5**	2	< 0.5
Diquat	0	0	9	5	**9**	**< 0.5**	136	32
Flazasulfuron	0	0	1	1	**1**	**< 0.5**	0	0
Glyphosate	0	0	6	3	**6**	**7**	1	1
Isoxaben	5	6	22	13	**27**	**1**	56	5
Pendimethalin	5	6	22	13	**27**	**7**	35	16
Propyzamide	3	4	2	1	**6**	**2**	9	6
All herbicides/desiccants	**13**	**6**	**175**	**50**	**188**	**19**	**391**	**107**
Area grown	77		169		**247**		276	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report(3)

Table 10 Blackcurrant insecticide, acaricide and physical control formulations – 2020

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

Insecticides/acaricides	All blackcurrant 2020			All blackcurrant 2018[1]	
	ha	**%**	**kg**	ha	kg
Lambda-cyhalothrin	**538**	**95**	**4**	331	2
Spinosad	**143**	**48**	**7**	0	0
Spirodiclofen	**143**	**48**	**5**	0	0
Spirotetramat	**128**	**43**	**10**	31	2
Thiacloprid	**158**	**53**	**19**	529	63
All insecticides/acaricides	**1,110**	**95**	**44**	**896**	**69**
Physical control					
Unspecified physical control agents[2]	**3**	**1**	**N/A**	0	0
All physical control	**3**	**1**	**N/A**	**0**	**0**
Area grown	**299**			282	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]
(2) Refer to Appendix 3 for definitions
N/A = not applicable

Table 11 Blackcurrant fungicide and sulphur formulations – 2020

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

Fungicides	All blackcurrant 2020			All blackcurrant 2018[1]	
	ha	%	kg	ha	kg
Boscalid/pyraclostrobin	535	95	268	531	261
Bupirimate	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cyprodinil/fludioxonil	97	32	60	172	107
Fenhexamid	240	80	144	81	60
Kresoxim-methyl	145	49	15	178	18
Myclobutanil	342	81	26	85	8
Pyrimethanil	97	32	77	85	68
All fungicides	**1,457**	**95**	**591**	**1,219**	**585**
Sulphur	742	85	4,465	522	3,353
Area grown	299			282	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 12 Blackcurrant herbicide and desiccant formulations – 2020

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

Herbicides/desiccants	All blackcurrant 2020			All blackcurrant 2018(1)	
	ha	%	kg	ha	kg
Carfentrazone-ethyl	99	33	1	2	< 0.5
Clopyralid	< 0.5	< 0.5	< 0.5	0	0
Fluazifop-p-butyl	< 0.5	< 0.5	< 0.5	0	0
Flufenacet/metribuzin	242	81	98	171	76
Glyphosate	102	34	89	85	30
Isoxaben	< 0.5	< 0.5	< 0.5	4	< 0.5
Pendimethalin	242	81	125	174	99
Propyzamide	2	1	2	85	86
All herbicides/desiccants	**687**	**82**	**315**	**698**	**326**
Area grown	299			282	

(1) For a full list of formulations recorded in 2018 please refer to the 2018 report(3)

Table 13 Other soft fruit insecticide and acaricide formulations – 2020

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

Insecticides/acaricides	Non-protected other soft fruit		Protected other soft fruit		All other soft fruit 2020[1]		All other soft fruit 2018[2]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Abamectin	0	0	10	3	**10**	**< 0.5**	19	< 0.5
Cyantraniliprole	0	0	11	4	**11**	**1**	9	< 0.5
Deltamethrin	0	0	2	1	**2**	**< 0.5**	0	0
Fatty acids C7-C20	0	0	1	< 0.5	**1**	**6**	0	0
Indoxacarb	0	0	5	2	**5**	**< 0.5**	9	< 0.5
Lambda-cyhalothrin	25	14	261	58	**286**	**3**	90	1
Pyrethrins	0	0	14	5	**14**	**1**	197	10
Spinosad	0	0	23	8	**23**	**2**	85	8
Thiacloprid	20	13	494	94	**514**	**62**	257	30
All insecticides/acaricides	**44**	**14**	**820**	**95**	**865**	**75**	**687**	**53**
Area grown	153		273		**426**		356	

(1) In 2020 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, honeyberry, jostaberry, loganberry, tayberry, tummelberry and whitecurrant

(2) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 14 Other soft fruit biological, molluscicide and physical control formulations – 2020

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 2020[1]		All other soft fruit 2018[2]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Heterorhabditis bacteriophora	3	2	822	50	**826**	**N/A**	2	N/A
Neoseiulus cucumeris	0	0	56	9	**56**	**N/A**	4	N/A
Parasitic wasps (species not recorded)	0	0	11	4	**11**	**N/A**	3	N/A
Phytoseiulus persimilis	0	0	21	4	**21**	**N/A**	0	N/A
Steinernema feltiae	0	0	89	26	**89**	**N/A**	15	N/A
Steinernema kraussei	0	0	186	23	**186**	**N/A**	19	N/A
All biological control agents	**3**		**1,186**		**1,190**	**N/A**	**44**	**N/A**
Biopesticides								
Bacillus amyloliquefaciens strain D747	0	0	8	3	**8**	**5**	0	0
Bacillus subtilis strain QST 713	0	0	14	2	**14**	**1**	17	2
Beauveria bassiana ATCC - 74040	0	0	15	4	**15**	**3**	0	0
All biopesticides	**0**		**36**		**36**	**9**	**17**	**2**
All biologicals[3]	**3**	**2**	**1,223**	**74**	**1,226**	**9**	**61**	**2**
Molluscicides								
Ferric phosphate	0	0	6	2	**6**	**1**	0	0
All molluscicides	**0**	**0**	**6**	**2**	**6**	**1**	**50**	**4**

Cont…

Table 14 Other soft fruit biological, molluscicide and physical control formulations – 2020 continued

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

Physical control	Non-protected other soft fruit		Protected other soft fruit		All other soft fruit 2020[(1)]		All other soft fruit 2018[(2)]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Unspecified physical control agents[(4)]	11	7	51	13	**61**	**N/A**	0	0
Total physical control	**11**	**7**	**51**	**13**	**61**	**N/A**	**0**	**0**
Area grown	153		273		**426**		356	

(1) In 2020 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, honeyberry, jostaberry, loganberry, tayberry, tummelberry and whitecurrant
(2) For a full list of formulations recorded in 2018 please refer to the 2018 report[(3)]
(3) All biologicals includes biological control agents and biopesticides
(4) Refer to Appendix 3 for definitions
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 – 2020

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

Fungicides	Non-protected other soft fruit		Protected other soft fruit		All other soft fruit 2020[1]		All other soft fruit 2018[2]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Boscalid/pyraclostrobin	0	0	128	40	**128**	**46**	57	19
Bupirimate	4	2	0	0	**4**	**1**	11	3
Cyprodinil/fludioxonil	2	2	219	45	**221**	**112**	186	94
Dimethomorph	0	0	1	< 0.5	**1**	**2**	0	0
Fenhexamid	2	1	250	73	**252**	**189**	152	93
Fenpropimorph	5	2	0	0	**5**	**2**	64	42
Kresoxim-methyl	< 0.5	< 0.5	0	0	**< 0.5**	**< 0.5**	30	3
Myclobutanil	59	13	4	2	**63**	**6**	5	< 0.5
Proquinazid	19	13	0	0	**19**	**1**	0	0
Pyrimethanil	0	0	114	37	**114**	**73**	111	79
Tebuconazole	0	0	4	1	**4**	**1**	0	0
All fungicides	**91**	**16**	**721**	**77**	**811**	**432**	**675**	**342**
Sulphur	0	0	15	5	**15**	**60**	3	2
Area grown	153		273		**426**		356	

(1) In 2020 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, honeyberry, jostaberry, loganberry, tayberry, tummelberry and whitecurrant
(2) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 16 Other soft fruit herbicide and desiccant formulations – 2020

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

Herbicides/desiccants	Non-protected other soft fruit		Protected other soft fruit		All other soft fruit 2020[1]		All other soft fruit 2018[2]	
	ha	%	ha	%	**ha**	**kg**	ha	kg
Carfentrazone-ethyl	20	13	0	0	**20**	**< 0.5**	23	< 0.5
Clopyralid	5	3	0	0	**5**	**< 0.5**	0	0
Diquat	0	0	27	10	**27**	**6**	75	27
Fluazifop-p-butyl	5	3	0	0	**5**	**< 0.5**	19	4
Flufenacet/metribuzin	20	13	27	10	**46**	**19**	30	16
Glyphosate	30	20	0	0	**30**	**25**	11	11
Isoxaben	9	6	0	0	**9**	**1**	55	7
Napropamide	0	0	27	10	**27**	**35**	41	53
Pendimethalin	29	19	2	1	**31**	**16**	54	39
Propyzamide	22	14	0	0	**22**	**16**	43	32
All herbicides/desiccants	**139**	**26**	**83**	**11**	**221**	**120**	**361**	**192**
Area grown	153		273		**426**		356	

(1) In 2020 other soft fruit crops included blueberry, blackberry, gooseberry, redcurrant, honeyberry, jostaberry, loganberry, tayberry, tummelberry and whitecurrant
(2) For a full list of formulations recorded in 2018 please refer to the 2018 report[3]

Table 17 Compounds encountered in the soft fruit survey for the first time in 2020

Active substance	Type(1)	Area (ha)	Weight (kg)
Cyflumetofen	I	150	30
Dimethenamid-P	H	121	48
Flazasulfuron	H	19	< 0.5
Aureobasidium pullulans	BP	18	4

(1) Pesticide type = BP: Biopesticides, H: Herbicide and I: Insecticide

Table 18 Mode of action/chemical group of insecticide active substances - 2020

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
Sodium channel modulators	Deltamethrin	Pyrethroid	3A	183	2
	Lambda-cyhalothrin	Pyrethroid	3A	1,732	14
	Pyrethrins	Pyrethrin	3A	32	2
All sodium channel modulators				**1,946**	**17**
Nicotinic acetylcholine receptor (naAChR) competitive modulators	Thiacloprid	Neonicotinoid	4A	1,542	177
All nicotinic acetylcholine receptor (naAChR) competitive modulators				**1,542**	**177**
Nicotinic acetylcholine receptor (naAChR) allosteric modulators	Spinosad	Spinosyns	5	617	39
All nicotinic acetylcholine receptor (naAChR) allosteric modulators				**617**	**39**
Glutamate-gated chloride channel (GluCl) allosteric modulators	Abamectin	Avermectin	6	112	1
All glutamate-gated chloride channel (GluCl) allosteric modulators				**112**	**1**
Mite growth inhibitors	Clofentezine	Clofentezine	10A	465	76
	Etoxazole	Etoxazole	10B	271	10
All mite growth inhibitors				**736**	**85**
Mitochondrial complex **III** electron transport inhibitors	Bifenazate	Bifenazate	20D	787	68

Cont…

Table 18 Mode of action/chemical group of insecticide active substances – 2020 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
All mitochondrial complex III electron transport inhibitors				**787**	**68**
Voltage-dependent sodium channel blockers	Indoxacarb	Oxadiazine	22A	131	7
All voltage-dependent sodium channel blockers				**131**	**7**
Inhibitors of acetyl CoA carboxylase	Spirodiclofen	Tetronic and tetramic acid derivitives	23	339	20
	Spirotetramat	Tetronic and tetramic acid derivitives	23	1,402	131
All inhibitors of acetyl CoA carboxylase				**1,741**	**151**
Mitochondrial complex II electron transport inhibitors	Cyflumetofen	Beta-ketonitrile derivative	25A	150	30
All mitochondrial complex II electron transport inhibitors				**150**	**30**
Ryanodine receptor modulators	Cyantraniliprole	Diamide	28	30	2
All ryanodine receptor modulators				**30**	**2**
Unclassified	Fatty acids C7-C20			149	682
All unclassified				**149**	**682**
All insecticides				7,941	1,260
Area grown (1)				2,193	

(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[6]

Table 19 Mode of action/chemical group of fungicide active substances - 2020

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 acids metabolism	Metalaxyl-M	Phenylamide	Acylalanine	4	1	< 0.5
	Bupirimate	hydroxy-(2-amino-) pyrimidines	hydroxy-(2-amino-) pyrimidines	8	194	45
All nucleic acid synthesis					**195**	**46**
Respiration	Boscalid	SDHI	Pyridine-carboxamides	7	2,324	899
	Fluopyram	SDHI	Pyridinyl-ethyl-benzamides	7	1,766	352
	Fluxapyroxad	SDHI	Pyrazole-4-carboxamides	7	754	34
	Azoxystrobin	Qo inhibitor	Methoxy-acrylates	11	973	231
	Kresoxim-methyl	Qo inhibitor	Oximino-acetates	11	396	46
	Pyraclostrobin	Qo inhibitor	Methoxy-carbamates	11	2,324	226
	Trifloxystrobin	Qo inhibitor	Oximino-acetates	11	1,766	352
	Fluazinam	not available	2,6-dinitro-anilines	29	26	2
All respiration					**10,330**	**2,140**
Amino acids and protein synthesis	Cyprodinil	Anilino - pyrimidine	Anilino - pyrimidine	9	1,767	611
	Mepanipyrim	Anilino - pyrimidine	Anilino - pyrimidine	9	337	120
	Pyrimethanil	Anilino - pyrimidine	Anilino - pyrimidine	9	1,094	766
All amino acids and protein synthesis					**3,198**	**1,498**
Signal transduction	Fludioxonil	Phenylpyrroles	Phenylpyrroles	12	1,767	407
	Proquinazid	Aza-naphthalenes	Quinazolinone	13	516	18

Cont…

Table 19 Mode of action/chemical group of fungicide active substances – 2020 continued

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
	Quinoxyfen	Aza-naphthalenes	Phenylpyrroles	13	36	5
All signal transduction					**2,319**	**430**
Sterol biosynthesis in membranes	Difenoconazole	DeMethylation inhibitor	Triazoles	3	771	25
	Myclobutanil	DeMethylation inhibitor	Triazoles	3	1,724	107
	Penconazole	DeMethylation inhibitor	Triazoles	3	1,286	62
	Tebuconazole	DeMethylation inhibitor	Triazoles	3	19	3
	Fenpropimorph	Morpholine	Morpholines	5	14	5
	Fenhexamid	KRI fungicides SBI: Class III	Hydroxyanilides	17	2,661	1,779
	Fenpyrazamine	KRI fungicides SBI: Class III	Amino-pyrazolinone	17	605	332
All sterol biosynthesis in membranes					**7,080**	**2,312**
Cell wall biosynthesis	Dimethomorph	Carboxylic acid amide	Morpholine/cinamic acid amides	40	352	483
All cell wall biosynthesis					**352**	**483**
Chemicals with multi-site activity	Chlorothalonil	Chloronitrile	Chloronitrile	M 05	9	9
All chemicals with multi-site activity					**9**	**9**

Cont…

Table 19 Mode of action/chemical group of fungicide active substances - 2020

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
Unknown mode of action	Cyflufenamid	Phenyl-acetamide	Phenyl-acetamide	U 06	1,142	16
All unknown mode of action					**1,142**	**16**
Not specified	Potassium hydrogen carbonate			NC	458	2,301
All not classified					**458**	**2,301**
All fungicides					**25,082**	**9,233**
Sulphur	Sulphur				1,418	5,112
Area grown(1)					2,193	

(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[7]

Table 20 Mode of action/chemical group of herbicide active substances - 2020

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

Mode of Action	Active Substance	Chemical Group	HRAC	Total Soft Fruit	Total Soft Fruit
				ha	kg
Inhibition of acetyl CoA carboxylase	Clethodim	Cyclohexanedione 'DIMS'	1	58	7
	Fluazifop-P-butyl	Aryloxyphenoxy-propionate 'FOPS'	1	5	< 0.5
All inhibition of acetyl CoA carboxylase				**63**	**7**
Inhibition of acetolactate synthase ALS	Flazasulfuron	Sulfonylurea	2	19	< 0.5
All inhibition of acetolactate synthase ALS				**19**	**< 0.5**
Microtubule assembly inhibition	Pendimethalin	Dinitroaniline	3	491	266
	Propyzamide	Benzamide	3	210	135
All microtubule assembly inhibition				**701**	**401**
Auxin Mimics	Clopyralid	Pyridine carboxylates	4	55	5
All auxin mimics				**55**	**5**
Inhibition of photosynthesis at photosystem II	Metamitron	Triazinone	5	56	78
	Metribuzin	Triazinone	5	288	50
All inhibition of photosynthesis at photosystem II				**344**	**128**
Inhibition of EPSP synthase	Glyphosate	Glycine	9	317	397
All inhibition of EPSP synthase				**317**	**397**
Inhibition of glutamine synthetase	Glufosinate-Ammonium	Phosphinic acid	10	1	1
All inhibition of glutamine synthetase				**1**	**1**

Cont…

Table 20 Mode of action/chemical group of herbicide active substances – 2020 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 protoporphyrinogen oxidase	Carfentrazone-Ethyl	Triazolinone	14	477	5
All inhibition of protoporphyrinogen oxidase				**477**	**5**
Inhibition of VLCFAs	Dimethenamid-P	Chloroacetamide	15	121	48
	Flufenacet	Oxyacetamide	15	288	68
All inhibition of VLCFAs				**409**	**116**
Photosystem-I-electron diversion	Diquat	Bibyridylium	22	59	14
All photosystem-I-electron diversion				**59**	**14**
Inhibition of cellulose synthesis	Isoxaben	Benzamide	29	263	19
All inhibition of cellulose synthesis				**263**	**19**
Unclassified	Napropamide	Acetamide	0	107	125
All unclassified				**107**	**125**
All herbicides				**2,815**	**1,220**
Area grown(1)				2,193	

(1) Includes multi-cropping
Note: Active substances have been grouped by their mode of action. Full details on mode of action classification and the 2020 review and HRAC/WSSA code changes can be found on the Herbicide Resistance Action Committee (HRAC) webpage[8]

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(1)	2020	2018	% change
1	Fenhexamid	F	2,661	2,487	7
2	Pyraclostrobin	F	2,324	1,176	98
3	Boscalid	F	2,324	1,176	98
4	Fludioxonil	F	1,767	1,703	4
5	Cyprodinil	F	1,767	1,703	4
6	Trifloxystrobin	F	1,766	1,714	3
7	Fluopyram	F	1,766	1,714	3
8	Lambda-cyhalothrin	I	1,732	1,216	42
9	Myclobutanil	F	1,724	90	1,820
10	Thiacloprid	I	1,542	1,807	-15
11	Sulphur	SU	1,418	1,085	31
12	Spirotetramat	I	1,402	180	680
13	Penconazole	F	1,286	957	34
14	Cyflufenamid	F	1,142	938	22
15	Pyrimethanil	F	1,094	1,028	6
16	Azoxystrobin	F	973	1,056	-8
17	*Neoseiulus cucumeris*	B	970	75	1,188
18	*Heterorhabditis bacteriophora*	B	859	11	7,737
19	Bifenazate	I	787	310	154
20	Difenoconazole	F	771	206	274

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(1)	2020	2018	% change
1	Sulphur	SU	5,112	4,058	26
2	Potassium hydrogen carbonate	F	2,301	2,604	-12
3	Fenhexamid	F	1,779	1,719	3
4	Boscalid	F	899	455	97
5	Pyrimethanil	F	766	723	6
6	Fatty acids C7-C20	I	682	230	196
7	Cyprodinil	F	611	621	-1
8	Dimethomorph	F	483	342	41
9	Fludioxonil	F	407	414	-1
10	Glyphosate	H	397	81	388
11	Trifloxystrobin	F	352	341	3
12	Fluopyram	F	352	341	3
13	Fenpyrazamine	F	332	240	38
14	Pendimethalin	H	266	181	47
15	Azoxystrobin	F	231	262	-12
16	Pyraclostrobin	F	226	114	97
17	Thiacloprid	I	177	216	-18
18	Propyzamide	H	135	224	-40
19	Spirotetramat	I	131	17	674
20	Napropamide	H	125	303	-59

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

Table 23 Total soft fruit crop, comparison with previous years

Pesticide usage in 2016, 2018 and 2020, area treated with formulations and active substances (a.s.) and the weight (kg) applied

	2016			2018			2020		
	Formulations	**a.s.**	**Weight**	**Formulations**	**a.s.**	**Weight**	**Formulations**	**a.s.**	**Weight**
	ha	**ha**	**kg**	**ha**	**ha**	**kg**	**ha**	**ha**	**kg**
Insecticides/acaracides	5,741	5,741	461	5,973	5,973	645	7,941	7,896	1,260
Molluscicides	293	293	68	823	823	150	712	712	115
Fungicides	13,788	16,940	7,055	16,911	22,291	11,017	18,454	25,098	9,233
Sulphur	781	781	3,687	1,085	1,085	4,058	1,418	1,418	5,112
Herbicides/desiccants	3,958	4,163	1,837	2,894	3,098	1,199	2,411	2,819	1,220
Biological control agents [(1)]	622	622	N/A	1,129	1,129	N/A	3,463	3,463	N/A
Biopesticides	852	852	70	2,921	2,921	198	1,211	1,211	235
Physical control	6	24	47	50	50	97	339	339	N/A
All pesticides	**26,041**	**29,416**	**13,225**	**31,786**	**37,371**	**17,363**	**35,948**	**42,956**	**17,175**
Area of all soft fruit crops (ha)[(2)]	1,876			2,088			2,193		

(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
N/A = not applicable

Appendix 2 – Survey statistics

Census and sample information

Table 24 Census crop areas 2020

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

Crop	Scotland 2020	Scotland 2018	% change
Strawberry	1,194	1,133	5
Raspberry	241	271	-11
Blackcurrant	297	279	6
Blueberry	265	219	21
Mixed and other soft fruits	172	147	17
All soft fruit	**2,168**	**2,050**	**6**

Note: Data taken from the 2020 and 2018 June Agricultural Census.
All areas exclude multicropping
It was estimated from the crops encountered in the 2020 sample, that 32 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 - 2020

Number of holdings surveyed in each region and size group

Size(1) (ha)	North	Angus	South	Scotland
0.01 - 4.99	19	4	10	**33**
5.00 - 9.99	0	4	3	**7**
10.00 - 19.99	1	5	1	**7**
20 +	0	12	5	**17**
All sizes	**20**	**25**	**19**	**64**

(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 - 2020

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

Size[1] (ha)	Scotland[2]
0.01 - 4.99	5.32
5.00 - 9.99	9.49
10.00 - 19.99	0.00
20 +	118.77
All sizes	**133.58**

Table 27 Non-protected soft fruit census areas - 2020

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

Size[1] (ha)	Scotland[2]
0.01 - 4.99	101.79
5.00 - 9.99	68.51
10.00 - 19.99	78.21
20 +	312.06
All sizes	**560.57**

(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 - 2020

Area (ha) of protected soft fruit crops in sample

Size(1) (ha)	Scotland(2)
0.01 - 4.99	24.00
5.00 - 9.99	28.70
10.00 - 19.99	76.22
20 +	512.71
All sizes	**641.64**

Table 29 Protected soft fruit census areas - 2020

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

Size(1) (ha)	Scotland(2)
0.01 - 4.99	46.51
5.00 - 9.99	98.80
10.00 - 19.99	200.68
20 +	1,261.83
All sizes	**1,607.81**

(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 - 2020

Size[1] (ha)	North	Angus	South
0.01 - 4.99	12.1967	76.2453	13.7613
5.00 - 9.99		20.8264	3.5906
10.00 - 19.99			
20 +		2.5261	

Table 31 Protected soft fruit raising factors - 2020

Size[1] (ha)	North	Angus	South
0.01 - 4.99	1.0491	3.0280	1.7975
5.00 - 9.99		3.0489	4.3067
10.00 - 19.99	1.1742	2.7201	3.3860
20 +		2.5808	2.1415

(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 - 2020

Crop	North Adj. 1	Angus Adj. 1	South Adj. 1	Adj 2
Strawberry	5.2227	8.1317	0.9406	1.0000
Raspberry	10.1239	1.8207	1.1315	1.0000
Blackcurrant	0.7916	0.9668	0.2471	1.0000
Other soft fruit	1.4996	2.0216	2.1513	1.0000

Table 33 Protected soft fruit first and second adjustment factors - 2020

Crop	North Adj. 1	Angus Adj. 1	South Adj. 1	Adj 2
Strawberry	1.0683	1.1479	0.9520	1.0000
Raspberry	0.7389	0.6597	0.8143	1.0000
Other soft fruit	46.1965	0.8768	2.4173	1.0000

Response rates

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

Table 34 Response rate

	2020	% total
Target sample	82	100
Total achieved	**64**	**78**
Total number of refusals/non-contact	20	
Total number of farms approached	**84**	

Financial burden to farmers

To minimise the burden on farmers and to comply with COVID_19 restrictions, the survey team used non-visit methods of collection such as email, post or telephone call.

To determine the total burden that the 2020 Soft Fruit Crop Survey placed on those providing the information, the surveyors recorded the time that 56 respondents spent providing the data during the surveys. This sample represents 88 per cent of growers surveyed. The median time taken to provide the information was 10 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 £15.62)[9]

The total financial burden to all growers resulting from participation in the 2020 Soft Fruit Crop survey was calculated to be £167.

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**[(10)] 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 2018[(3)] and 2016[(4)] 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 to 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 2020. This can include perennial crops planted the previous year and plants such as strawberries planted in early 2020. 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.

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

33) In the pesticide tables, some pesticide treatments may be reported as '**unspecified**'. This description was used for occasions where the use of a particular treatment was reported by the grower, but they were unable to provide details of the product used. For these treatments, we are able to provide an area treated but no weight of pesticide used since the exact pesticide is unknown.

Appendix 4 – Survey methodology

Sampling and data collection

Using the June 2020 Agricultural Census[10], 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.

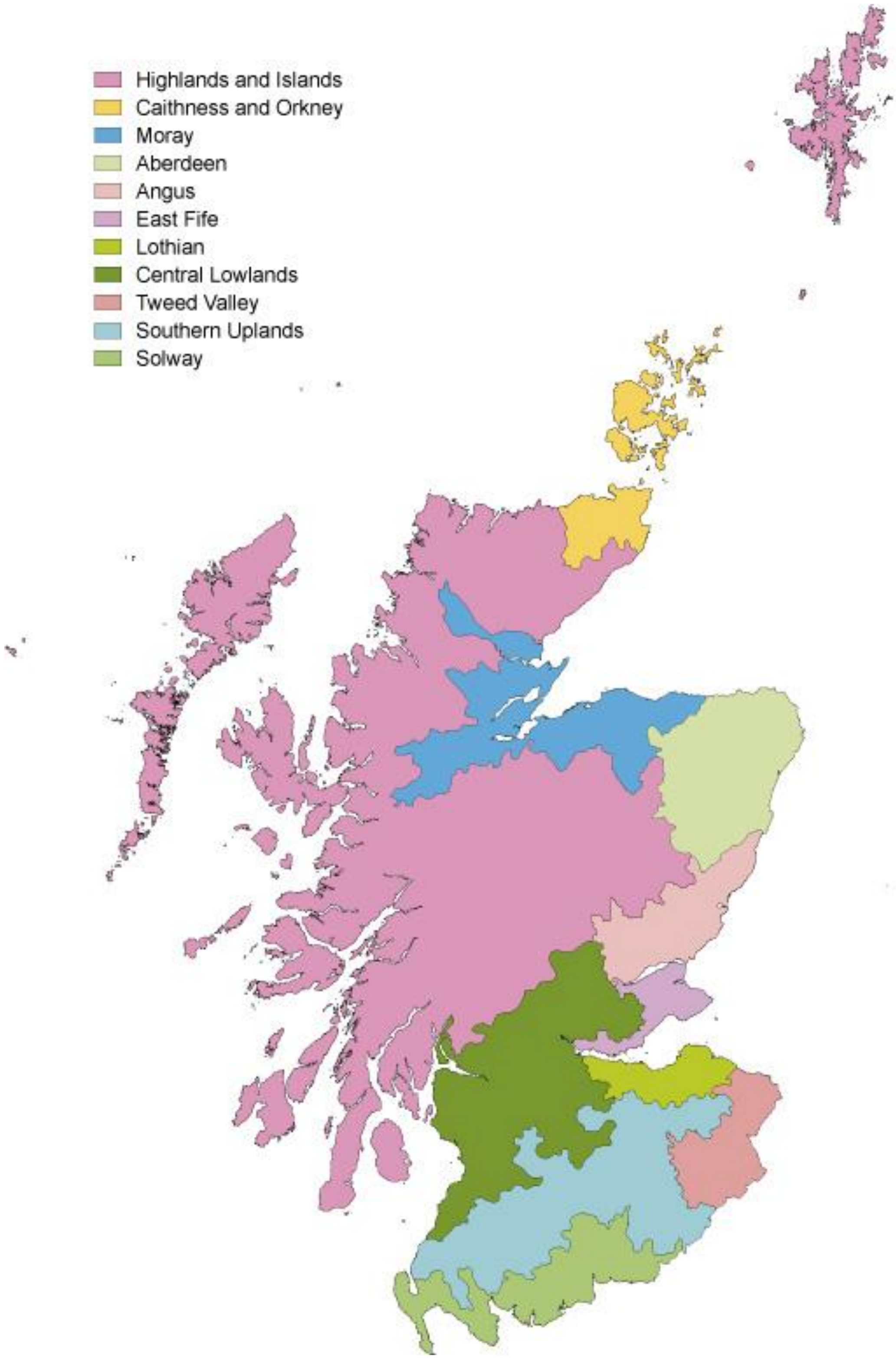
The survey covered pesticide applications to soft fruit crops where all or the majority of the growing season was in 2020. As well as recording treatments applied directly to the crop, data was also collected on land preparation treatments prior to sowing or planting the crop.

Following an introductory letter and phone call, data were collected by either a phone interview or by email. Where necessary, information was also collected from agronomists and contractors. In total, information was collected from holdings 64 growing soft fruit crops (Table 25). These holdings represent 36 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 and 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 and 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[11]



Changes from previous years

A change in sample methodology should be noted when comparing the 2020 data with the previous surveys. All data in 2020 was collected using non-visit methods such as phone interview or email due to restrictions imposed by the COVID-19 pandemic. In previous years data were collected by a combination of personal interview during a visit to the holding and/or by phone/email. This change in data collection method may have impacted the number and type of respondents. Every effort was made to achieve a robust sample despite soft fruit growers dealing with EU exit and COVID restrictions which resulted in a reduced number of participants. This additional effort and change in data collection method resulted in a delay to the publication date.

This report presents information about grower adoption of Integrated Pest Management (IPM). IPM data was not collected during the 2018 survey. The data presented represents the second in the series of surveys of IPM measure on soft fruit crops, first collected alongside the 2016 soft fruit crop survey, allowing the adoption of IPM techniques to be monitored.

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) 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 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 12 per cent for area and 13 per cent for quantity (Table 35).

The RSE for constituent protected and non-protected crop groups varied from 12 to 71 per cent for area and 17 to 69 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 - 2020

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	24	20
Strawberry	14	20
Blackcurrant[(1)]	25	26
Other soft fruit	30	28
All soft fruit crops	**12**	**13**

Table 36 Relative standard errors for protected and non-protected soft fruit crops - 2020

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[(1)]	24	17
Protected strawberry	12	19
Protected other soft fruit	29	25
Non-protected raspberry[(2)]	NC	NC
Non-protected strawberry[(2)]	NC	NC
Non-protected blackcurrant[(1)]	23	24
Non-protected other soft fruit[(1)]	71	69
All non-protected crops[(1)]	**32**	**36**
All protected crops	**14**	**16**

(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
(2) Standard errors could not be calculated (NC) for non-protected raspberries and non-protected strawberries because there were too few active substances recorded. Therefore, estimates for these crops should be treated with caution.

Appendix 6 – Integrated pest management

It is a requirement of the retained EU law Directive 2009/128/EC of the European Parliament and of the Council[12] (equivalent to the EU Sustainable use of Pesticides Directive 2009/128/EC) that member states should promote low pesticide input pest management, in particular Integrated Pest Management (IPM). The Directive defines IPM as follows "'integrated pest management' means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. 'Integrated pest management' emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

Information about the uptake of IPM measures by Scottish growers was collected alongside the 2020 soft fruit pesticide usage survey. IPM data have previously been collected and published for all crop groups in our cycle of pesticide usage surveys (vegetable crops 2015 and 2019, protected edible crops 2015 and 2019, arable crops 2016, soft fruit crops 2016 and fodder crops 2017). Our intention is to monitor IPM uptake in each crop sector every four years. This 2020 IPM survey represents the second in the series of surveys of IPM measures on soft fruits, allowing the adoption of IPM techniques to be monitored. These datasets will be used as an indicator of the success of Scottish Government funded IPM research, knowledge transfer and promotion activities.

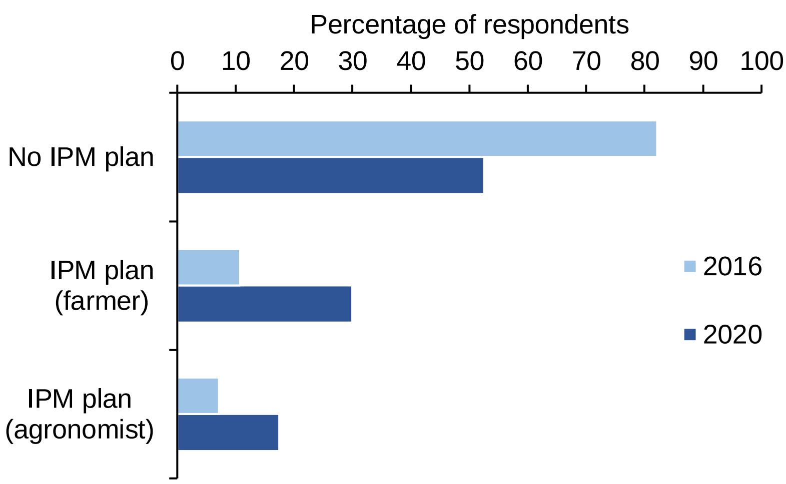
Unlike the other statistics in this report, the figures reported in this section are not raised to produce national estimates but represent only the responses of those surveyed. The IPM sample, whilst smaller than that sampled for the pesticide usage survey, provides a good representation of Scottish regions and farm size groups.

Pearson chi-square tests were used to assess statistical evidence for changes, with permutation tests used when expected values were five or less. When comparing between 2016 and 2020, any evidence of a statistical change in the proportion of growers reporting under a category is indicated by a p-value. Any other notable differences that might indicate a direction of travel are also recorded in the text. If no comparison is made, then the responses recorded are similar between 2016 and 2020. It is worth noting that the sample size was much larger in the 2020 survey (50 holdings verses 33 holdings in 2016) therefore may be more representative of the population. Also, the average holding size in the 2020 survey was 13.9 ha of soft fruit compared to 8.1 ha in 2016 which may influence the responses to the survey questions. These factors should be taken into consideration when making comparison between 2020 and 2016.

In total IPM data was collected from 40 growers representing 50 holdings and collectively growing 695 ha of crops. This sample represented 32 per cent of Scotland's 2020 soft fruit area. Of these growers, 48 per cent had an IPM plan (30 per cent completed their own IPM plan and 18 per cent had a plan completed by their agronomist) and 52 per cent did not have an IPM plan (Figure 30). This provides some evidence that the proportion of growers completing an IPM plan has increased from the 2016 survey where 18 per cent of growers had an IPM plan (p-value = 0.12). Using an IPM plan helps growers to make the best possible, and most sustainable, use of all available methods for pest control.

Since the 2016 survey, the requirement to complete an IPM plan has been added to some farm assurance schemes; for example, farmers certified with Red Tractor are required to complete the NFU/VI IPM plan[13].

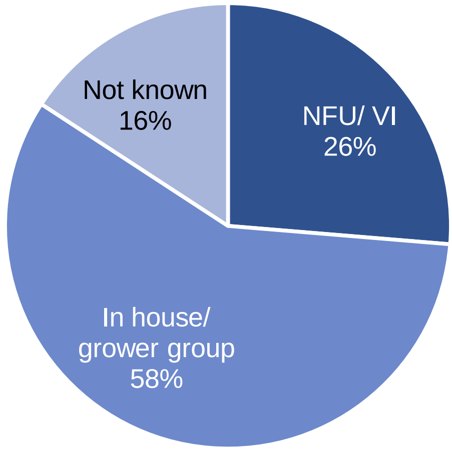
Figure 30 IPM: Percentage of respondents with an IPM plan 2016-2020



Note: The proportion of growers completing an IPM plan has increased from 2016 to 2020 (p-value = 0.12)

Although more plans were completed in 2020 there was little change in the proportions of plans completed by growers or by agronomist. Of those completing a plan, agronomists completed 37 per cent in 2020 and 40 per cent in 2016. Of those growers who had an IPM plan in 2020, either completed themselves or by their agronomist, 26 per cent used the NFU/VI IPM plan, 58 per cent used an in house or grower group plan and 16 per cent did not know the type of plan that was being used (Figure 31). Two respondents stated that they had more than one type of plan being used on their holdings and included plans with biocontrol companies.

Figure 31 IPM: Type of IPM plan – 2020



Farmers were asked about their IPM activities in relation to three categories; risk management, pest monitoring and pest control. Information was collected about all activities each grower conducted in relation to these categories and the responses are reported in the following sections. The term 'pest' is used throughout to denote diseases, weeds and invertebrate pests.

Risk management

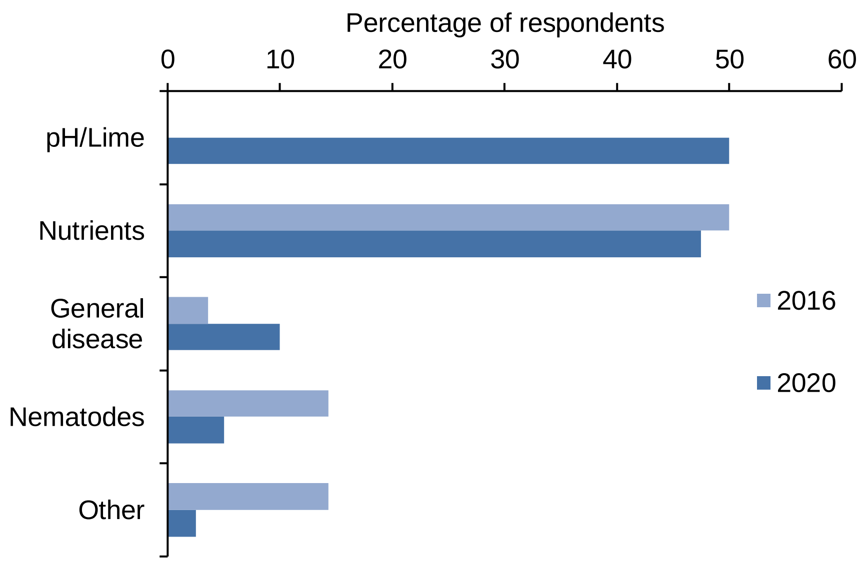
IPM programmes aim to prevent, or reduce, the risk of pests becoming a threat by minimising the likelihood of damage occurring that will require subsequent control. Table 37 presents an overview of the risk management measures adopted by those growers surveyed. In both 2020 and 2016, all growers sampled reported that they implemented at least one measure associated with an IPM risk management approach. There were no statistically significant differences in the responses to summary risk management questions between 2016 and 2020.

Forty-three per cent of growers in 2020 and 54 per cent in 2016 used crop rotation to reduce the risk of pest damage. Rotation breaks the link between pathogen and host, reducing pest population build-up. It can also improve soil fertility and structure, and consequently crop vigour. Sixty-three per cent tested their soil in order to tailor inputs to improve crop performance in 2020, this was an increase from 54 per cent in 2016 (Table 37). Soil testing allows growers to make informed decisions about the inputs required and optimal crop choice for their land. Most testing encountered in 2020 was for pH or lime (50 per cent). This was the biggest change observed from 2016, however, growers were not asked directly about testing soil for pH in 2016, therefore these responses are underestimated in 2016 and classified under 'Other' (Figure 32). The proportions of growers testing for nutrients were similar in both surveys (50 per cent in 2016 to 48 per cent in 2020). There was a decrease in 2020 for testing for nematodes (14 per cent to five per cent). In 2020, more growers indicated that they tested for general diseases than in 2016 (four per cent to 10 per cent). Respondents indicated that the majority of the disease testing in 2020 was for verticillium wilt.

Table 37 IPM: Summary of responses to risk management questions 2016-2020

Risk management activity	Percentage positive response	
	2020	**2016**
Crop rotation	43	54
Soil testing	63	54
Cultivation of seed bed to reduce pest risk	50	61
Cultivation at sowing to reduce pest risk	50	39
Varietal or seed choice to reduce pest risk	45	57
Catch and cover cropping	18	29
Protection or enhancement of beneficial organism populations	93	82
Manipulation of environmental factors	50	32
Crop hygiene	90	93
Any risk management activity	**100**	**100**

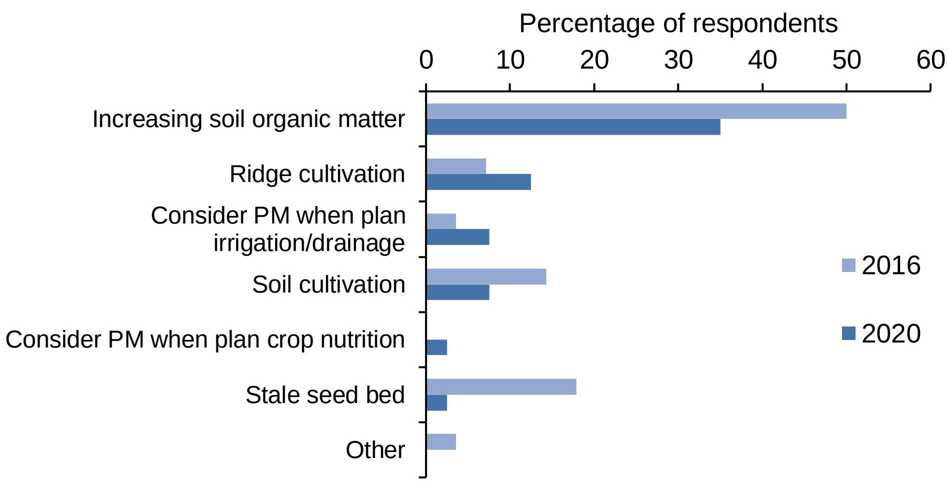
Figure 32 IPM: Soil testing 2016-2020



Note: In 2016 growers were not directly asked about testing for pH or lime. However, pH testing was recorded under 'Other' in 2016. Therefore the 2016 data are underestimated
'Other' in 2020 included tests for vine weevil
'Other' in 2016 included pH and water tests

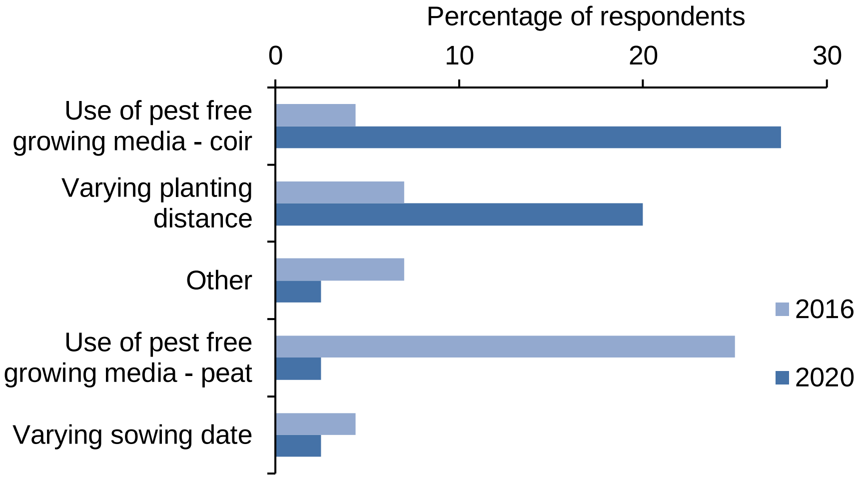
Half of growers in 2020 (50 per cent) and 61 per cent in 2016 reported that they managed their seed bed agronomy to improve crop performance and reduce pest risk (Table 37). In 2020, 35 per cent of growers increased soil organic matter which was a decrease from 50 per cent in 2016. In 2020, three per cent used a stale seed bed for weed management with 18 per cent in 2016 (Figure 33). Stale seed beds allow weeds to germinate before sowing the next crop; these are often treated with a herbicide, depleting the seed bank, and resulting in lower weed pressure, and potentially pesticide use in the succeeding crop. Eight per cent of growers considered pest management when planning irrigation and drainage, an increase from four per cent in 2016. Three per cent of growers also considered pest management when planning crop nutrition however this question was not asked directly in 2016 and cannot be compared. Other methods employed by growers in 2020 included soil cultivation (eight per cent) and ridge cultivation (13 per cent). Ridge cultivation can lower the risk of infection with root rots especially in heavier soils. For comparison in 2016, 14 per cent carried out soil cultivation and seven per cent ridge cultivation. In 2016, other techniques included using raised beds. In 2020, 50 per cent of growers amended cultivation methods at sowing with the aim of increasing crop success, an increase from the 39 per cent in 2016 (Table 37). Twenty per cent varied the planting distance and three per cent varied the sowing date in 2020. In 2016, seven per cent varied the planting distance and four per cent varied the sowing date. Three per cent used a growing media made of peat and 28 per cent used coir in 2020. In contrast, four per cent used coir and 25 per cent used peat in 2016. Three per cent used other cultivation methods at sowing in 2020, slightly less than in 2016 (seven per cent) (Figure 34).

Figure 33 IPM: Seed bed cultivations 2016-2020



Note: 'Other' in 2016 includes using raised beds
PM = pest management

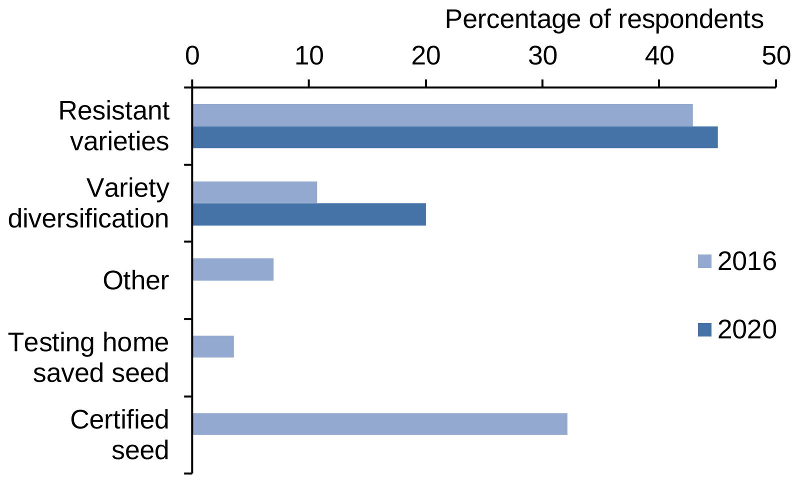
Figure 34 IPM: Cultivations at sowing 2016-2020



Note: ‘Other’ in 2020 includes using an unspecified growing media
‘Other’ in 2016 includes varying planting depth and new soils

Forty-five per cent of growers in 2020 and 57 per cent in 2016 considered risk management when selecting seeds and/or varieties (Table 37). Forty-five per cent selected pest resistant varieties to reduce damage and the need for pesticide input and 20 per cent of growers used diversification of varieties to increase overall crop resilience to pests and environmental stresses in 2020. These are both increases from 2016 with 43 per cent using resistant varieties and 11 per cent using diversification of varieties. In 2020 there were decreases in the proportion of growers using certified seed and testing home saved seed when compared to 2016 (Figure 35). In 2016, 32 per cent of growers used certified seed and four per cent tested home saved seed. No growers indicated that they used either of these techniques in 2020. Other techniques used in 2016 included buying variety suited to the growing region and buying plants from a recommended organic supplier.

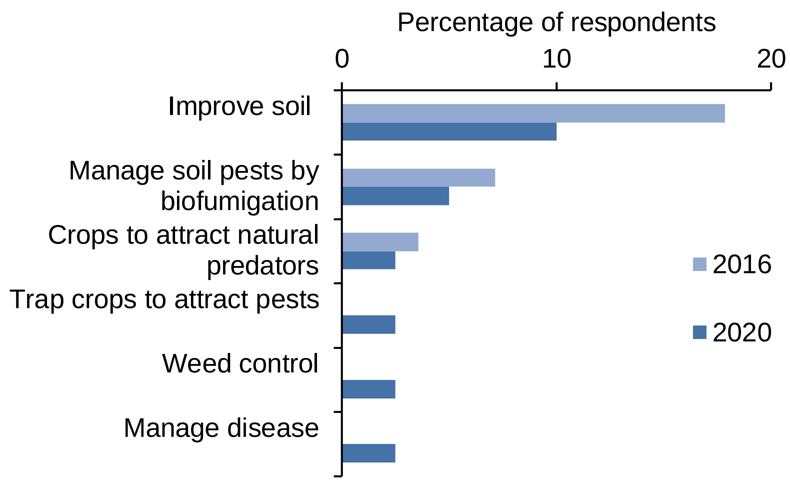
Figure 35 IPM: Variety and seed choice 2016-2020



Note: 'Other' in 2016 includes buying variety suited to the growing region and buying plants from a recommended organic supplier

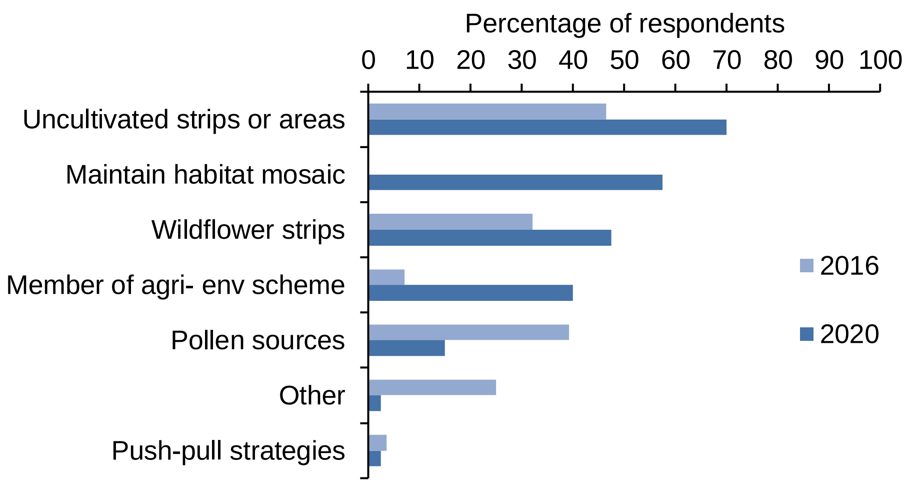
Eighteen per cent of growers sowed catch or cover crops in 2020, a decrease from 29 per cent in 2016 (Table 37). In 2020, 10 per cent of growers used cover and catch crops such as clover and phacelia to improve soil quality, a decrease from 18 per cent in 2016. Three per cent were used to suppress weeds, three per cent used crops such as oilseed radish to attract natural predators (similar to four per cent in 2016), five per cent used crops such as mustard with bio-fumigation properties (a decrease from seven per cent in 2016) and three per cent used crops to manage disease. Three per cent used trap crops to attract pests.

Figure 36 IPM: Catch and cover cropping 2016-2020



Ninety-three per cent of growers stated that they adopted techniques to protect or enhance populations of beneficial organisms, an increase from 82 per cent in 2016 (Table 37). In 2020 there were increases in all of the categories surveyed when last asked in 2016 except for push-pull strategies and pollen sources (Figure 37). Seventy per cent left uncultivated areas, including leaving margins, headlands and other areas wild and using buffer strips to increase biodiversity. Fifty-eight per cent maintained a habitat mosaic including planting and maintaining hedgerows, tree planting and wetland restoration. Fifteen per cent planted pollen sources and 48 per cent planted wildflower strips. There was evidence for an increase in the proportion of growers who took part in an agri-environment scheme (seven per cent in 2016 compared to 40 per cent in 2020, p-value = 0.005) with the main scheme reported as the Scottish Government agri-environment climate scheme (AECS). Other actions to support beneficial organism populations also reported in 2020 were use of biologicals only. Other categories in 2016 included maintaining hedging, ponds and wetland areas which have been categorised in 2020 as maintain habitat mosaic and therefore a comparison between these two categories is not suitable. The other technique recorded under other in 2016 was beetle banks.

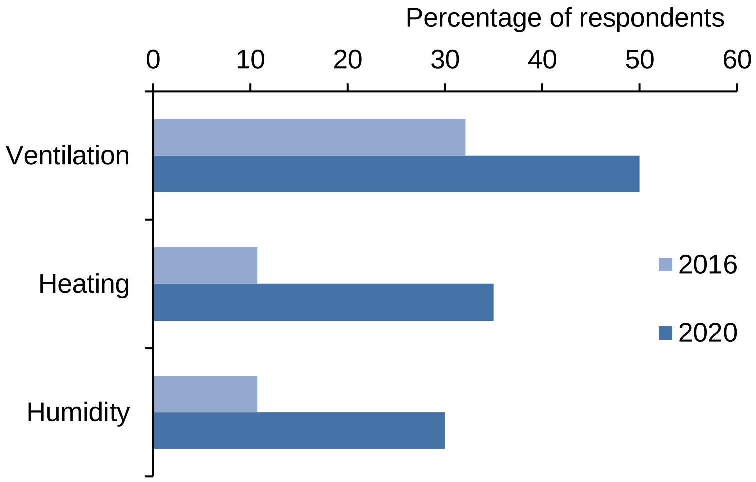
Figure 37 IPM: Protection and enhancement of beneficial organism populations 2016-2020



Note: In 2020, ‘other’ activities included use of biologicals only
‘Other’ categories in 2016 included beetle banks and maintaining habitat mosaic which was asked directly in 2020 and therefore a comparison between these two categories is not suitable

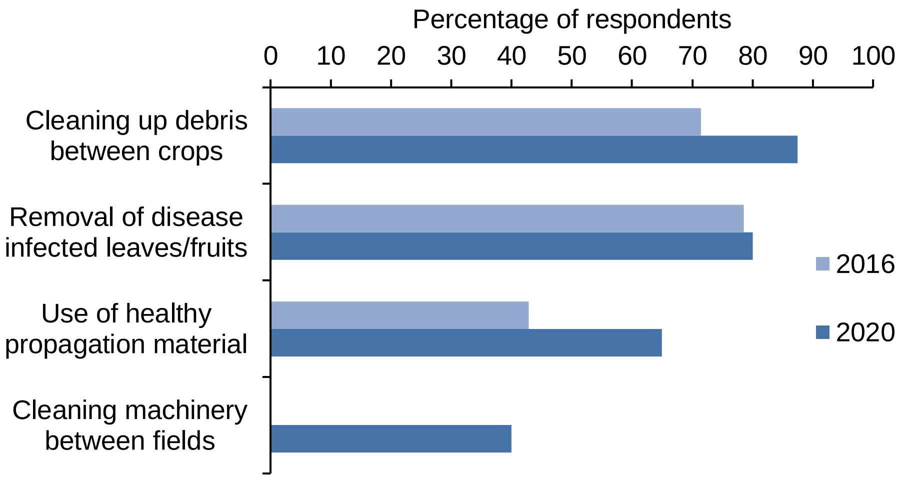
By controlling environmental factors growers can provide optimum growing conditions for plants which can enhance productivity and increase resilience to pests and disease. In 2020, 50 per cent of growers stated that they used manipulation of environmental factors to decrease the risk of pests, an increase from 32 per cent in 2016. This increase is influenced by the fact that the proportion of crops grown under protection was much higher in the 2020 sample compared to the 2016 sample. Half of the growers used ventilation in 2020 an increase from 32 per cent in 2016. Thirty-five per cent manipulated heating in 2020 with 11 per cent in 2016. In 2020, 30 per cent changed humidity compared to 11 per cent in 2016.

Figure 38 IPM: Manipulation of environmental factors 2016-2020



Finally, 90 per cent of the growers sampled reported that they adopted good crop hygiene techniques to reduce risk in 2020, which is similar to 2016 where it was 93 per cent (Figure 39). These included removal of diseased leaves or fruits (80 per cent), removal of debris between crops (87 per cent) and 65 per cent stated that they controlled risk by using healthy propagation material. These are all increases from 2016 where the responses were 78, 71 and 42 per cent respectively. Growers were directly asked in 2020 if they clean machinery between fields where 40 per cent indicated that they did. This was not asked in 2016 and therefore cannot be compared.

Figure 39 IPM: Crop hygiene 2016-2020



Pest monitoring

In IPM, pests are monitored both to determine whether control is economically justified and to effectively target control options. IPM programmes aim to monitor and identify pests, so that appropriate control decisions can be made in conjunction with action thresholds. Table 38 presents an overview of the pest monitoring measures adopted by the growers surveyed in 2016 and 2020. The responses show an increase in most techniques between 2016 and 2020. There were no statistically significant differences in the responses to summary pest monitoring questions between 2016 and 2020. Eighty-five per cent of the growers sampled implemented at least one pest monitoring measure, similar to the 89 per cent in 2016.

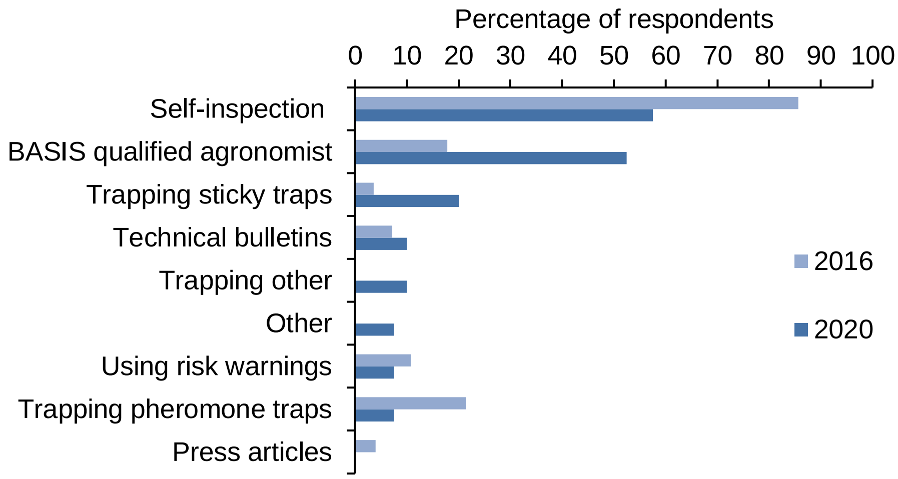
Table 38 IPM: Summary of responses to pest monitoring questions 2016-2020

Pest monitoring activity	Percentage positive response	
	2020	2016
Setting action thresholds for crops	53	32
Monitor and identify pests	78	86
Use of specialist diagnostics	45	39
Regular monitoring of crop growth stage	80	71
Any pest monitoring activity	**85**	**89**

Seventy-eight per cent of growers surveyed reported that they regularly monitored and identified pests with 80 per cent regularly monitoring crop growth stages in 2020, compared to 86 and 71 per cent in 2016 respectively (Table 38). Over half in 2020 (53 per cent) also used action thresholds when monitoring pest populations compared with 32 per cent in 2016. Under half (45 per cent) reported that they used specialist diagnostics to identify pests in 2020, an increase from 39 per cent in 2016.

Pest monitoring information was primarily gained by self-inspection of crops (58 per cent in 2020 and 86 per cent in 2016) (Figure 40). There was an increase in the proportion of growers seeking advice from BASIS qualified agronomists from 18 per cent in 2016 to 53 per cent in 2020. The 2020 sample contained a higher proportion of larger farms which are more likely to employ a BASIS qualified agronomist. In 2020 there was a slight decrease in the use of risk warnings, from 11 per cent in 2016 to eight per cent in 2020.

Figure 40 IPM: Monitoring and identifying pests 2016-2020

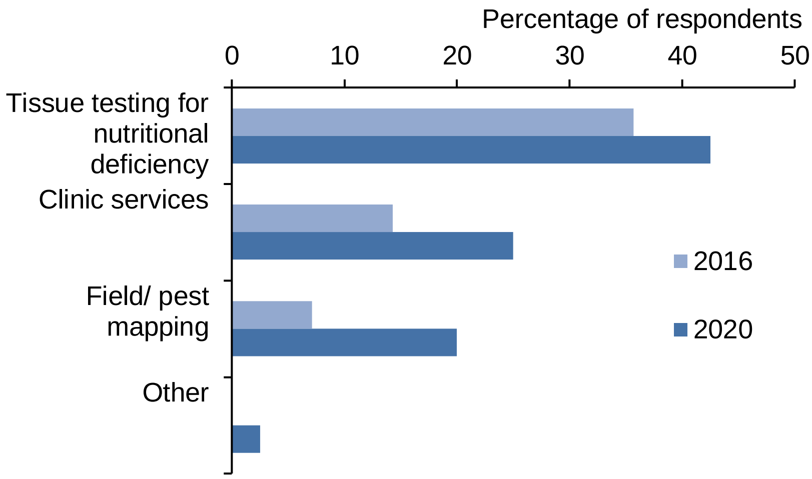


Note: 'Other' in 2020 using phone applications, using cameras to monitor pests and monitoring humidity and temperature
Trapping other included vinegar, sugar solution and drop traps

No growers mentioned the use of press articles in 2020 compared with four per cent in 2016. Sticky traps were used by 20 per cent of growers, an increase from four per cent in 2016. There was a decrease in the use of pheromone traps from 2016 to 2020 (21 per cent to eight per cent). Other types of trapping recorded in 2020 includes the use of vinegar traps to monitor spotted wing drosophila and sugar solution traps. Other methods of pest monitoring reported in 2020 included using phone applications, using cameras to monitor pests and monitoring humidity and temperature.

Forty-five per cent of respondents also used specialist diagnostics when dealing with pests that were more problematic to identify or monitor in 2020, an increase from 39 per cent in 2016 (Table 38). Forty-three per cent used tissue testing for nutritional deficiencies. Twenty per cent of growers used field or pest mapping to aid crop monitoring (Figure 41). A quarter of growers used clinic services to identify unknown pests. All of these categories were an increase on the responses in 2016 (36, seven and 14 per cent respectively). Other methods recorded in 2020 included the use of sap analysis.

Figure 41 IPM: Use of specialist diagnostics 2016-2020



Note: ‘Other’ in 2020 included sap analysis

Pest control

If monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs evaluate the best control method in relation to effectiveness and risk. Control programmes incorporate non-chemical methods alongside, or instead of, chemical control. Use of chemical pest control should be as targeted as possible and the risk of resistance development should be minimised. The effectiveness of the control programme should be reviewed regularly to gauge success and improve their regime as necessary. Table 39 presents an overview of the pest control measures adopted by the growers surveyed. In 2020, 43 per cent of respondents (17 of 40 growers representing 50 holdings) had organic holdings.

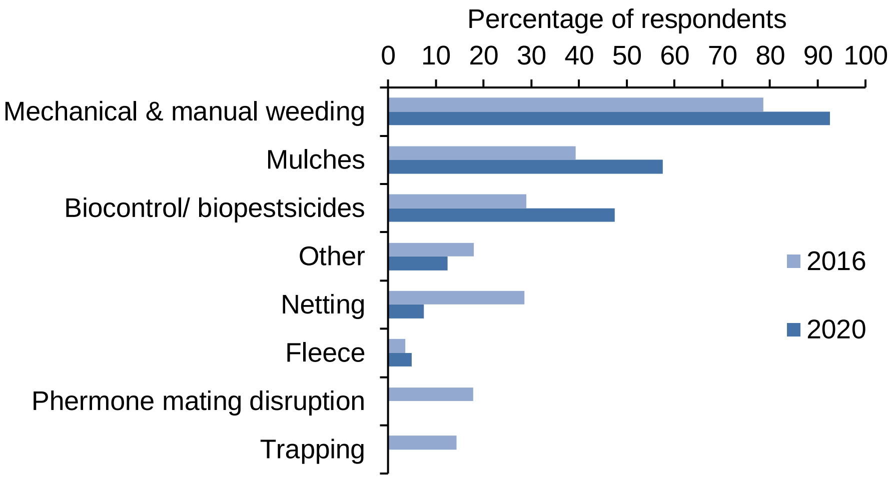
The overwhelming majority of the growers sampled in 2020 and in 2016 adopted at least one IPM pest control activity (95 per cent in 2020 and 96 per cent in 2016). There is a similar proportion of growers in 2020 and 2016 who adopt the use of non-chemical control (95 per cent in 2020 and 96 per cent in 2016). There is an increase in the use of targeted pesticide application in 2020 with 50 per cent compared to 46 per cent in 2016. Growers following anti-resistance strategies increased from 32 per cent in 2016 to 50 per cent in 2020. In 2020, the response to summary pest control questions was similar to 2016 (Table 39).

Table 39 IPM: Summary of responses to pest control questions 2016-2020

Pest control activity	Percentage positive response	
	2020	2016
Non-chemical control used in partnership or instead of chemical control	95	96
Targeted pesticide application	50	46
Follow anti-resistance strategies	50	32
Monitor success of crop protection methods	68	71
Any pest monitoring activity	**95**	**96**

Ninety-five per cent of growers in 2020 reported that they used non-chemical control in partnership or instead of chemical control, similar to the survey in 2016 (Table 39). The most common non-chemical method employed in 2020 was manual or mechanical weeding used by 93 per cent of respondents, an increase from 79 per cent in 2016 (Figure 42). A range of physical control methods which prevent pest access to the crop were also used. Mulches were used by 58 per cent of growers surveyed in 2020, up from 39 per cent in 2016. Netting (eight per cent in 2020 and 29 per cent in 2016) and fleeces (five per cent in 2020 and four per cent in 2016) were also used. Trapping and use of pheromone mating disruption techniques were recorded in 2016 but not in 2020. The use of biocontrol and biopesticides was accounted in 48 per cent of surveyed holdings for 2020, an increase from 29 per cent in 2016. Other non-chemical methods used in 2020 were using soapy water to control pests, using poultry for slug control, growing garlic at the end of rows deter sucking pests and hand trimming crops to increase air flow. Other non-chemical methods used in 2016 included using ash, egg shells or shale to control slugs, using soapy water to control pests, using glue bands on trees, using copper tape around beds, using poultry for slug and aphid control and hand picking slugs and caterpillars.

Figure 42 IPM: Non-chemical control 2016-2020

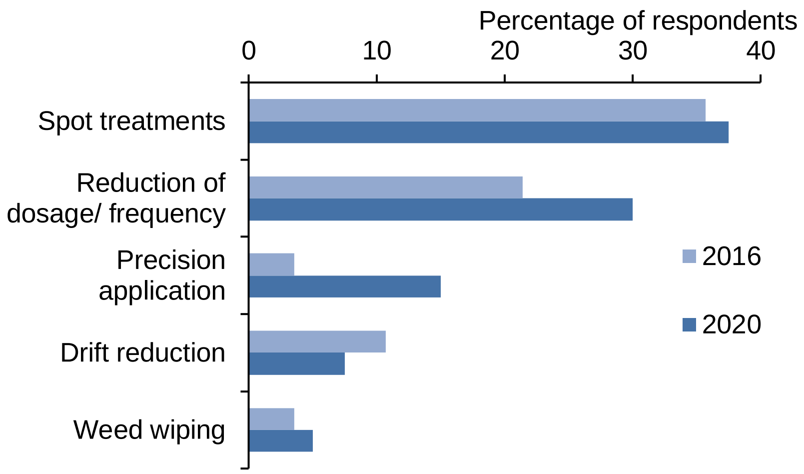


Note: 'Other' in 2020 includes using soapy water to control pests, using poultry for slug control, growing garlic at the ends of rows to deter sucking pests and hand trimming crops to increase air flow
'Other' in 2016 included using ash, egg shells or shale to control slugs, using soapy water to control pests, using glue bands on trees, using copper tape around beds, using poultry for slug and aphid control and hand picking slugs and caterpillars

Half of growers in 2020 stated that they targeted their pesticide applications to reduce pesticide use, an increase from 46 per cent in 2016 (Table 39). The most common method used by 38 per cent of growers in 2020, was spot treatments, similar to 2016 (Figure 43). Eight per cent of growers decreased pesticide application by using drift reduction apparatus, a decrease from 11 per cent in 2016. Precision applications such as the use of GPS were used by 15 per cent of growers, an increase from four per cent recorded in 2016. Reducing the dosage or frequency of pesticide were used by 30 per cent of growers in 2020, compared to 21 per cent in 2016. The use of weed wiping (direct herbicide application to weeds), was used by five per cent of growers in 2020, similar to 2016 (four per cent).

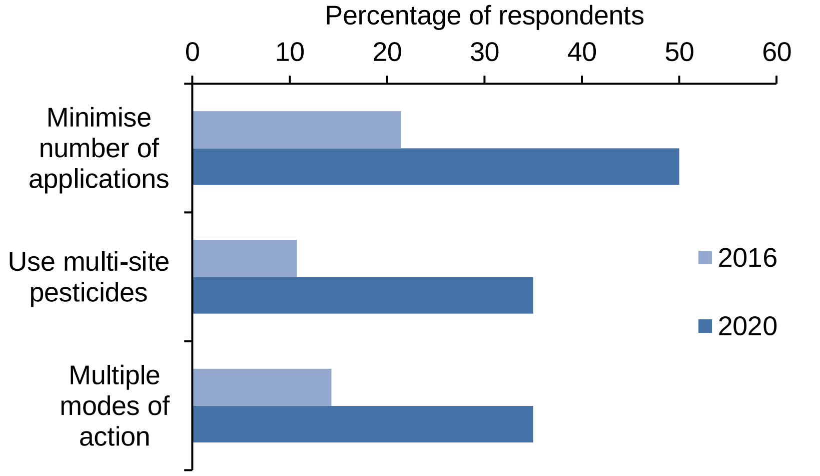
In addition, 50 per cent of growers in 2020 stated that they followed anti-resistance strategies, an increase from 32 per cent in 2016 (Table 39). Anti-resistance strategies are used to minimise the risk of development of pest resistance.

Figure 43 IPM: Targeted pesticide application 2016-2020



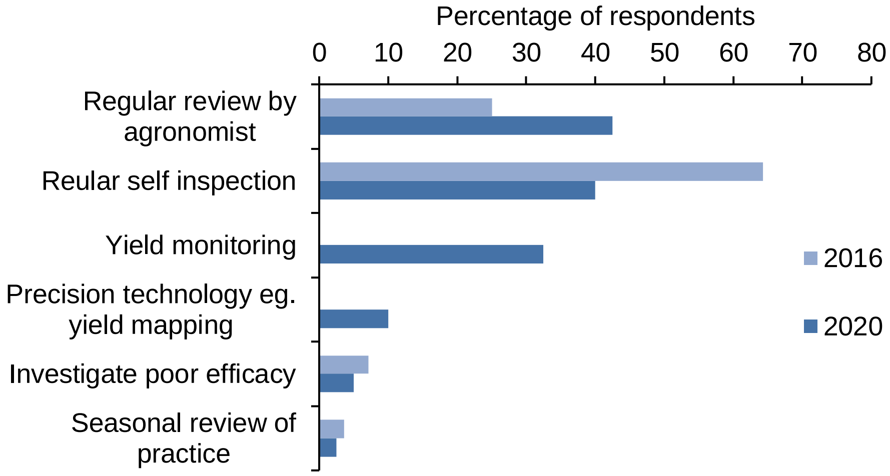
In 2020, 50 per cent of growers minimised the number of pesticide applications used, an increase from 21 per cent in 2016. Thirty-five per cent of growers in 2020, used a range of pesticides with multiple modes of action, an increase from 14 per cent in 2016. Thirty-five per cent of growers used pesticides with multi-site modes of action, compared to only 11 per cent in 2016 (Figure 44). The increase in the use of BASIS qualified agronomists in the 2020 sample may account for the rise in the use of anti-resistance strategies.

Figure 44 IPM: Types of anti-resistance strategies 2016-2020



An important aspect of IPM is monitoring the success of risk management and crop protection practices to continually improve regimes. Sixty-eight per cent of growers in 2020 stated that they monitored the success of their crop protection measures, a slight decrease from 71 per cent in 2016 (Table 39). Between 2016 and 2020, there has been a decrease in the proportion of growers using regular self-inspection to monitor their crop protection success and an increase in the proportion having a regular review with their agronomist. In 2020, 43 per cent of growers had a regular review with their agronomist to monitor crop protection success, an increase from 25 per cent in 2016 and 40 per cent of growers conducted regular self-inspections of their crops, a decrease from 64 per cent in 2016. There was a similar decrease in the use of self-inspection to monitor and identify pests from 2016 to 2020 (Figure 45). Seasonal review of practice and investigating causes of poor efficacy were used by a smaller proportion of growers in 2020 compared to 2016 (three and five per cent respectively in 2020 and four and seven per cent in 2016). Precision technologies such as yield mapping was used on 10 per cent of holdings in 2020. The measuring of success by examining the results of harvest and comparing with historic yields (yield monitoring) was directly asked in the 2020 survey where 33 per cent of growers said they used yield monitoring to monitor the success of crop protection methods. This was not surveyed in 2016 and therefore cannot be compared.

Figure 45 IPM: Monitoring success of crop protection measures 2016-2020



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