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Pesticide Usage in Scotland

A National Statistics Publication for Scotland

Outdoor Vegetable Crops 2015

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C. Monie, G. Reay & J. Wardlaw

Science and Advice for Scottish Agriculture (SASA)
Roddinglaw Road, Edinburgh, Scotland, EH12 9FJ
psu@sasa.gsi.gov.uk
www.sasa.gov.uk/pesticides

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Executive summary

This report presents information from a survey of pesticide use on outdoor vegetable crops grown for human consumption in Scotland during 2015. The crops surveyed included vining peas, broad beans, Brussels sprouts, calabrese, carrots, turnips & swedes and other minor vegetable crops.

The estimated area of outdoor vegetable crops grown in Scotland in 2015 was approximately 16,700 hectares (Table 35). This represents a four per cent increase from the previous survey in 2013 and a nine per cent increase from 2011. Peas and beans accounted for 51 per cent of the outdoor vegetable crop area, leaf brassicas 18 per cent, carrots 18 per cent, turnips and swedes nine per cent and other vegetable crops four per cent (Figure 2). Data were collected from a total of 90 holdings, representing 13 per cent of the total vegetable crop area grown. Ratio raising was used to produce estimates of national pesticide usage from sampled data.

The estimated total area of outdoor vegetable crops treated with a pesticide formulation (area grown multiplied by no. of treatments) was ca. 178,900 ha (± seven per cent Relative Standard Error, RSE) with a combined weight of ca. 67,300 kg (± eight per cent RSE). Overall, pesticides were applied to 98 per cent of the vegetable crop area. Herbicides were applied to 98 per cent of the crop area, insecticides to 90 per cent, fungicides 86 per cent, molluscicides to 12 per cent and 79 per cent of seed was treated.

When the pesticide application data are corrected for the area of crop grown, there were 11 pesticide treated hectares for each hectare of crop grown in 2015. This represents an increase of 15 per cent from 2013 and 19 per cent from 2011. The weight of pesticides applied per hectare of crop grown was four kilograms in 2015. This represents a 22 per cent increase from 2013 and an 18 per cent increase from 2011.

Overall pesticide application was higher in 2015 than that reported in 2013 as disease pressure was lower than average in 2013. The application of fungicides, sulphur and herbicides and to a lesser extent, insecticides and seed treatments have increased since 2013. Biopesticides and growth regulators were recorded in 2015, but were not recorded in the 2013 survey. The application of molluscicides has decreased since 2013.

In terms of area treated, the most used foliar fungicide active substance was azoxystrobin. However, when foliar and seed treatment use is taken into account, metalaxyl-M was the most commonly used fungicide. Lambda-cyhalothrin and pendimethalin were the most used insecticide and herbicide active substances respectively. Metalaxyl-M was the most used seed treatment active substance. The fungicide fenhexamid was recorded for the first time in 2015.

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.

Introduction

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

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

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

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

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

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

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

Structure of report and how to use these statistics

This report is intended to provide data in a useful format to a wide variety of data users. The general trends section provides commentary of recent changes in survey data and longer term trends. The 2015 pesticide usage section summarises the pesticide usage on all outdoor vegetable crops in 2015. Appendix 1 presents all estimated pesticide usage in three formats (area of formulations and area and quantity of active substances). These different measures are provided to satisfy the needs of different data users (see Appendix 3 for examples). Appendix 2 summarises survey statistics including census and holding information, raising factors and survey response rates. Appendix 3 defines many of the terms used throughout the report. Appendix 4 describes the methods used during sampling, data collection and analysis as well as measures undertaken to avoid bias and reduce uncertainty. Any changes in method from previous survey years are also explained.

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

Data uses

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

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

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

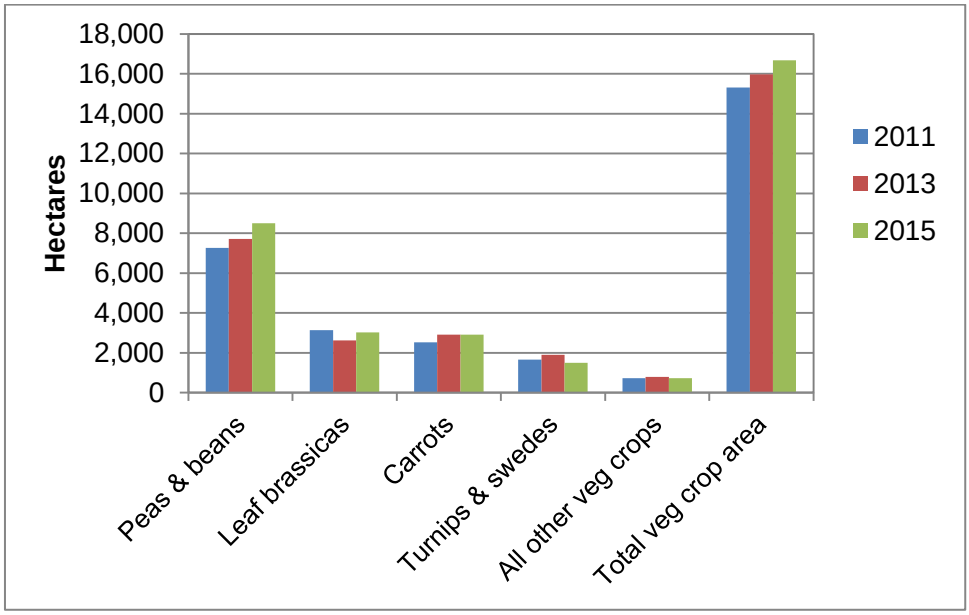
General trends

Crop area

The estimated area of outdoor vegetable crops grown in 2015 was 16,672 hectares (Table 35). This represents a four per cent increase from 2013[3] and a nine per cent increase from 2011[4]. Since the last survey, areas of cabbages, broad beans, calabrese and vining peas increased (47, 27, 19 and seven per cent respectively); while turnips and swedes and Brussels sprouts decreased (21 and six per cent respectively) The carrot crop area remained unchanged (Figure 1).

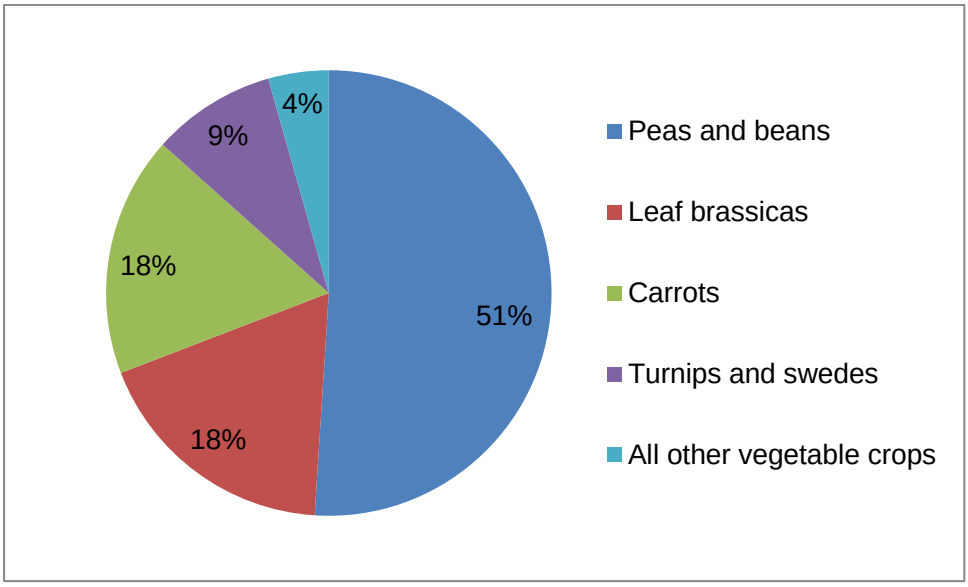
In 2015, peas and beans accounted for 51 per cent of the outdoor vegetable crop area, leaf brassicas 18 per cent, carrots 18 per cent, turnips and swedes nine per cent and other vegetable crops four per cent (Figure 2).

Figure 1 Area of vegetable crops grown in Scotland 2011-2015



Note: 2011 and 2013 vegetable crop areas include multi-cropping

Figure 2 Vegetable crop areas 2015 (percentage of total area)



Pesticide usage

The majority of vegetable crops (98 per cent) received a pesticide treatment in 2015. Vining peas, calabrese, turnips and swedes, Brussels sprouts, and broad beans were found to have the highest overall proportion of crop treated with pesticide (Figures 9 & 10, Table 1). Carrots, other vegetable crops and other brassicas (see appendix 3 – definitions and notes for crop list) were found to have the lowest proportion treated (93, 94 and 95 per cent respectively). In terms of the average number of applications of pesticides, the treated area of vegetable crops received on average 5.8 sprays (excluding seed treatments). It should be noted this only applies to the treated proportion of the crop (98 per cent). Brussel sprouts received the highest number of applications with an average of 14 sprays. In contrast, vining peas only received two sprays on average (Table 1).

It is estimated that the area of outdoor vegetable crops treated with a pesticide formulation in 2015 was ca. 178,900 hectares compared with ca. 149,600 hectares in 2013 and ca. 138,500 hectares in 2011 (Table 35). This represents an increase of 20 per cent since 2013 and 29 per cent since 2011. In terms of weight of pesticide applied, 67 tonnes was applied in 2015, representing an increase of 27 per cent from 2013 and an increase of 28 per cent from 2011 (Table 35).

In order to make accurate comparisons between the 2015 data and the data collected in previous surveys, it is important to take into account differences in crop areas between the years. Therefore, the number of treated hectares per hectare of crop grown and the total weight of pesticide used per hectare of crop grown were calculated. Once crop area has been taken into account, there has been an increase in the area and weight of pesticides applied (Figures 5 & 8). In 2015, for each hectare of crop grown, around 11 pesticide treated hectares were recorded (Figure 5). This represents an increase of 15 per cent from 2013 and 19 per cent from 2011. The estimated quantity of pesticides applied per hectare of crop grown was four kilograms (Figure 8).

This represents an increase of 22 per cent from 2013 and an increase of 18 per cent from 2011.

Fungicides were the most frequently used pesticides on outdoor vegetable crops, followed by herbicides and insecticides (Figure 3). This pattern was also observed in 2013 and 2011 (Figure 4). In 2015, fungicides accounted for 33 per cent of the total pesticide treated area and 30 per cent of the total weight of active substances applied (Figures 3 & 6). When changes in crop area are taken into account, the area treated by fungicides increased by 32 per cent from 2013 to 2015 and 18 per cent between 2011 and 2015 (Figure 5). From 2013 to 2015, there was an increase of 42 per cent in the quantity of fungicides used per hectare of crop grown (Figure 8). From 2011 to 2015, there was a decrease of one per cent in the quantity of fungicides used per hectare of crop grown. The increased use of fungicides in 2015 was not the result of high disease pressure, which was suppressed by the cool spring. As reported in the previous survey, 2013 was a notable low disease year[3].

Sulphur accounted for one per cent of the total pesticide treated area and nine per cent of the total weight of active substances applied (Figures 3 & 6). When changes in area grown are taken into account, there was a 64 per cent increase in the use of sulphur between 2013 and 2015 and a 43 per cent increase between 2011 and 2015 (Figure 5). The quantity of sulphur applied per hectare of crop grown increased by 14 per cent from 2013 to 2015 and increased by 55 per cent from 2011 to 2015 (Figure 8). The majority of sulphur use was on calabrese and vining peas, which have seen increases in crop area (Table 1). Where reasons were specified, sulphur was used for the control of disease.

In 2015, herbicides accounted for 28 per cent of the total pesticide treated area and 50 per cent of the total weight of active substances applied (Figures 3 & 6), the same pattern as observed in 2013. When changes in crop area are taken into account, there is an increase in area treated with herbicide formulations of 16 per cent from 2013 to 2015 and 24 per cent from 2011 to 2015 (Figure 5). In terms of weight of active substance applied, when area of crop grown is taken into account, there was an increase of 22 per cent from 2013 to 2015 and an increase of 28 per cent from 2011 to 2015 (Figure 8). In 2015, the cool dry spring lead to delayed emergence of weeds and also to poor activity of some herbicides, which may have resulted in additional sprays (Fiona Burnett, SRUC pers.comm.).

Insecticides accounted for 25 per cent of the total pesticide treated area and six per cent of the total weight of active substances applied (Figures 3 & 6). The levels of insecticides used in 2015 were very similar to those used in 2013. When changes in area of crop grown are taken into account, there was a three per cent increase from 2013 to 2015 and a 25 per cent increase from 2011 to 2015 in the area treated with insecticide formulations (Figure 5). This pattern is repeated in terms of quantity applied per hectare of crop grown, with a two per cent increase from 2013 to 2015 and a 49 per cent increase from 2011 (Figure 8).

Over 75 per cent of leaf brassica crops and 19 per cent of other vegetable crops were grown from transplants. The remaining crops were all grown directly from seed. Of these, vining peas, broad beans and turnips and swedes had the highest proportion of treated seed with all of the seed reported as treated (Table 1). Seed treatments accounted for nine per cent of the total area treated and two per cent of the total weight of active substances applied (Figures 3 & 6). When changes in crop area are taken into account, there was an increase in area treated by seed treatments of seven per cent from 2013 to 2015 and an increase of 22 per cent from 2011 to 2015 (Figure 5). The quantity of seed treatment applied per hectare of crop grown remained at similar levels, with a four per cent increase from 2013 to 2015 and a five per cent increase from the from 2011 to 2015 (Figure 8).

Molluscicides accounted for four per cent of the total pesticide treated area and two per cent of the total weight of active substances (Figures 3 & 6). When changes in crop areas between years are taken into account, there is a decrease in molluscicide applications per unit area of 17 per cent between 2013 and 2015 and a decrease of 30 per cent between 2011 and 2015 (Figure 5). The quantity of molluscicides applied per hectare of crop grown decreased by 21 per cent from 2013 to 2015 and by 54 per cent from 2011 to 2015 (Figure 8). This pattern may be partly explained by the current industry-led stewardship scheme which aims to promote and encourage best practice with metaldehyde slug pellets to minimise environmental impacts. Also, the late and cold spring may have reduced the levels of slug activity[(5)].

Growth regulators accounted for less than one per cent of the total pesticide treated area and one per cent of the total weight of active substances applied (Figures 3 & 6). Growth regulators were only recorded on parsnips within the other vegetable crops category (Table 14). No growth regulators were recorded on outdoor vegetable crops in 2013 or in 2011.

Biopesticides were encountered on Brussels sprouts, cabbages and in the other vegetable crop category. Biopesticides accounted for less than one per cent of the total pesticide treated area and less than one per cent of the total weight of active substances applied (Figures 3 & 6). No biopesticides were recorded in the 2013 survey. When changes in crop area are taken into account, there was a 198 per cent increase in area treated and a 130 per cent increase in weight of active substance applied from 2011 to 2015 (Figures 5 & 8).

As well as overall trends with pesticide groups since 2013, there has been variation in the use of individual active substances. For example, the use of the fungicide cyprodinil, increased by 120 per cent in terms of area treated and 112 per cent in terms of quantity of active substance applied (Tables 33 & 34). The fungicide active substance fenhexamid was recorded in this survey series for the first time. The area treated by the herbicide glyphosate increased by 110 per cent by area treated and 76 per cent by quantity of active substance applied. The herbicide prosulfocarb increased by 100 per cent in terms of quantity of active substance applied and 99 per cent in terms of area treated. The fungicide copper oxychloride increased by 91 per cent in terms of area treated and 102 per cent in terms of quantity of active

substance applied. Some of the patterns seen in use of active substances can be attributed to changes in crop area. For example, glyphosate was recorded on peas, broad beans and calabrese, all of which showed increases in crop area grown.

For the first time in this series of reports, fungicides and herbicides have been classified into groups according to their mode of action (Tables 30-32). It is hoped this information will provide useful trend data in future reports.

Figure 3 Use of pesticides on outdoor vegetable crops (percentage of total area treated with formulations) – 2015

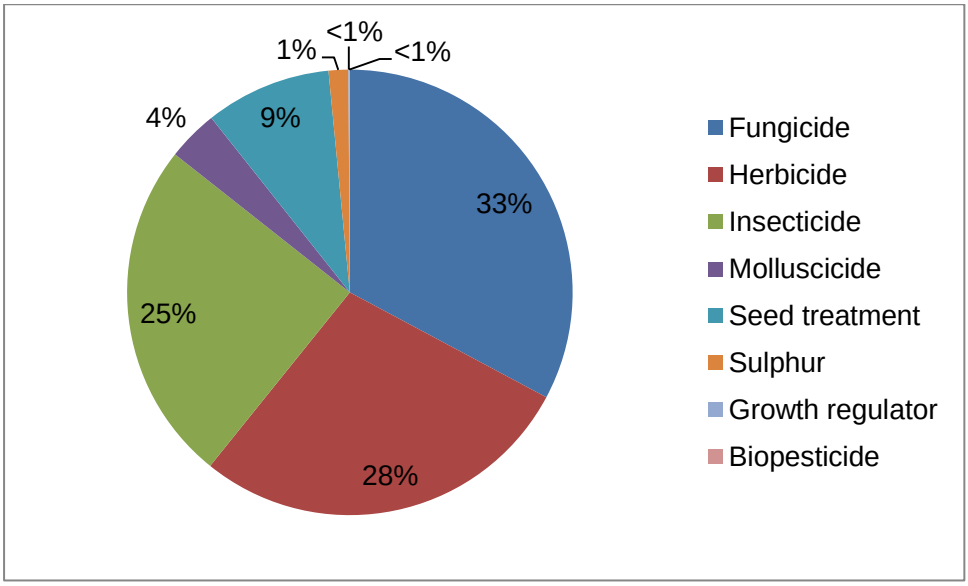


Figure 4 **Area of vegetable crops treated with the major pesticide groups in Scotland 2011-2015**

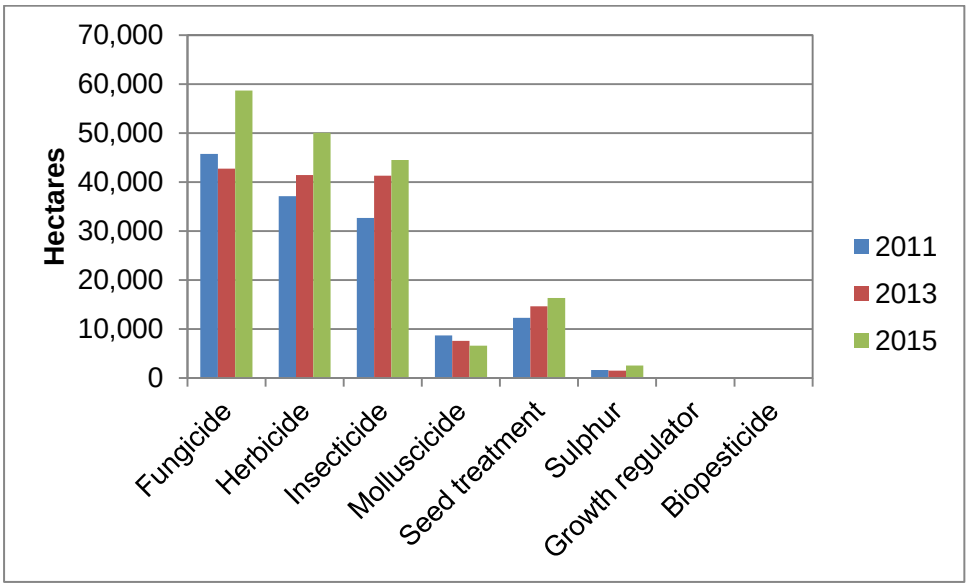


Figure 5 **Number of pesticide treated hectares (formulations) per each hectare of crop grown**

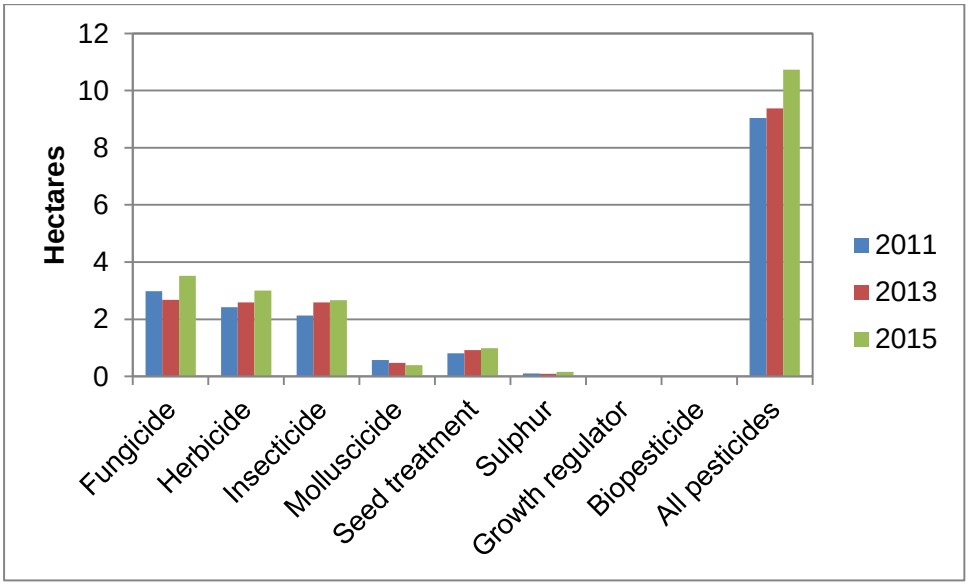


Figure 6 **Use of pesticides on outdoor vegetable crops (percentage of total quantity of active substances applied) – 2015**

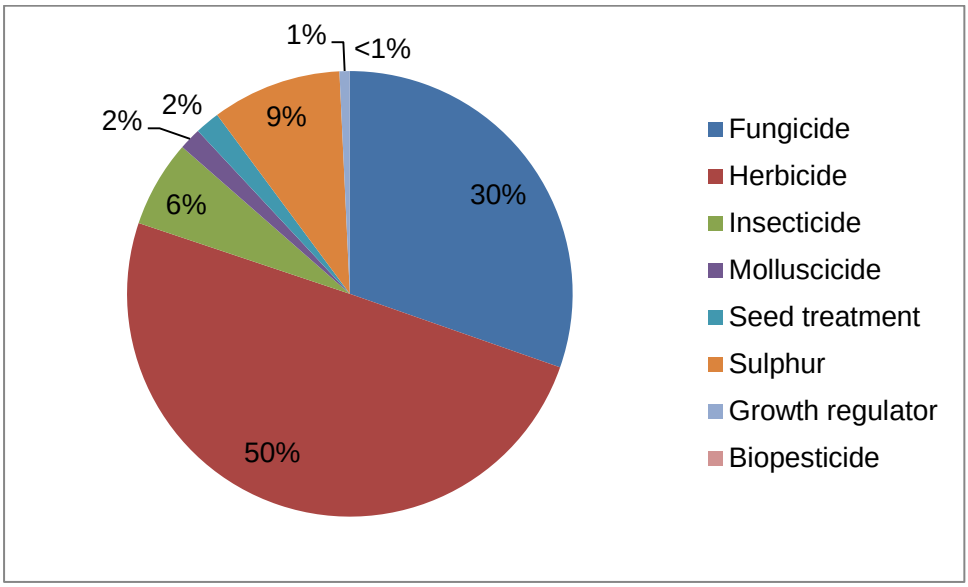


Figure 7 **Quantity of the major pesticide groups applied to vegetable crops in Scotland 2011-2015**

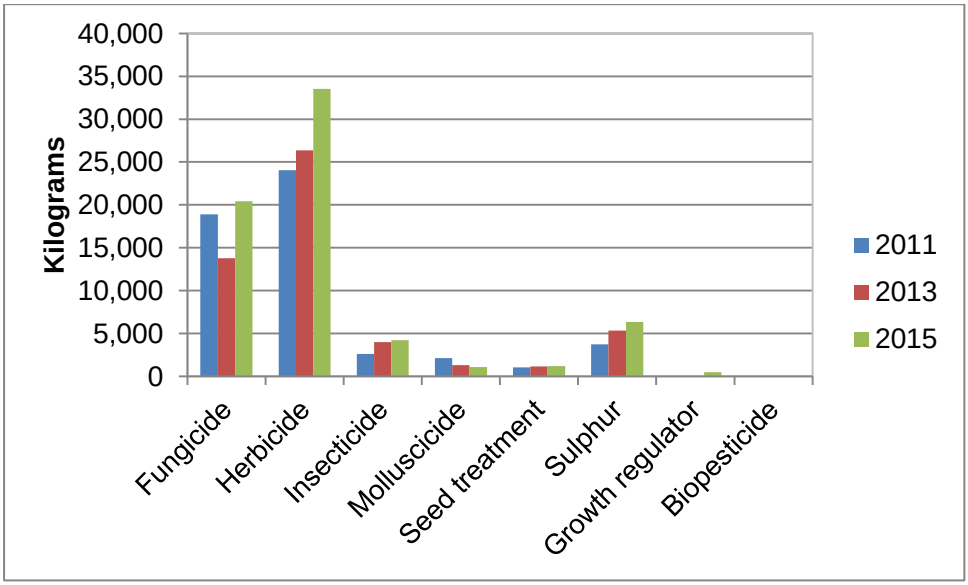


Figure 8 Weight of pesticides applied per each hectare of crop grown

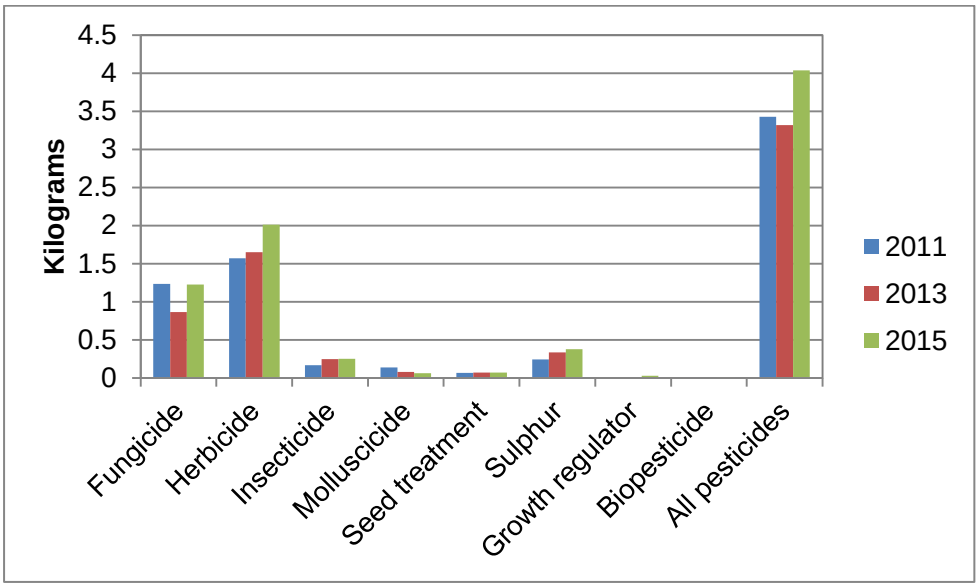
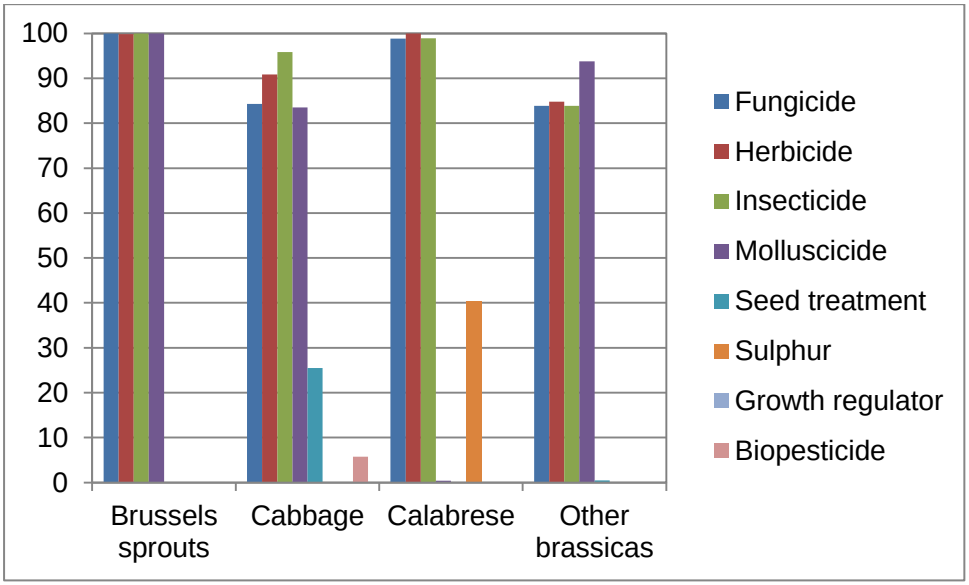
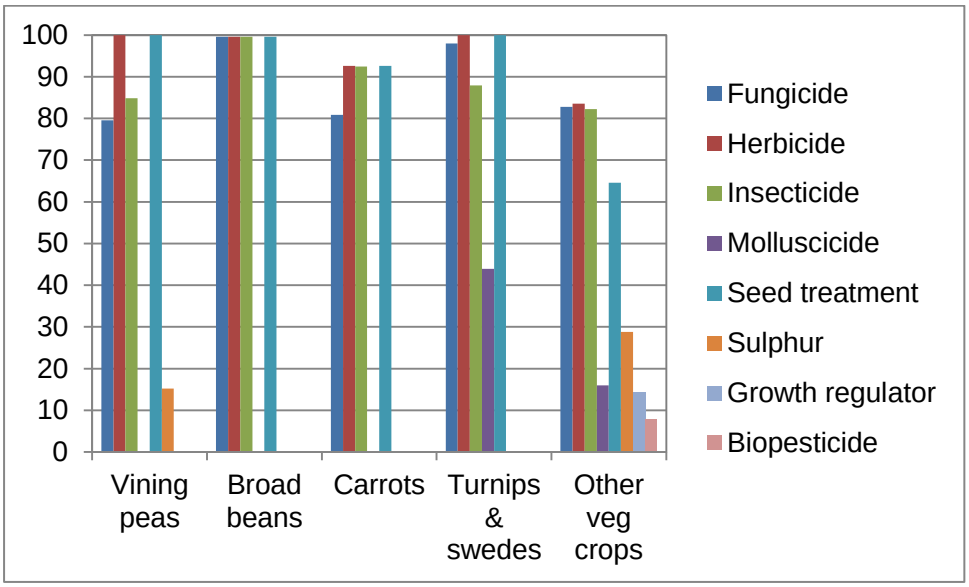


Figure 9 Percentage of leaf brassica crops treated with pesticides 2015



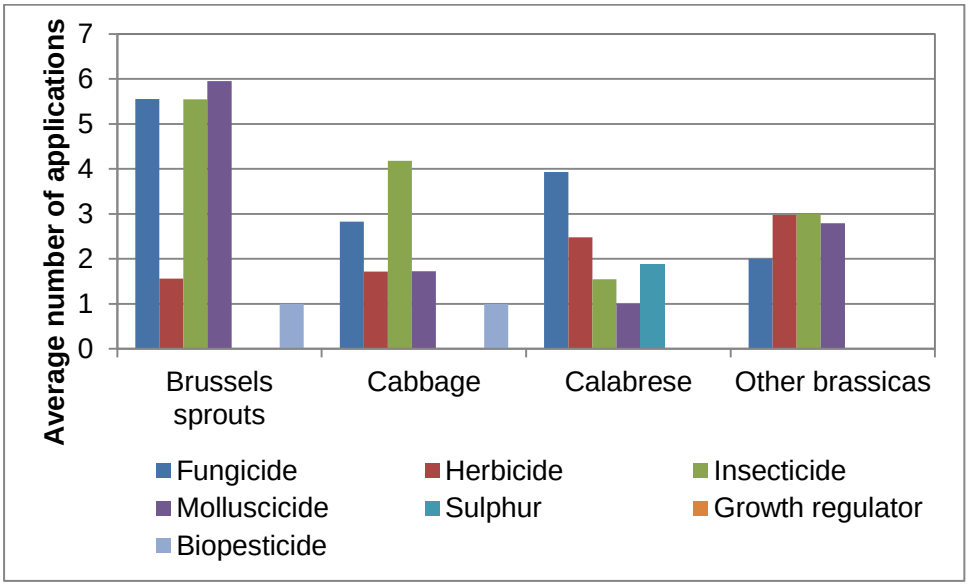
Note: Other brassicas include sprouting broccoli, cauliflower and kale.

Figure 10 Percentage of legumes and vegetable crops treated with pesticides 2015



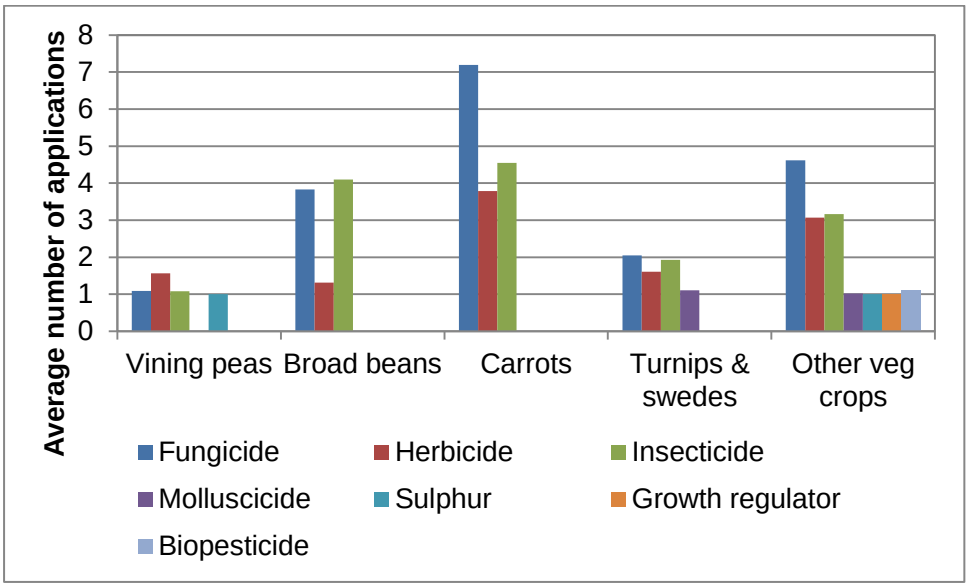
Note: Other vegetable crops include beetroot, curly parsley, garlic, leeks, leeks, lettuce, onions, parsnips, podded peas, radish, rhubarb, rocket and runner beans.

Figure 11 Average number of pesticide applications on treated area of leaf brassica crops - 2015



Note: Other brassicas include sprouting broccoli, cauliflower and kale.
Average number of applications calculated for area treated with that pesticide group only. See Appendix 3 - definitions and notes for details and Table 1 for percentage of crop treated.

Figure 12 Average number of pesticide applications on treated area of legumes and vegetable crops – 2015



Note: Other vegetable crops include beetroot, curly parsley, garlic, leeks, leeks, lettuce, onions, parsnips, podded peas, radish, rhubarb, rocket and runner beans. Average number of applications calculated for area treated with the pesticide group only. See Appendix 3 - definitions and notes for details and Table 1 for percentage of crop treated.

Integrated pest management

For the first time in this series of surveys, additional data collection was conducted in relation to grower adoption of Integrated Pest Management (IPM) measures (see Appendix 6 for full details). All growers were asked a series of questions about the IPM activities that they were implementing for their vegetable crop production. Unlike the other statistics in this report, the figures relating to IPM are not raised (i.e. are not national estimates) but represent only the responses of those surveyed.

In total IPM data was collected from 25 growers and grower groups, representing 84 holdings and 84 per cent of the sampled outdoor vegetable crop area. Of these growers, 64 per cent did not have an IPM plan, 20 per cent of growers completed their own IPM plan and 16 per cent had a plan completed by their agronomist (Figure 40). Despite the majority of growers not completing an IPM plan uptake of a wide range of IPM activities was encountered. Growers were asked about their IPM activities in relation to three categories; risk management, pest monitoring and pest control.

A number of risk management measures were adopted by the growers surveyed (Table 48). Practically all growers (96 per cent) used crop rotation to manage the risk of pest damage. The majority of growers (88 per cent) tested their soils in order to tailor inputs to improve crop performance. Just over three quarters of growers managed their seed bed production to reduce risk and just over half of growers amended cultivation methods at sowing to try to increase crop success. Almost ninety per cent of the growers surveyed also considered risk management when selecting seeds and/or varieties. Over a third of respondents (36 per cent) sowed catch or cover crops as part of their crop production cycle and 72 per cent of the growers sampled adopted techniques to protect or enhance populations of beneficial insects.

A number of pest monitoring activities were also recorded (Table 49). Ninety six per cent of growers regularly monitored crop growth stages and also monitored and identified pests on their crops. Most growers (88 per cent) used action thresholds when monitoring pest populations. The majority of respondents (60 per cent) also used specialist diagnostics when dealing with pests that were more problematic to identify or monitor

The pest control measures adopted by the growers surveyed are presented in Table 50. The majority of growers (76 per cent) used non-chemical control in partnership or instead of chemical control. Seventy six per cent of growers stated that they targeted their pesticide applications using monitoring data. In addition, 80 per cent of growers stated that they followed anti-resistance strategies. Finally all respondents stated that they monitored the success of their crop protection measures.

2015 Pesticide usage

Vining peas

- An estimated 7,029 hectares of peas were grown in Scotland in 2015, an increase of seven per cent since 2013
- 100 per cent of the crop was treated with a pesticide
- Pesticides were applied to 31,284 treated hectares
- 12,317 kilograms of pesticide were applied in total
- 34 per cent of pesticides applied were herbicides, 23 per cent seed treatments, 21 per cent insecticides, 19 per cent fungicides and three per cent sulphur (Figure 13). No molluscicides or biopesticides were applied to the vining pea crop
- Vining pea crops received on average 2.5 pesticide sprays (Table 1). These sprays included 1.6 herbicide applications (applied to the whole crop area), 1.1 fungicide and insecticide applications (applied to 80 and 85 per cent respectively) and one application of sulphur (applied to 15 per cent)
- In relation to timings of pesticide applications, 86 per cent of sulphur, 84 per cent of fungicide and 80 per cent of insecticide applications were in July, whilst 49 per cent of herbicides on vining peas were applied in May (Figure 14)
- Where reasons were given, 94 per cent of fungicide use (including sulphur) was for general disease control and six per cent was for mildew. The only specified reason for herbicide use was for general weed control and for insecticide use was aphid control
- The most common varieties encountered were Corus, Spandimo and Romance, accounting for 38, 18 and 13 per cent of the sample area respectively

Summary of pesticide use on vining peas:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	6,076	1,662	80	Boscalid/pyraclostrobin (3,133)
Herbicides	10,659	4,810	100	Imazamox/pendimethalin (6,300)
Insecticides	6,450	806	85	Pirimicarb (6,450)
Sulphur	1,069	4,277	15	N/A
Seed treatments	7,029	762	100	Cymoxanil/fludioxonil/ metalaxyl-M (7,029)

Figure 13 Use of pesticides on vining peas (percentage of total area treated with formulations) – 2015

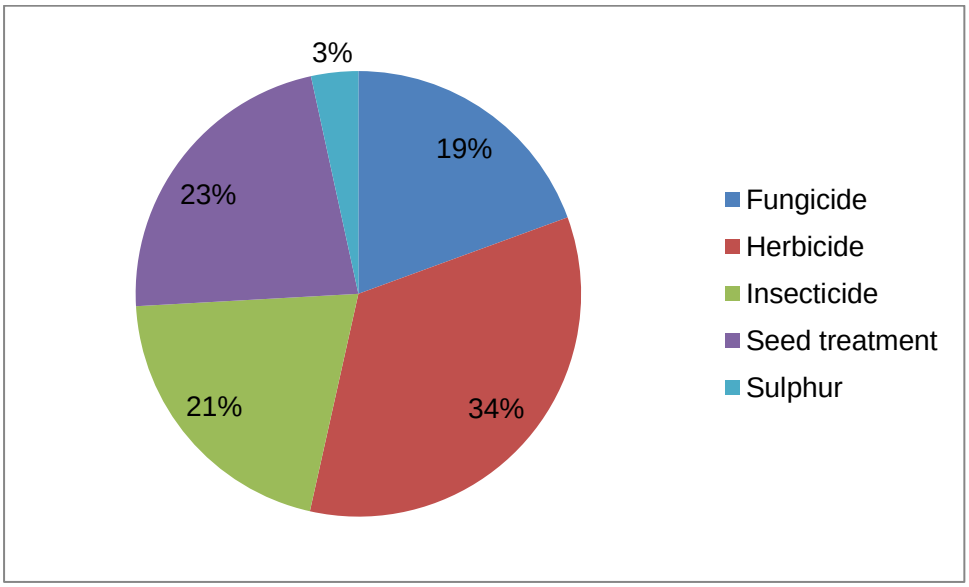
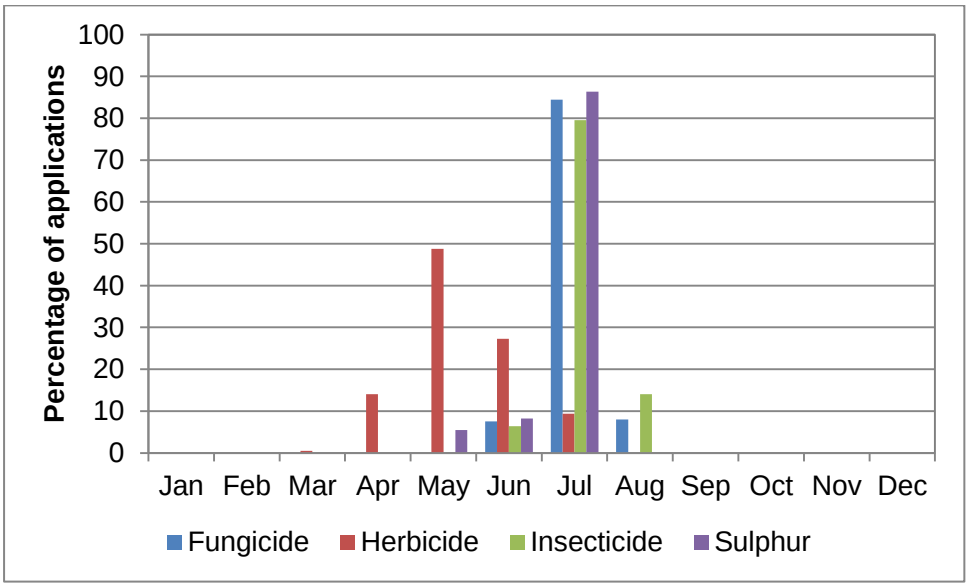


Figure 14 Timing of pesticide applications on vining peas – 2015



Broad beans

- An estimated 1,475 hectares of broad beans were grown in Scotland in 2015, an increase of 27 per cent since 2013. This was comprised of 1,469 hectares recorded in the 'broad beans' census category and six hectares recorded in the 'other vegetable' census category.
- 100 per cent of the crop was treated with a pesticide
- 20,808 hectares of pesticide formulations were applied
- 5,988 kilograms of pesticide were used in total on the crop
- 51 per cent of pesticides applied were fungicides, 29 per cent insecticides, 11 per cent seed treatments and nine per cent herbicides (Figure 15)
- No molluscicides, sulphur or biopesticides were applied to the broad bean crop
- The broad bean crop received on average 6.3 pesticide sprays (Table 1). These included 4.1 insecticide, 3.8 fungicide and 1.3 herbicide applications
- 61 per cent of fungicide applications and 58 per cent of insecticide applications were in July and 73 per cent of herbicide applications were in May (Figure 16)
- Where reasons were given, all herbicide use was for general weed control. The only specified reason for insecticide use was for control of aphids
- The two varieties encountered were Listra, accounting for 71 per cent of the crop sampled and Talia accounting for 29 per cent

Summary of pesticide use on broad beans:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	10,634	3,856	100	Tebuconazole (3,399)
Herbicides	1,931	1,562	100	Imazamox/ pendimethalin (1,469)
Insecticides	6,013	276	100	Lambda-cyhalothrin (2,937) pirimicarb (2,314)
Seed treatments	2,230	294	100	Thiram (1,469)

Figure 15 Use of pesticides on broad beans (percentage of total area treated with formulations) - 2015

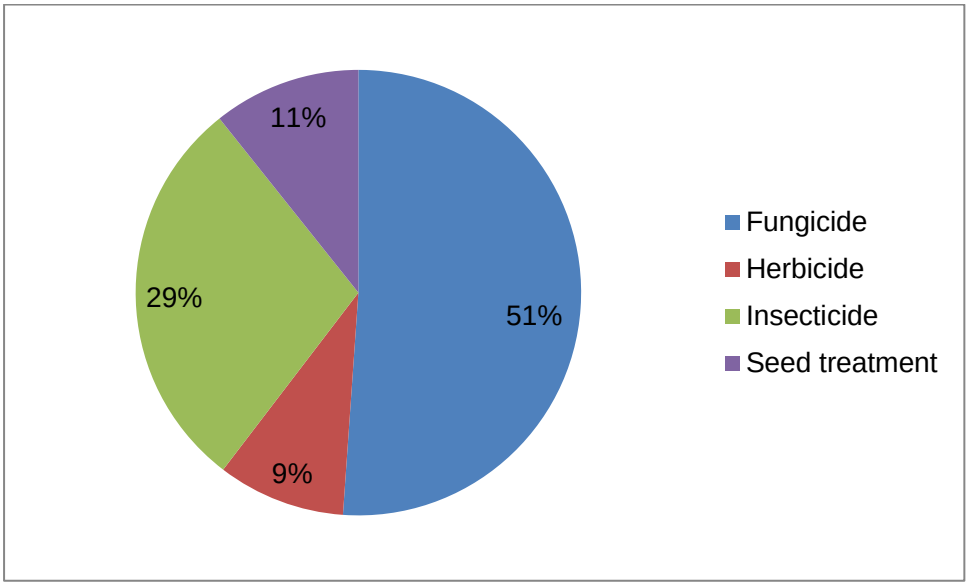
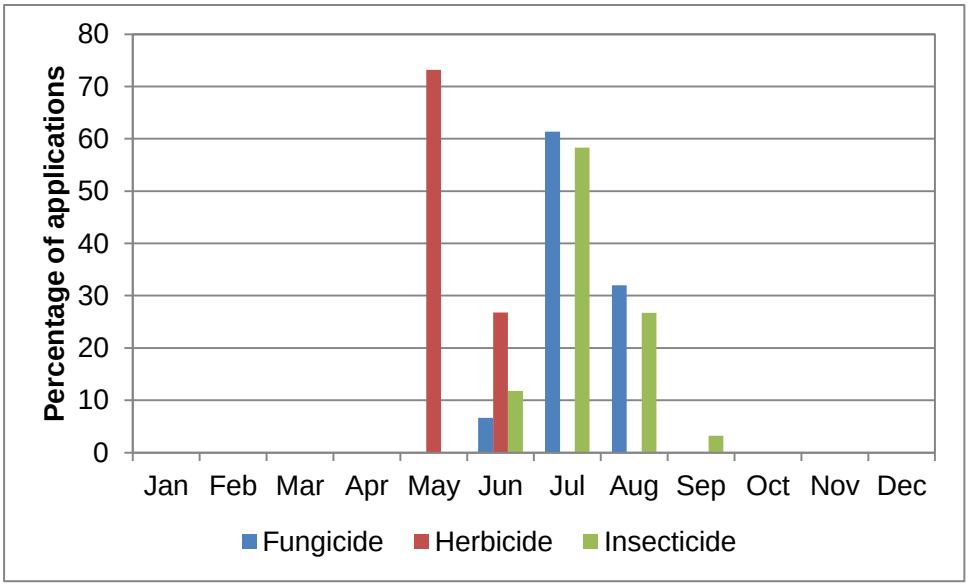


Figure 16 Timing of pesticide applications on broad beans – 2015



Brussels sprouts

- An estimated 777 hectares of Brussels sprouts were grown in Scotland in 2015, a decrease of six per cent since 2013. 776 hectares were recorded in the 'Brussels sprouts' census category and one hectare was recorded in the 'other vegetable' census category.
- All of the Brussels sprouts crop was grown from transplants
- 100 per cent of the crop was treated with a pesticide
- Pesticides were applied to 20,062 treated hectares
- 4,206 kilograms of pesticides were applied to the crop
- 39 per cent of pesticides applied were insecticides, 30 per cent fungicides, 23 per cent molluscicides, eight per cent herbicides and less than one per cent biopesticides (Figure 17)
- No sulphur was applied to the Brussels sprouts crop
- The Brussels sprouts crop received on average 14.2 pesticide applications (Table 1). These included 5.9 molluscicide, 5.6 fungicide, 5.5 insecticide and 1.6 herbicide applications
- Fungicides were applied to the Brussels sprouts crop between June and November, insecticides were applied between May and November and molluscicides were applied from April to November (Figure 18). 69 per cent of herbicides were applied in May and all biopesticide applications were in July
- Where reasons were given, 28 per cent of fungicide use was for *Alternaria*, 24 per cent for general disease control and 22 per cent for light leaf spot. The remainder identified a range of other diseases as the target (Figure 19)
- 44 per cent of herbicide applications were for general weed control, 27 per cent for annual meadow grass, 28 per cent for annual broad-leaved weeds and one per cent for volunteer potatoes
- 45 per cent of insecticide use was for aphids and 44 per cent for caterpillars (Figure 20)
- The most common varieties encountered were Petrus, Brodie and Doric, accounting for 53, 21 and 15 per cent of the sample area respectively

Summary of pesticide use on Brussels sprouts:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	6,004	1,704	100	Tebuconazole/ trifloxystrobin (1,785)
Herbicides	1,626	1,232	100	Pendimethalin (776)
Insecticides	7,807	529	100	Lambda-cyhalothrin (1,832)
Molluscicides	4,624	741	100	Metaldehyde (2,376)
Biopesticides	1	<0.5	<0.5	*Bacillus Thuringiensis* var. *kurstaki* (1)

Figure 17 Use of pesticides on Brussels sprouts (percentage of total area treated with formulations) – 2015

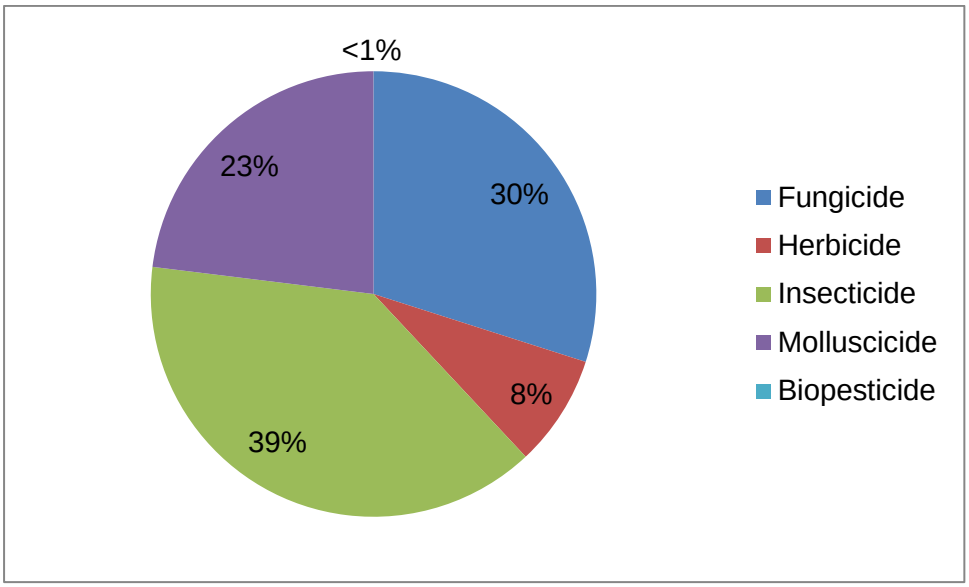


Figure 18 Timing of pesticide applications on Brussels sprouts - 2015

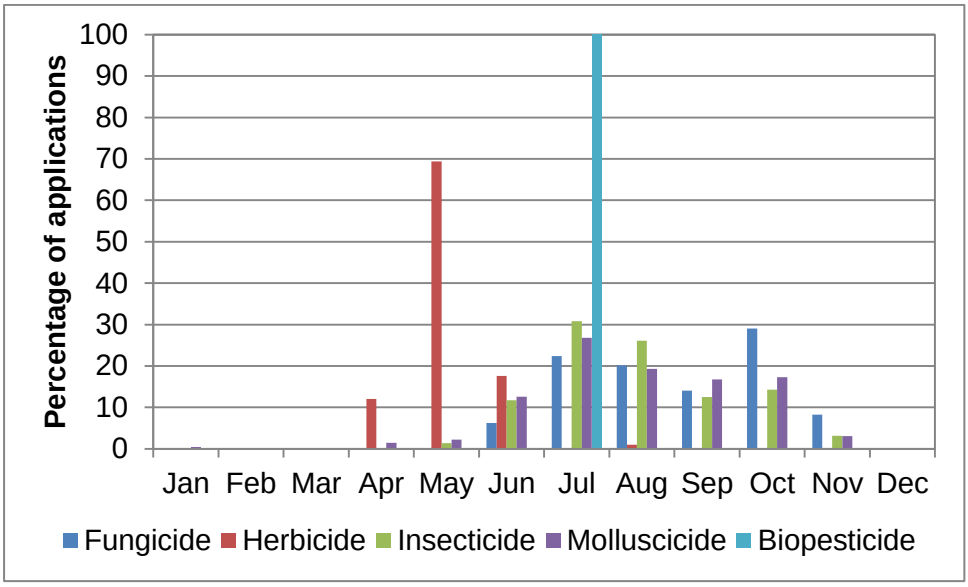


Figure 19 Reasons for use of fungicides on Brussels sprouts (where specified)

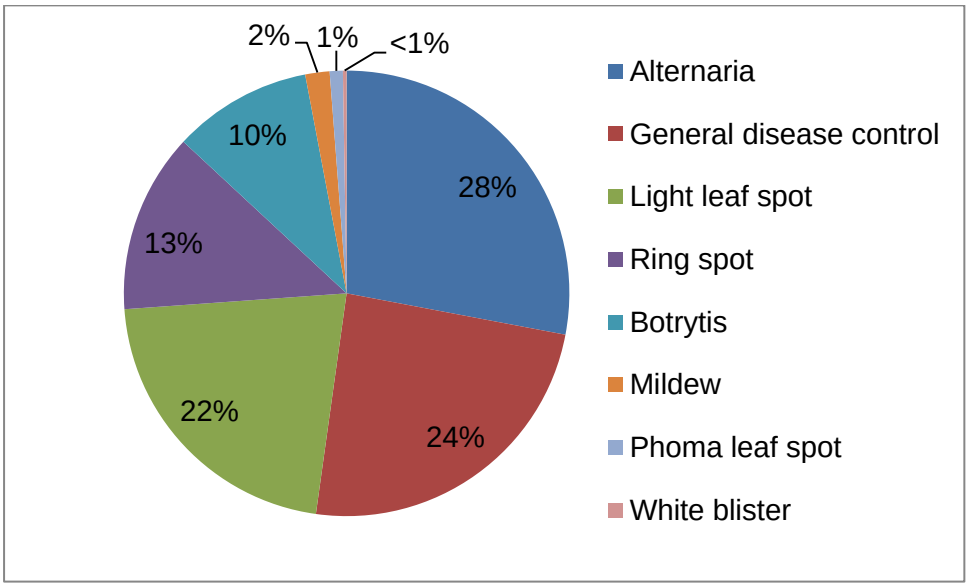
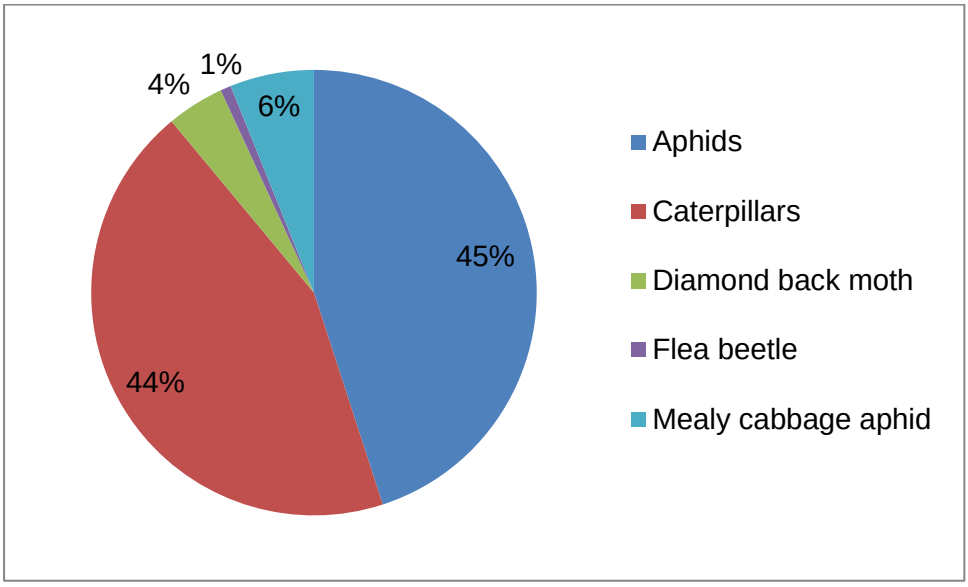


Figure 20 Reasons for use of insecticides on Brussels sprouts (where specified)



Cabbages

- An estimated area of 299 hectares of cabbages was grown in Scotland in 2015. This represents an increase of 47 per cent since 2013. 204 hectares were recorded in the 'cabbage and savoys' census category and 95 hectares in the 'other vegetable' census category.
- 75 per cent of the cabbages crop was grown from transplants
- 97 per cent of the crop was treated with a pesticide
- Pesticides were applied to 4,452 treated hectares
- 791 kilograms of pesticide were applied to the crop
- 51 per cent of pesticides applied were insecticides, 17 per cent fungicides, 17 per cent herbicides, 10 per cent molluscicides, five per cent seed treatments and less than one per cent were biopesticides (Figure 21)
- No sulphur use was recorded on cabbages
- The 97 per cent of the cabbage crop treated with a pesticide received on average 7.6 pesticide applications (Table 1). These applications included 4.2 insecticides (applied to 96 per cent of the crop), 2.8 fungicides (applied to 84 per cent) and 1.7 herbicide and molluscicide applications (applied to 91 and 84 per cent respectively)
- 51 per cent of herbicide applications were in May. (Figure 22). 70 per cent of molluscicide applications and 62 per cent of fungicide applications were in June and all biopesticide applications were in July. The majority of insecticides were applied in June and July.
- Where reasons were provided, 38 per cent of fungicide use was for *Alternaria*, 38 per cent for ring spot, 24 per cent for light leaf spot and less than one per cent for white blister
- 50 per cent of herbicide use was for general weed control , 25 per cent for annual meadow grass and 25 per cent for annual broad-leaved weeds
- Where reasons were specified, 70 per cent of insecticide use was for caterpillars and 30 per cent for aphid control

Summary of pesticide use on cabbages:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	780	226	84	Boscalid/ pyraclostrobin (264)
Herbicides	738	387	91	Clomazone (272), metazachlor (272)
Insecticides	2,259	108	96	Indoxacarb (630), lambda-cyhalothrin (619)
Molluscicides	430	69	84	Metaldehyde (340)
Biopesticides	17	<0.5	6	*Bacillus Thuringiensis* var. *kurstaki* (17)
Seed treatments	229	0.2	25	Iprodione, metalaxyl-M & thiram (all 76)

Figure 21 Use of pesticides on cabbages (percentage of total area treated with formulations) – 2015

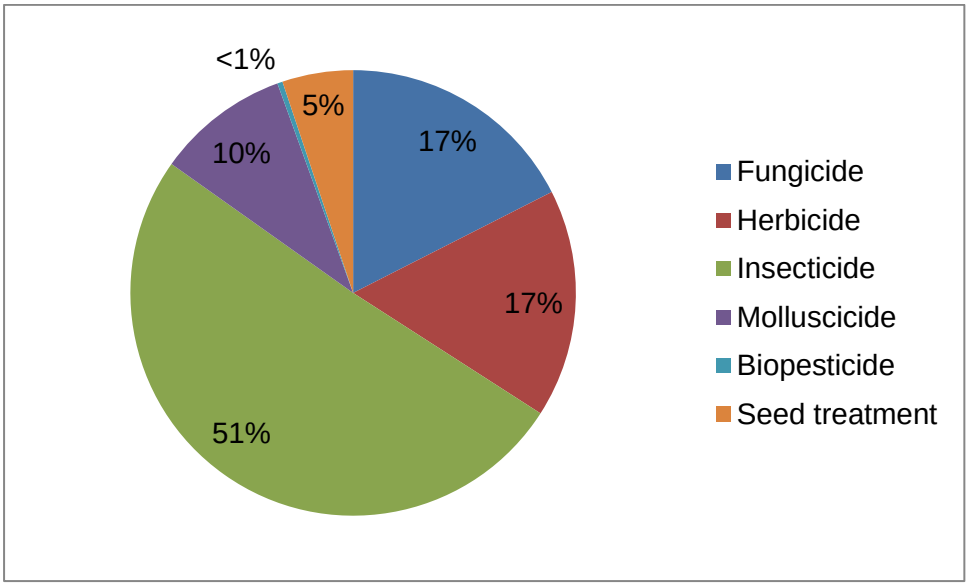
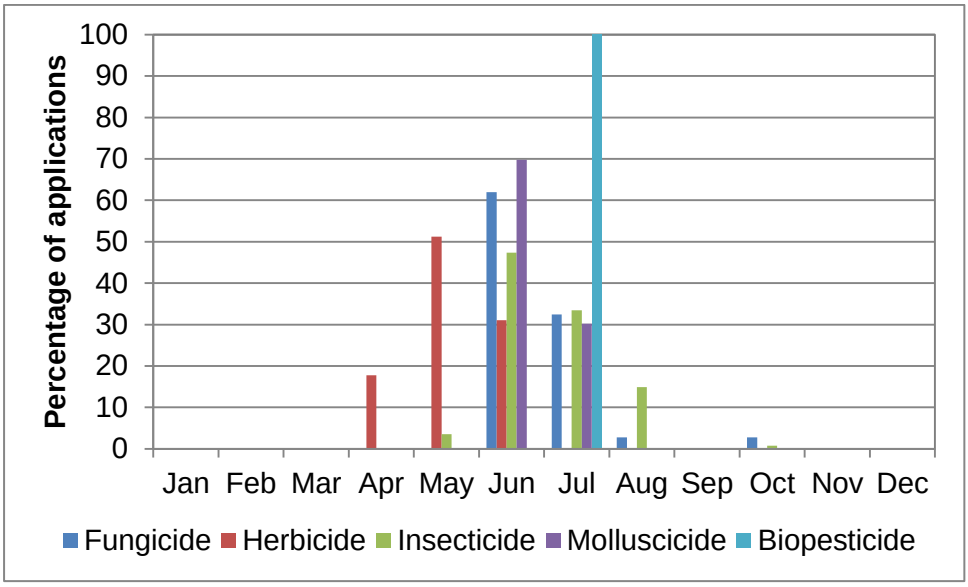


Figure 22 Timing of pesticide applications on cabbages - 2015



Calabrese

- An estimated 1688 hectares of calabrese was grown in Scotland in 2015, an increase of 19 per cent since 2013. This included 1,513 hectares recorded in the 'calabrese' census category and 175 hectares recorded in the 'other vegetable' census category.
- Over 99 per cent of the calabrese crop was grown from transplants
- 100 per cent of the crop was treated with a pesticide
- Pesticides were applied to 15,938 treated hectares
- 8,036 kilograms of pesticide were applied in total
- 41 per cent of pesticides applied were fungicides, 31 per cent herbicides, 20 per cent insecticides, eight per cent sulphur, under one per cent molluscicides and seed treatments (Figure 23)
- No biopesticides were recorded on the calabrese crop
- The calabrese crop received on average 7.7 pesticide applications (Table 1). These sprays included 3.9 fungicide applications (applied to 99 per cent of the crop area), 1.9 sulphur applications (applied to 40 per cent), 2.5 herbicide applications and 1.5 insecticide applications (applied to 99 per cent)
- 81 per cent of sulphur applications were in September (Figure 24). Fungicides were applied from June to October, herbicides from April to August, insecticides were mostly applied in July and August and molluscicides were applied from May to July
- Where reasons were given, over 99 per cent of fungicide use (including sulphur) was for general disease control and under one per cent was for white blister
- 87 per cent of herbicide use was for general weed control and nine per cent for crop destruction (Figure 25)
- Where reasons were specified, 98 per cent of insecticide use was for general pests, one per cent for aphids and one per cent for caterpillars
- The most common varieties encountered were Parthenon and Monrello, accounting for 25 and 10 per cent of the sample area respectively

Summary of pesticide use on calabrese:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	6,555	2,624	99	Copper oxychloride (5,258)
Herbicides	4,914	4,097	100	Glyphosate (2,060)
Insecticides	3,183	100	99	Lambda-cyhalothrin (2,412)
Molluscicides	6	<0.5	0.4	Metaldehyde (6)
Sulphur	1,276	1,215	40	N/A
Seed treatment	4	0.003	<0.5	Iprodione, metalaxyl-M & thiram (all 1)

N/A = not applicable

Figure 23 Use of pesticides on calabrese (percentage of total area treated with formulations) - 2015

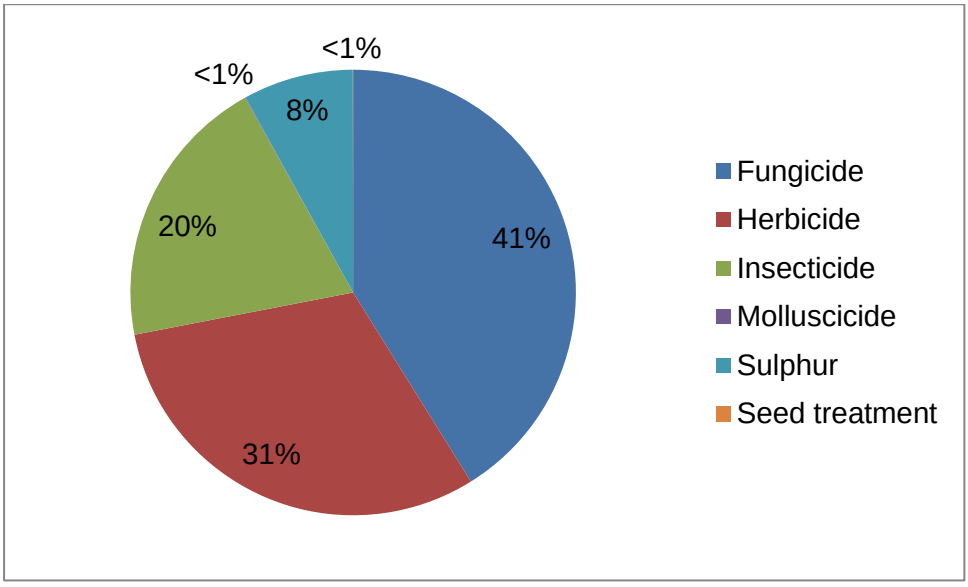


Figure 24 Timing of pesticide applications on calabrese – 2015

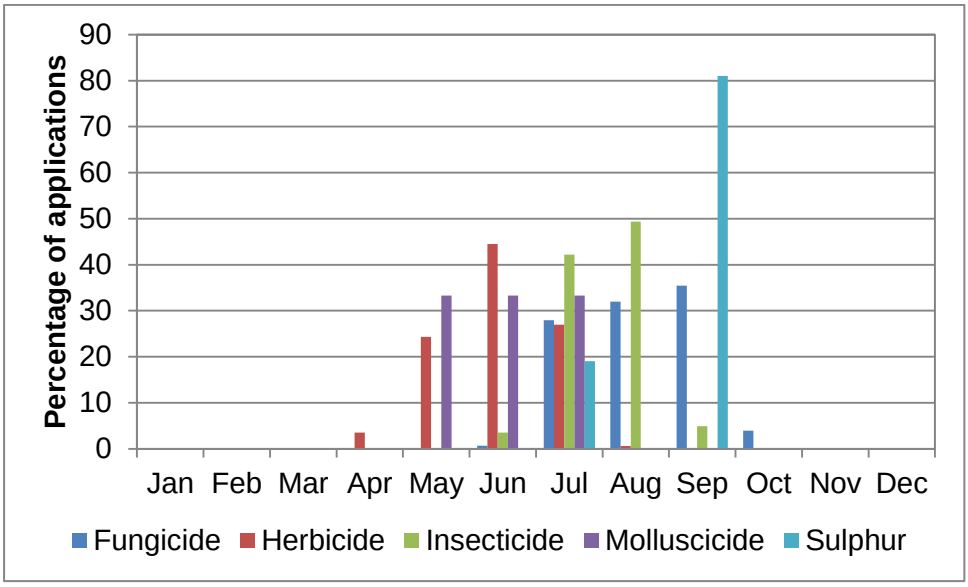
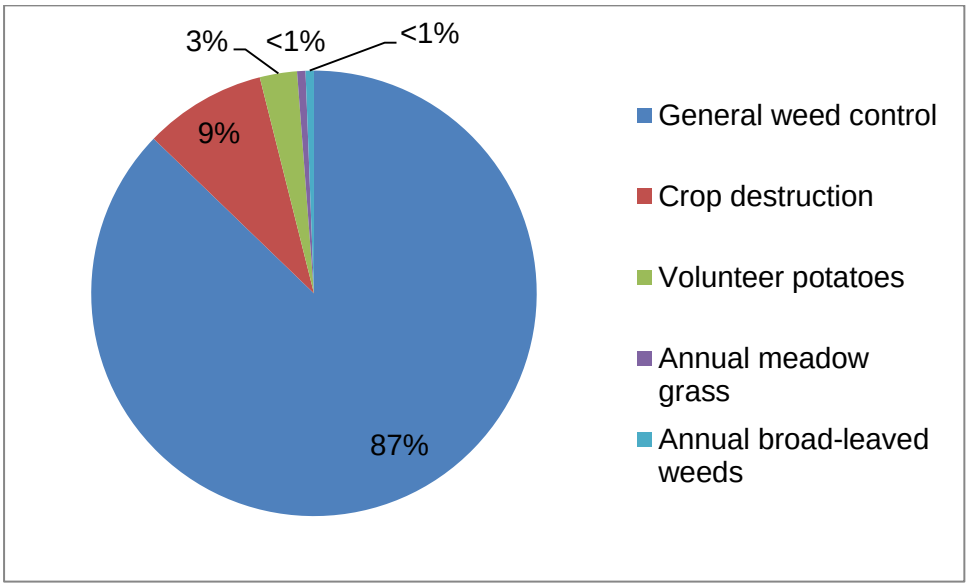


Figure 25 Reasons for use of herbicides on calabrese (where specified)



Other brassicas

- Other brassicas encountered in the 2015 survey were sprouting broccoli, cauliflower and kale
- The total estimated area of other brassicas was 260 hectares
- 94 per cent of other brassicas were grown from transplants
- 95 per cent of the other brassica crop was treated with a pesticide
- Pesticides were applied to 3,093 treated hectares
- 750 kilograms of pesticide were applied in total
- 43 per cent of pesticides applied were insecticides, 22 per cent molluscicides, 21 per cent herbicides, 14 per cent fungicides and less than one per cent seed treatments (Figure 26)
- No biopesticides or sulphur were recorded on the other brassica crop
- The 95 per cent of the other brassicas crop area treated with a pesticide received on average nine pesticide applications (Table 1). These included 3 herbicide and insecticide applications (applied to 85 and 84 per cent of the crop respectively), 2.8 molluscicide applications (applied to 94 per cent) and two fungicide applications (84 per cent)
- In terms of timing of applications, all fungicides were applied in August, 67 per cent of herbicides were applied in June, 67 per cent of insecticides and 68 per cent of molluscicides were applied in July (Figure 27)
- Where reasons were given, all fungicide use was for general disease control, all herbicide use was for general weed control and all insecticide use was for general pest control

Summary of pesticide use on other brassicas:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	437	109	84	Azoxystrobin (437)
Herbicides	660	454	85	Glyphosate (437)
Insecticides	1,311	104	84	Lambda-Cyhalothrin (655)
Molluscicides	681	83	94	Metaldehyde (681)
Seed treatment	4	0.003	0.5	Iprodione (1), Metalaxyl-M (1), Thiram (1)

Figure 26 Use of pesticides on other brassicas (percentage of total area treated with formulations) - 2015

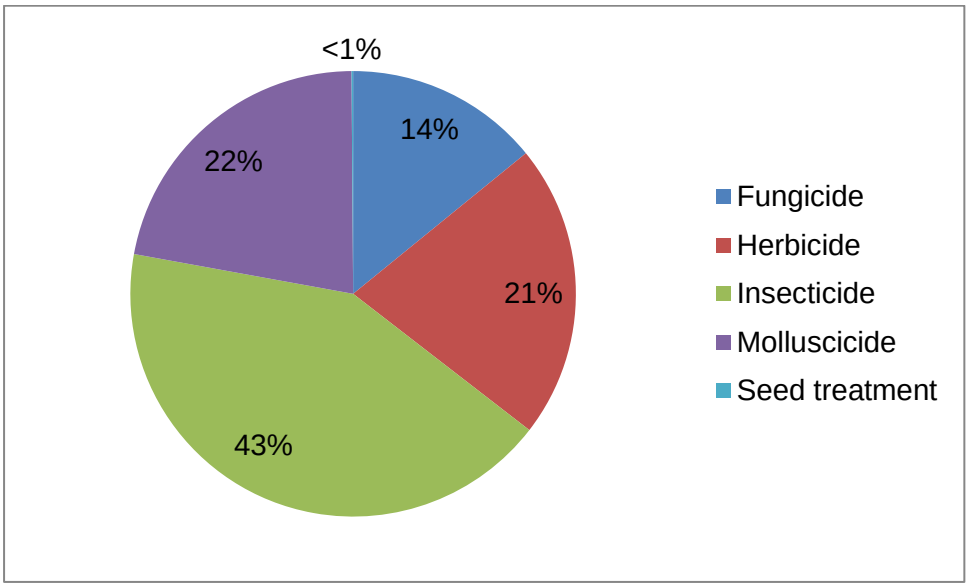
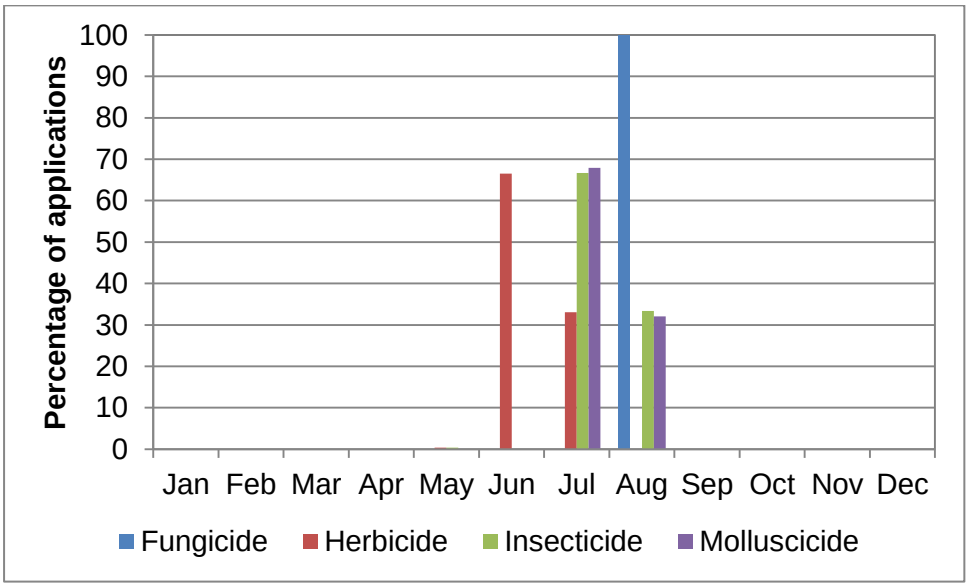


Figure 27 Timing of pesticide applications on other brassicas - 2015



Carrots

- An estimated 2,908 hectares of carrots were grown in Scotland in 2015, very similar to the area grown in 2013. This consists of 2,877 hectares recorded in the 'carrot' census category and 31 hectares recorded in the 'other vegetable' census category.
- 93 per cent of the crop was treated with a pesticide
- Pesticides were applied to 58,990 treated hectares
- 20,475 kilograms of pesticide were applied to the crop
- 36 per cent of pesticides applied were herbicides, 35 per cent fungicides, 21 per cent insecticides and eight per cent seed treatments (Figure 28)
- No molluscicides, biopesticides or sulphur were used on the carrot crop
- The 93 per cent of the carrot crop treated with a pesticide received on average 10.6 pesticide applications (Table 1). These applications included 7.2 fungicide applications (applied to 81 per cent of the crop), 4.6 insecticide applications (applied to 92 per cent) and 3.8 herbicide sprays (applied to 93 per cent)
- Fungicides were applied to the carrot crop from May to October, herbicides were applied from March to August and insecticides were applied from March to October (Figure 29)
- Where reasons were given, 52 per cent of fungicide use was for *Sclerotinia* and 20 per cent was for general disease control Figure 30)
- 66 per cent of herbicide use was for general weed control and 19 per cent was for annual broad-leaved weeds (Figure 31)
- 79 per cent of insecticide use was for carrot fly, 12 per cent for nematodes and nine per cent for aphids
- The most common variety encountered was Nairobi, accounting for 58 per cent of the sample area surveyed

Summary of pesticide use on carrots:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	20,706	7,705	81	Prothioconazole (3,211), fenpropimorph (3,140)
Herbicides	21,114	10,939	93	Linuron (7,542)
Insecticides	12,441	1,718	92	Lambda-cyhalothrin (8,207)
Seed treatment	4,729	113	93	Cymoxanil/fludioxonil/ metalaxyl-M (2,312)

Figure 28 Use of pesticides on carrots (percentage of total area treated with formulations) – 2015

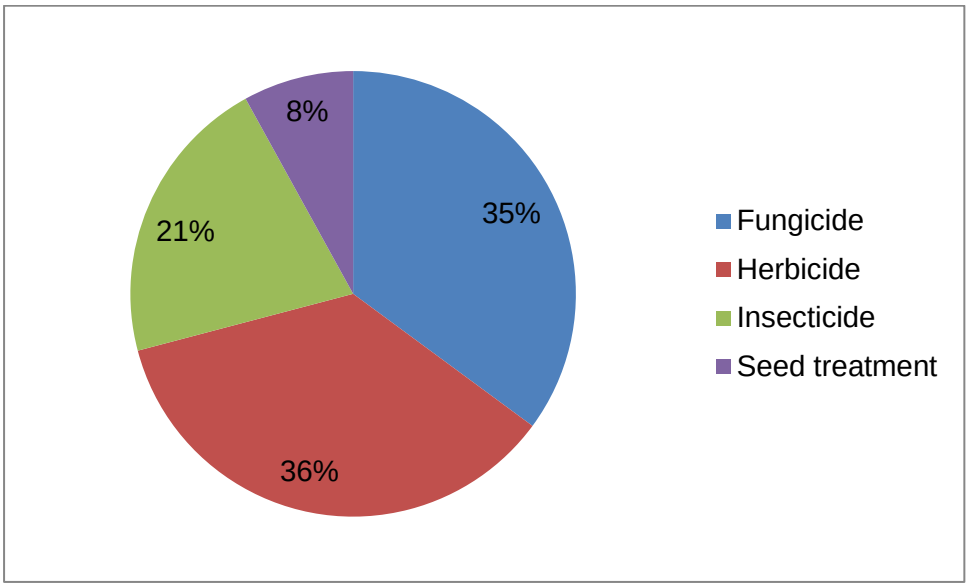


Figure 29 Timing of pesticide applications on carrots - 2015

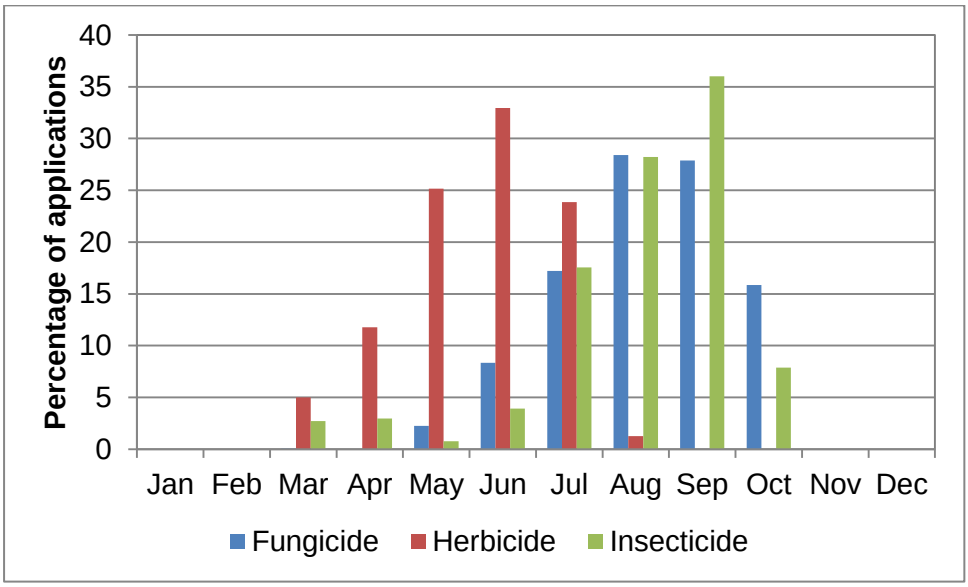


Figure 30 Reasons for use of fungicides on carrots (where specified)

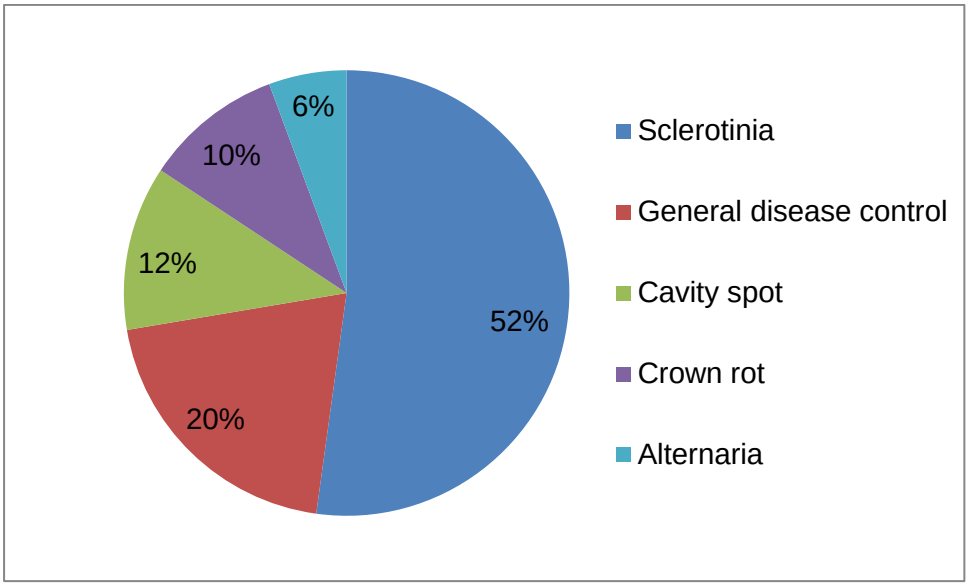
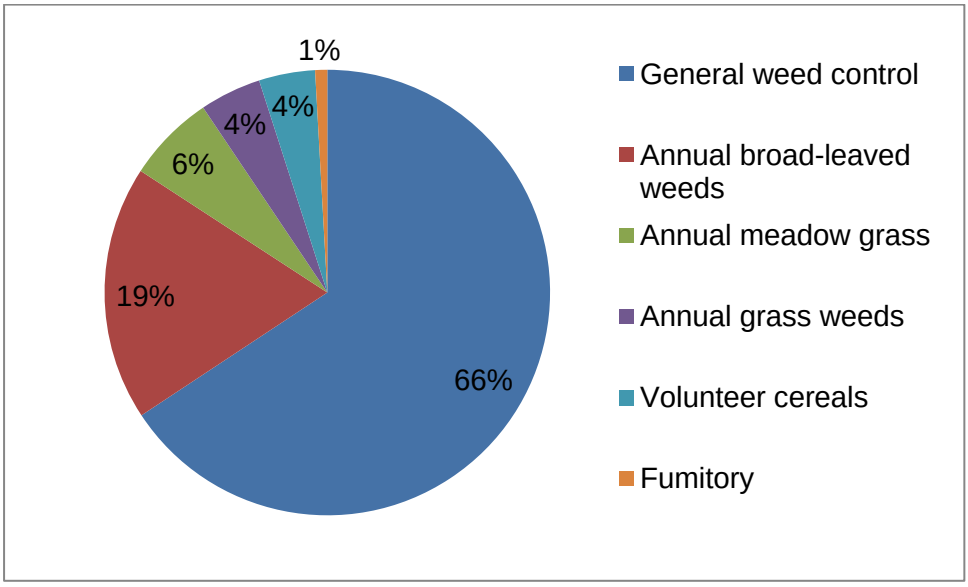


Figure 31 Reasons for use of herbicides on carrots (where specified)



Turnips and swedes

- The total estimated area of turnips and swedes grown in 2015 was 1,503 hectares, representing a 21 per cent decrease from 2013. 1,479 hectares were recorded in the 'turnips & swedes' census category and 24 hectares were recorded in the 'other vegetable' census category.
- 100 per cent of the turnip and swede crop was treated with a pesticide
- Pesticides were applied to 14,203 treated hectares
- 3,291 kilograms of pesticide were applied to the crop
- 32 per cent of pesticides applied were fungicides, 29 per cent herbicides, 22 per cent insecticides, 12 per cent seed treatments and five per cent molluscicides (Figure 32)
- No biopesticides or sulphur were applied to the turnips and swedes crop
- The turnips and swedes crop received on average 4.5 pesticide applications (Table 1). These included 2 fungicide applications (applied to 98 per cent of the crop area), 1.9 insecticide applications (applied to 88 per cent) and 1.6 herbicide applications. In addition, 44 per cent of the crop received on average of 1.1 applications of molluscicide
- 49 per cent of fungicides and 43 per cent of insecticides were applied to the turnips and swedes crop in July, 72 per cent of molluscicides and 56 per cent of herbicides were applied in May (Figure 33)
- Where reasons were given, 68 per cent of fungicide use was for general disease control, 11 per cent was for *Alternaria*, 11 per cent was for light leaf spot and 10 per cent for phoma leaf spot
- 63 per cent of herbicide use was for general weed control and 15 per cent was for annual broad-leaved weeds (Figure 34)
- 50 per cent of insecticide use was for aphids, 30 per cent for general pests and 20 per cent for caterpillars
- The most common variety encountered was Magres, accounting for 88 per cent of the sample area surveyed

Summary of pesticide use on turnips and swedes:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	4,566	1,088	98	Prothioconazole (2,063)
Herbicides	4,159	1,789	100	Metazachlor (1,352), Clomazone (1,346)
Insecticides	3,104	208	88	Deltamethrin (1,059)
Molluscicides	728	173	44	Metaldehyde (728)
Seed treatment	1,645	33(1)	100	Thiram (979)

(1) The total weight of seed treatment is underestimated as some seed treatments were unspecified.

Figure 32 Use of pesticides on turnips and swedes (percentage of total area treated with formulations) – 2015

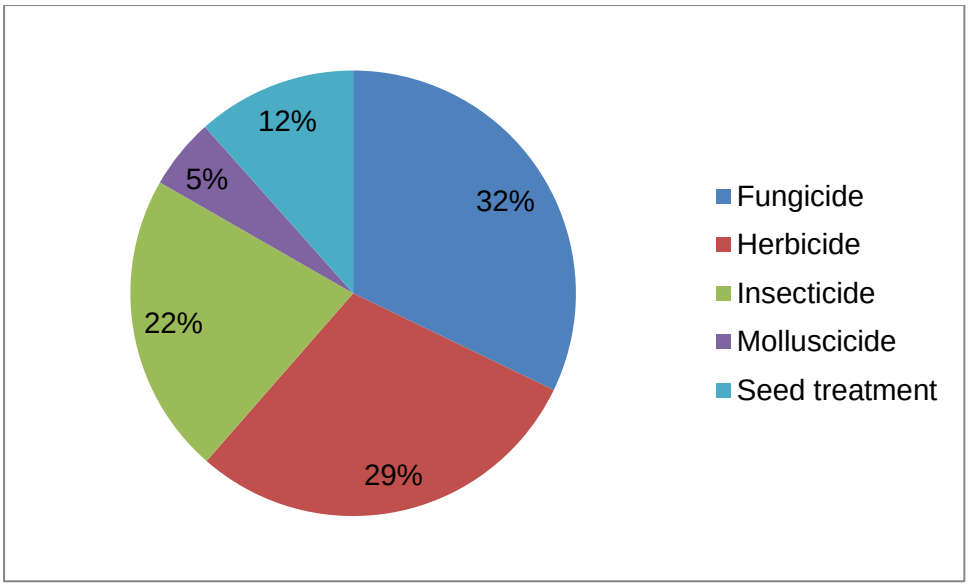


Figure 33 Timing of pesticide applications on turnips and swedes – 2015

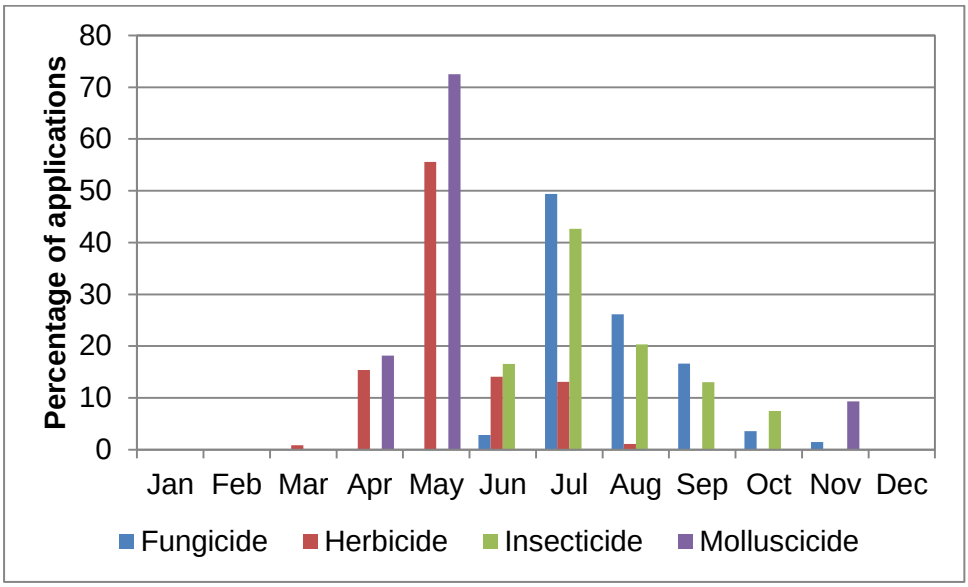
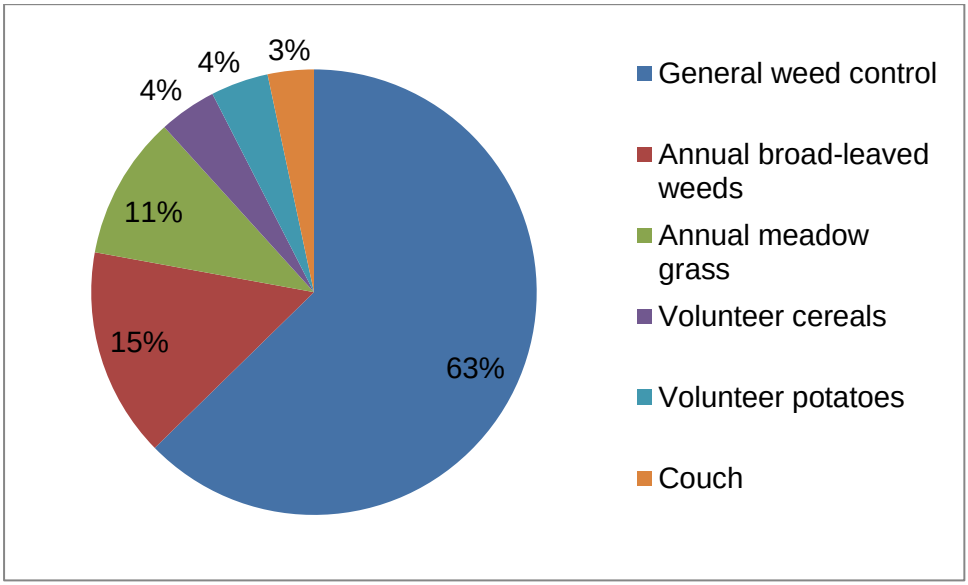


Figure 34 Reasons for use of herbicides on turnips and swedes (where specified)



Other vegetable crops

- Other vegetable crops encountered in the 2015 survey were beetroot, curly parsley, garlic, leeks, lettuce, onions, parsnips, podded peas, radish, rocket and runner beans. The data from the 'rhubarb' census category has also been included with other vegetable crops as too few holdings were encountered to report this crop separately.
- The total estimated area of other vegetable crops was 730 hectares
- 19 per cent of other vegetable crops were grown from transplants
- 94 per cent of other vegetable crops were treated with a pesticide
- Pesticides were applied to 9,316 treated hectares
- 6,056 kilograms of pesticides were applied to the crop
- 37 per cent of pesticides applied were herbicides, 32 per cent fungicides, 20 per cent insecticides, six per cent seed treatments, two per cent sulphur and one per cent molluscicides, biopesticides and growth regulators (Figure 35)
- The 94 per cent of the other vegetable crop category treated with a pesticide received on average 7.6 pesticide applications (Table 1). These included 4.6 fungicide applications (applied to 83 per cent of the crop area), 3.2 insecticide applications (applied to 82 per cent) and 3.1 herbicide applications (applied to 84 per cent). In addition, 16 and 29 per cent of the crop received on average one molluscicide and one sulphur application respectively.
- Fungicides were applied to other vegetable crops between May and October, herbicides were applied between March and July and insecticides were applied between March and October (Figure 36). All sulphur was applied in July and all growth regulators were applied in September. 51 per cent of molluscicides were applied in May and the majority of biopesticide applications were in July and August
- Where reasons were given, 48 per cent of fungicide use was for mildew and 26 per cent was for *Alternaria* (Figure 37)
- 66 per cent of herbicide use was for general weed control and 19 per cent was for annual broad-leaved weeds (Figure 38)
- 54 per cent of insecticide use was for aphids, 33 per cent was for carrot fly, eight per cent for nematodes and five per cent for caterpillars

Summary of pesticide use on other vegetable crops:

Pesticide group	Formulation area treated (ha)	Weight of pesticides applied (kg)	% of crop area treated	Most used formulations (ha)
Fungicides	2,943	1,455	83	Prothioconazole (743)
Herbicides	3,473	2,858	84	Linuron (1,229)
Insecticides	1,900	392	82	Lambda-cyhalothrin (974)
Growth regulator	104	500	14	Maleic hydrazide (104)
Biopesticides	63	2	8	*Bacillus subtilis* (63)
Molluscicides	119	15	16	Metaldehyde (119)
Sulphur	211	842	29	N/A
Seed treatment	504	1	65	Cymoxanil/fludioxonil/ metalaxyl-M (433)

N/A = not applicable

Figure 35 Use of pesticides on other vegetable crops (percentage of total area treated with formulations) – 2015

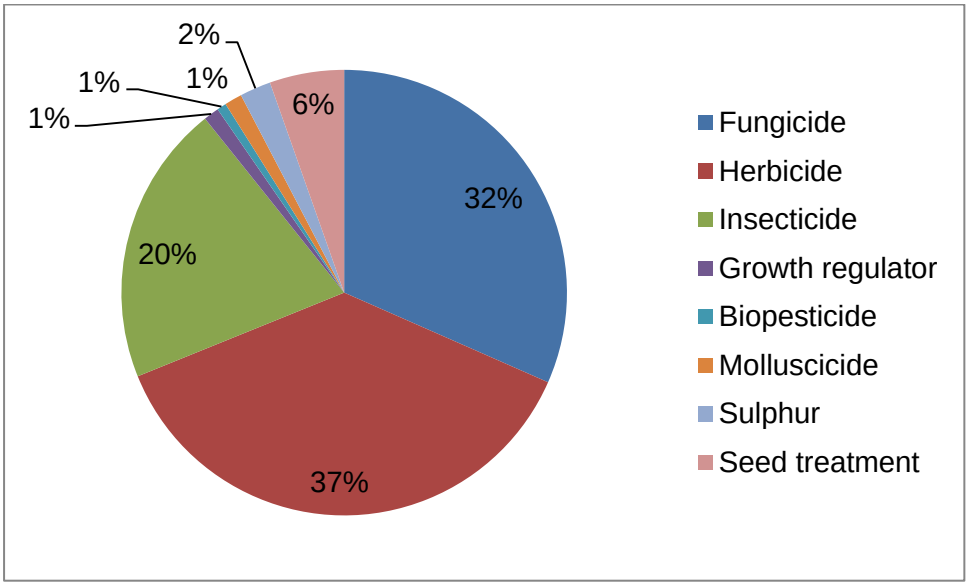


Figure 36 Timing of pesticide applications on other vegetables – 2015

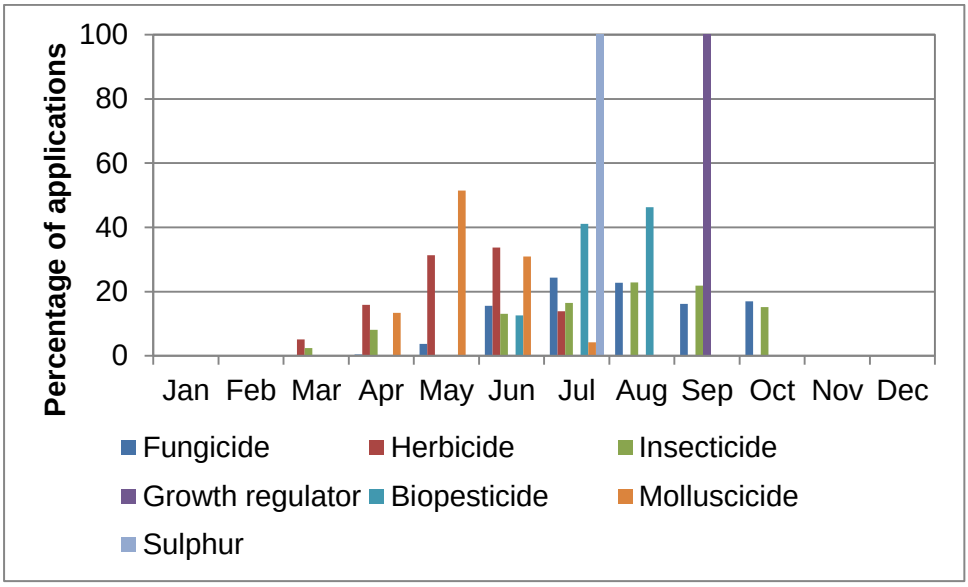


Figure 37 Reasons for use of fungicides on other vegetables (where specified)

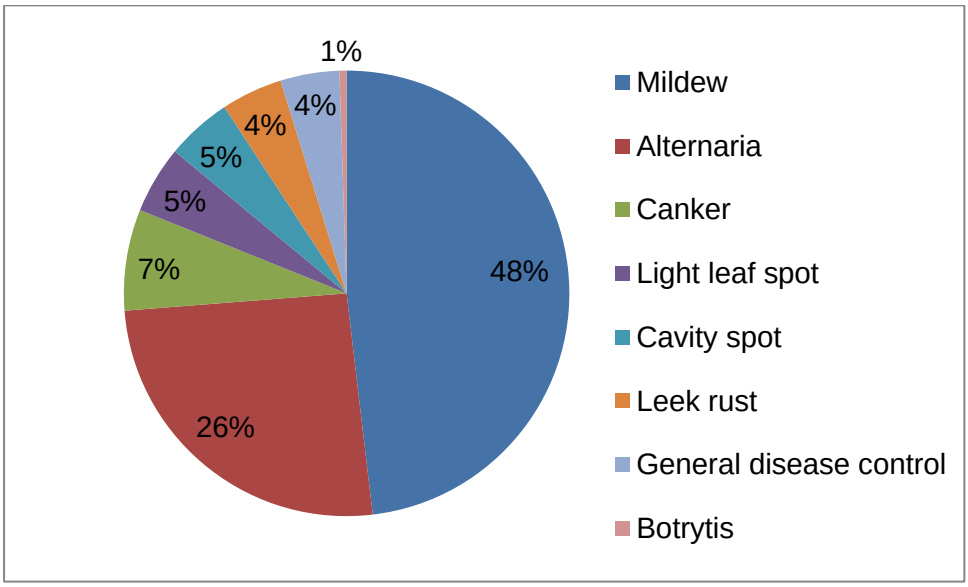
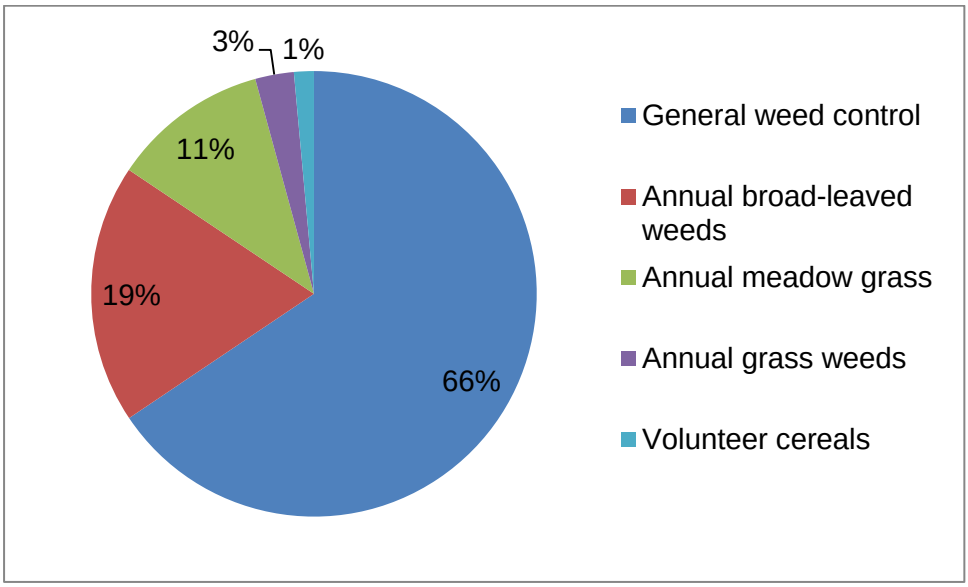


Figure 38 Reasons for use of herbicides on other vegetables (where specified)



Appendix 1 – Estimated application tables

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

Crop	Fungicides		Herbicides		Insecticides		Molluscicides	
	%	sp apps	%	sp apps	%	sp apps	%	sp apps
Vining peas	80	1.1	100	1.6	85	1.1	0	0.0
Broad beans	100	3.8	100	1.3	100	4.1	0	0.0
Brussels sprouts	100	5.6	100	1.6	100	5.5	100	5.9
Cabbage	84	2.8	91	1.7	96	4.2	84	1.7
Calabrese	99	3.9	100	2.5	99	1.5	<0.5	1.0
Other Brassicas	84	2.0	85	3.0	84	3.0	94	2.8
Carrots	81	7.2	93	3.8	92	4.6	0	0.0
Turnips & swede	98	2.0	100	1.6	88	1.9	44	1.1
Other vegetable crops	83	4.6	84	3.1	82	3.2	16	1.0
Total vegetable crops	**86**	**3.2**	**98**	**2.1**	**90**	**2.5**	**12**	**3.2**

Cont…

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

Crop	Sulphur		Biopesticides		Any pesticide (excluding STs)		Seed treatments	Any pesticide (including STs)
	%	sp apps	%	sp apps	%	sp apps	%	%
Vining peas	15	1.0	0	0.0	100	2.5	100	100
Broad beans	0	0.0	0	0.0	100	6.3	100	100
Brussels sprouts	0	0.0	<0.5	1.0	100	14.2	0	100
Cabbage	0	0.0	6	1.0	97	7.6	25	97
Calabrese	40	1.9	0	0.0	100	7.7	<0.5	100
Other Brassicas	0	0.0	0	0.0	95	9.0	0.5	95
Carrots	0	0.0	0	0.0	93	10.6	93	93
Turnips & swedes	0	0.0	0	0.0	100	4.5	100	100
Other vegetable crops	29	1.0	8	1.1	94	7.6	65	94
Total vegetable crops	**12**	**1.3**	**0.5**	**1.1**	**98**	**5.8**	**79**	**98**

Note: STs = seed treatments

The average number of spray applications is calculated only on the areas using each pesticide group and therefore the minimum number of applications is always going to be one (see appendix 3 – definitions and notes for details).

Growth regulators accounted for less than one per cent of the total pesticide treated area; therefore they have been excluded from table 1. See tables 14 and 28 for details.

Table 2 Peas and beans seed treatment formulations

Area (ha) and percentage of crop treated

Seed treatments	Vining peas		Broad beans		Total	2013
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Cymoxanil/fludioxonil/metalaxyl-M	7,029	100	761	52	**7,790**	7,234
Thiram	0	0	1,469	100	**1,469**	383
All seed treatments	**7,029**	**100**	**2,230**	**100**	**9,259**	**8,892**
No seed treatment	0	0	7	<0.5	**7**	95
Area grown	7,029		1,475		**8,504**	7,719

Table 3 Peas and beans insecticide formulations

Area (ha) and percentage of crop treated

Insecticides	Vining peas		Broad beans		Total	2013
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Alpha-cypermethrin	0	0	761	52	**761**	1,463
Lambda-cyhalothrin	0	0	2,937	100	**2,937**	766
Pirimicarb	6,450	85	2,314	61	**8,765**	5,977
All insecticides	**6,450**	**85**	**6,013**	**100**	**12,464**	**9,669**
Area grown	7,029		1,475		**8,504**	7,719

Table 4 Peas and beans fungicide and sulphur formulations

Area (ha) and percentage of crop treated

Fungicides	**Vining peas**		**Broad beans**		**Total**	**2013**
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Azoxystrobin	2,456	35	2,122	48	**4,578**	3,342
Boscalid/pyraclostrobin	3,133	45	1,469	100	**4,602**	2,536
Chlorothalonil/metalaxyl-M	0	0	2,176	100	**2,176**	1,880
Cyprodinil/fludioxonil	487	7	1,469	100	**1,956**	732
Tebuconazole	0	0	3,399	87	**3,399**	1,880
All fungicides	**6,076**	**80**	**10,634**	**100**	**16,711**	**10,369**
Sulphur	**1,069**	**15**	**0**	**0**	**1,069**	**1,054**
Area grown	7,029		1,475		**8,504**	7,719

Table 5 Peas and beans herbicide formulations

Area (ha) and percentage of crop treated

Herbicides	**Vining peas**		**Broad beans**		**Total**	**2013**
	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Bentazone	2,064	29	325	22	**2,389**	1,368
Clomazone/linuron	729	10	0	0	**729**	0
Glyphosate	1,565	22	137	9	**1,702**	370
Imazamox/pendimethalin	6,300	90	1,469	100	**7,768**	5,008
All herbicides	**10,659**	**100**	**1,931**	**100**	**12,589**	**12,341**
Area grown	7,029		1,475		**8,504**	7,719

Table 6 Leaf brassica seed treatment formulations

Area treated (ha), percentage of crop treated and percentage of crop grown from transplants

Seed treatments	Brussels sprouts		Cabbages		Calabrese		Other brassicas		Total	2013
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Iprodione	0	0	76	25	1	<0.5	1	1	**79**	1
Metalaxyl-M	0	0	76	25	1	<0.5	1	1	**79**	1
Thiram	0	0	76	25	1	<0.5	1	1	**79**	1
All seed treatments	**0**	**0**	**229**	**25**	**4**	**<0.5**	**4**	**1**	**236**	**116**
No seed treatment	0	0	0	0	0	0	13	5	**13**	0
Crop grown from transplant	777	100	223	75	1,687	100	246	94	**2,934**	2,512
Area grown	777		299		1,688		260		**3,025**	2,626

Note: other brassicas include broccoli, cauliflower and kale.

Table 7 Leaf brassica insecticide and molluscicide formulations

Area (ha) and percentage of crop treated

Insecticides	**Brussels sprouts**		**Cabbages**		**Calabrese**		**Other brassicas**		**Total**	**2013**
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Deltamethrin	1,249	91	340	54	0	0	0	0	**1,589**	2,861
Indoxacarb	1,530	100	630	96	171	10	0	0	**2,331**	1,765
Lambda-cyhalothrin	1,832	100	619	70	2,412	99	655	84	**5,518**	5,147
Pirimicarb	946	42	256	65	438	26	437	84	**2,077**	1,713
Pymetrozine	692	42	0	0	0	0	0	0	**692**	1,575
Spirotetramat	898	91	368	79	0	0	0	0	**1,265**	1,266
Thiacloprid	660	42	47	16	162	10	218	84	**1,087**	1,489
All insecticides	**7,807**	**100**	**2,259**	**96**	**3,183**	**99**	**1,311**	**84**	**14,560**	**15,992**
Molluscicides										
Ferric phosphate	1,846	91	90	30	0	0	0	0	**1,936**	4,158
Metaldehyde	2,376	100	340	84	6	<0.5	681	94	**3,403**	1,510
Methiocarb	403	49	0	0	0	0	0	0	**403**	199
All molluscicides	**4,624**	**100**	**430**	**84**	**6**	**<0.5**	**681**	**94**	**5,742**	**5,868**
Area grown	777		299		1,688		260		**3,025**	2,626

Table 8 Leaf brassica fungicide and sulphur formulations

Area (ha) and percentage of crop treated

Fungicides	Brussels sprouts		Cabbages		Calabrese		Other brassicas		Total	2013
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Azoxystrobin	373	42	90	30	659	39	437	84	**1,559**	1,332
Azoxystrobin/difenoconazole	556	43	158	53	0	0	0	0	**714**	638
Boscalid/pyraclostrobin	695	73	264	54	262	16	0	0	**1,221**	1,160
Chlorothalonil/metalaxyl-M	21	3	0	0	0	0	0	0	**21**	320
Copper oxychloride	0	0	0	0	5,258	99	0	0	**5,258**	2,533
Difenoconazole	396	24	68	23	0	0	0	0	**464**	727
Fluopicolide/propamocarb hydrochloride	0	0	0	0	376	22	0	0	**376**	32
Iprodione	822	87	0	0	0	0	0	0	**822**	641
Prothioconazole	1,356	91	0	0	0	0	0	0	**1,356**	1,765
Tebuconazole/trifloxystrobin	1,785	100	200	37	0	0	0	0	**1,985**	1,882
All fungicides	**6,004**	**100**	**780**	**84**	**6,555**	**99**	**437**	**84**	**13,776**	**11,372**
Sulphur	**0**	**0**	**0**	**0**	**1,276**	**40**	**0**	**0**	**1,276**	**101**
Area grown	777		299		1,688		260		**3,025**	2,626

Table 9 Leaf brassica herbicide formulations

Area (ha) and percentage of crop treated

Herbicides	Brussels sprouts		Cabbages		Calabrese		Other brassicas		Total	2013
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Clomazone	417	54	272	91	344	20	2	1	**1,035**	816
Clopyralid	16	2	0	0	343	15	0	0	**359**	22
Glyphosate	0	0	0	0	2,060	90	437	84	**2,497**	1,320
Metazachlor	417	54	272	91	1,595	94	221	85	**2,504**	2,117
Pendimethalin	776	100	194	65	556	33	0	0	**1,526**	1,303
Tepraloxydim	0	0	0	0	15	1	0	0	**15**	0
All herbicides	**1,626**	**100**	**738**	**91**	**4,914**	**100**	**660**	**85**	**7,938**	**5,646**
Area grown	777		299		1,688		260		**3,025**	2,626

Table 10 Leaf brassica biopesticide formulations

Area (ha) and percentage of crop treated

Biopesticides	**Brussels sprouts**		**Cabbages**		**Calabrese**		**Other brassicas**		**Total**	**2013**
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Bacillus thuringiensis var. *kurstaki*	1	<0.5	17	6	0	0	0	0	**18**	0
All Biopesticides	**1**	**<0.5**	**17**	**6**	**0**	**0**	**0**	**0**	**18**	**0**
Area grown	777		299		1,688		260		**3,025**	2,626

Note: *Bacillus thuringiensis* var. *kurstaki* is a bio-insecticide.

Table 11 Vegetables (excluding legumes and leaf brassicas) seed treatment formulations

Area treated (ha), percentage of crop treated and percentage of crop grown from transplants

Seed treatments	Carrots		Turnips & swedes		Other vegetable crops[1]		Total	2013
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Bacillus subtilis	0	0	30	2	0	0	**30**	486
Cymoxanil/fludioxonil/metalaxyl-M	2,312	80	0	0	433	59	**2,745**	2,025
Iprodione	0	0	0	0	2	0	**2**	43
Metalaxyl-M	317	11	0	0	0	0	**317**	0
Tefluthrin	1,465	50	0	0	9	1	**1,474**	1,454
Thiamethoxam	317	11	407	27	0	0	**724**	50
Thiram	317	11	979	65	60	8	**1,356**	1,555
Unspecified seed treatment[2]	0	0	229	15	0	0	**229**	0
All seed treatments	**4,729**	**93**	**1,645**	**100**	**504**	**65**	**6,878**	**5,614**
Crop grown from transplant	0	0	0	0	141	19	**141**	204
No seed treatment	216	7	0	0	37	5	**252**	1,381
Area grown	2,908		1,503		730		**5,142**	5,623

(1) Other vegetable crops include perennial rhubarb over one year old. Therefore, seed treatment and transplant information was not collected.
(2) Refer to Appendix 3 for definition.

Table 12 Vegetables (excluding legumes and leaf brassicas) insecticide and molluscicide formulations

Area (ha) and percentage of crop treated

Insecticides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	**2013**
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Acetamiprid	0	0	0	0	77	10	**77**	0
Cypermethrin	0	0	0	0	19	3	**19**	0
Deltamethrin	1,808	29	1,059	53	631	43	**3,498**	2,299
Lambda-cyhalothrin	8,207	81	986	44	974	65	**10,166**	10,365
Oxamyl	802	28	0	0	199	27	**1,001**	1,044
Pirimicarb	1,516	41	632	33	0	0	**2,148**	1,016
Pymetrozine	0	0	295	20	0	0	**295**	0
Thiacloprid	108	4	132	9	0	0	**240**	889
All insecticides	**12,441**	**92**	**3,104**	**88**	**1,900**	**82**	**17,445**	**15,612**
Molluscicides								
Metaldehyde	0	0	728	44	119	16	**847**	1,613
All molluscicides	**0**	**0**	**728**	**44**	**119**	**16**	**847**	**1,722**
Area grown	2,908		1,503		730		**5,142**	5,623

Table 13 Vegetables (excluding legumes and leaf brassicas) fungicide and sulphur formulations

Area (ha) and percentage of crop treated

Fungicides	Carrots		Turnips & swedes		Other vegetable crops		Total	2013
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Azoxystrobin	2,008	32	1,768	98	75	10	**3,851**	3,075
Azoxystrobin/difenoconazole	1,652	57	0	0	431	48	**2,083**	838
Boscalid/pyraclostrobin	2,947	81	433	29	325	36	**3,705**	2,325
Copper oxychloride	0	0	151	10	0	0	**151**	298
Cyprodinil/fludioxonil	2,169	67	0	0	101	14	**2,271**	1,189
Dimethomorph	0	0	0	0	159	11	**159**	0
Dimethomorph/mancozeb	0	0	0	0	233	11	**233**	0
Fenhexamid	0	0	0	0	11	2	**11**	0
Fenpropimorph	3,140	72	0	0	0	0	**3,140**	2,077
Iprodione/thiophanate-methyl	635	13	0	0	0	0	**635**	0
Mancozeb	0	0	0	0	263	36	**263**	269
Mancozeb/metalaxyl-M	0	0	0	0	60	6	**60**	38
Mandipropamid	0	0	0	0	81	11	**81**	24
Metalaxyl-M	2,143	74	0	0	101	14	**2,245**	1,609
Prothioconazole	3,211	60	2,063	98	743	66	**6,017**	5,869
Tebuconazole	2,010	50	151	10	0	0	**2,161**	578
Tebuconazole/trifloxystrobin	789	23	0	0	360	47	**1,149**	1,806
All fungicides	**20,706**	**81**	**4,566**	**98**	**2,943**	**83**	**28,215**	**21,012**

Cont…

Table 13 Vegetables (excluding legumes and leaf brassicas) fungicide and sulphur formulations continued

Area (ha) and percentage of crop treated

Sulphur	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	**2013**
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Sulphur	**0**	**0**	**0**	**0**	**211**	**29**	**211**	**340**
Area grown	2,908		1,503		730		**5,142**	5,623

Table 14 Vegetables (excluding legumes and leaf brassicas) herbicide and growth regulator formulations

Area (ha) and percentage of crop treated

Herbicides	Carrots		Turnips & swedes		Other vegetable crops		Total	2013
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Bentazone	0	0	0	0	43	6	**43**	28
Chloridazon	0	0	0	0	73	5	**73**	120
Clomazone	2,691	93	1,346	90	2	0	**4,039**	3,374
Clopyralid	0	0	512	31	0	0	**512**	245
Cycloxydim	0	0	132	9	0	0	**132**	30
Dimethenamid-P/pendimethalin	0	0	0	0	125	17	**125**	0
Diquat	110	4	0	0	293	40	**403**	98
Ethofumesate	0	0	0	0	21	3	**21**	0
Fluroxypyr	0	0	0	0	13	1	**13**	92
Glyphosate	0	0	66	4	0	0	**66**	337
Ioxynil	0	0	0	0	146	7	**146**	308
Lenacil	0	0	0	0	21	3	**21**	0
Linuron	7,542	93	0	0	1,229	61	**8,771**	6,137
Metamitron	0	0	0	0	330	45	**330**	439
Metazachlor	0	0	1,352	90	0	0	**1,352**	1,762
Metribuzin	2,623	57	0	0	0	0	**2,623**	2,625
Pendimethalin	3,268	93	0	0	450	62	**3,718**	2,779
Propaquizafop	733	25	373	25	28	4	**1,134**	1,441

Cont…

Table 14 Vegetables (excluding legumes and leaf brassicas) herbicide and growth regulator formulations continued

Area (ha) and percentage of crop treated

Herbicides	Carrots		Turnips & swedes		Other vegetable crops		Total	2013
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Propyzamide	0	0	0	0	81	11	**81**	73
Prosulfocarb	2,029	40	0	0	482	48	**2,511**	1,202
S-metolachlor	0	0	378	25	0	0	**378**	1,419
Tepraloxydim	2,116	70	0	0	136	19	**2,252**	1,698
All herbicides	**21,114**	**93**	**4,159**	**100**	**3,473**	**84**	**28,745**	24,495
Growth regulators								
Maleic hydrazide	0	0	0	0	104	14	**104**	0
All growth regulators	**0**	**0**	**0**	**0**	**104**	**14**	**104**	0
Area grown	2,908		1,503		730		**5,142**	5,623

Table 15 Vegetables (excluding legumes and leaf brassicas) biopesticide formulations

Area (ha) and percentage of crop treated

Biopesticides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	**2013**
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(ha)
Bacillus subtilis	0	0	0	0	63	8	**63**	0
All biopesticides	**0**	**0**	**0**	**0**	**63**	**8**	**63**	**0**(1)
Area grown	2,908		1,503		730		**5,142**	5,623

Note: *Bacillus subtilis* is a bio-fungicide.

(1) In 2013, 154 ha of *Bacillus amyloliquefaciens* was recorded on vegetable crops. However, this is classed as a biological control agent not a biopesticide. Refer to Appendix 3 for a definition.

Table 16 Peas and beans seed treatment active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Seed treatments	**Vining peas**		**Broad beans**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(kg)
Cymoxanil	7,029	100	761	52	**7,790**	258
Fludioxonil	7,029	100	761	52	**7,790**	129
Metalaxyl-M	7,029	100	761	52	**7,790**	451
Thiram	0	0	1,469	100	**1,469**	217
All seed treatments	**21,087**	**100**	**3,753**	**100**	**24,840**	**1,055**
No seed treatment	0	0	7	0	**7**	N/A
Area grown	7,029		1,475		**8,504**	

Note: no vining peas or broad beans were grown from transplants.
N/A = not applicable.

Table 17 Peas and beans insecticide active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Insecticides	**Vining peas**		**Broad beans**		**Total**	
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Alpha-cypermethrin	0	0	761	52	**761**	11
Lambda-cyhalothrin	0	0	2,937	100	**2,937**	18
Pirimicarb	6,450	85	2,314	61	**8,765**	1,052
All insecticides	**6,450**	**85**	**6,013**	**100**	**12,464**	**1,082**
Area grown	7,029		1,475		**8,504**	

Table 18 Peas and beans fungicide and sulphur active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Vining peas**		**Broad beans**		**Total**	
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Azoxystrobin	2,456	35	2,122	48	4,578	791
Boscalid	3,133	45	1,469	100	4,602	982
Chlorothalonil	0	0	2,176	100	2,176	1,795
Cyprodinil	487	7	1,469	100	1,956	656
Fludioxonil	487	7	1,469	100	1,956	437
Metalaxyl-M	0	0	2,176	100	2,176	135
Pyraclostrobin	3,133	45	1,469	100	4,602	246
Tebuconazole	0	0	3,399	87	3,399	476
All fungicides	**9,697**	**80**	**15,748**	**100**	**25,445**	**5,518**
Sulphur	**1,069**	**15**	**0**	**0**	**1,069**	**4,277**
Area grown	7029		1,475		**8,504**	

Table 19 Peas and beans herbicide active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	**Vining peas**		**Broad beans**		**Total**	
	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Bentazone	2,064	29	325	22	**2,389**	1,650
Clomazone	729	10	0	0	**729**	66
Glyphosate	1,565	22	137	9	**1,702**	1,418
Imazamox	6,300	90	1,469	100	**7,768**	443
Linuron	729	10	0	0	**729**	365
MCPB	807	11	0	0	**807**	1,190
Pendimethalin	6,300	90	1,469	100	**7,768**	6,626
All herbicides	**18,494**	**100**	**3,399**	**100**	**21,894**	**11,757**
Area grown	7,029		1,475		8,504	

Table 20 Leaf brassica seed treatments active substances

Area treated (ha), percentage of crop treated and grown from transplants and quantity (kg) of active substances for all crops

Seed treatments	Brussels sprouts		Cabbages		Calabrese		Other brassicas		Total	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Iprodione	0	0	76	25	1	<0.5	1	1	**79**	<0.5
Metalaxyl-M	0	0	76	25	1	<0.5	1	1	**79**	<0.5
Thiram	0	0	76	25	1	<0.5	1	1	**79**	<0.5
All seed treatments	**0**	**0**	**229**	**25**	**4**	**<0.5**	**4**	**1**	**236**	**<0.5**
No seed treatment	0	0	0	0	0	0	13	5	13	N/A
Crop grown from transplant	777	100	223	75	1,687	100	246	94	**2,934**	N/A
Area grown	777		299		1,688		260		**3,025**	

N/A= not applicable.

Table 21 Leaf brassica insecticide and molluscicide active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Insecticides	**Brussels sprouts**		**Cabbages**		**Calabrese**		**Other brassicas**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Deltamethrin	1,249	91	340	54	0	0	0	0	**1,589**	12
Indoxacarb	1,530	100	630	96	171	10	0	0	**2,331**	60
Lambda-cyhalothrin	1,832	100	619	70	2,412	99	655	84	**5,518**	33
Pirimicarb	946	42	256	65	438	26	437	84	**2,077**	397
Pymetrozine	692	42	0	0	0	0	0	0	**692**	138
Spirotetramat	898	91	368	79	0	0	0	0	**1,265**	95
Thiacloprid	660	42	47	16	162	10	218	84	**1,087**	104
All insecticides	**7,807**	**100**	**2,259**	**96**	**3,183**	**99**	**1,311**	**84**	**14,560**	**840**
Molluscicides										
Ferric phosphate	1,846	91	90	30	0	0	0	0	**1,936**	332
Metaldehyde	2,376	100	340	84	6	0	681	94	**3,403**	501
Methiocarb	403	49	0	0	0	0	0	0	**403**	60
All molluscicides	**4,624**	**100**	**430**	**84**	**6**	**<0.5**	**681**	**94**	**5,742**	**893**
Area grown	777		299		1,688		260		3,025	

Table 22 Leaf brassica fungicide and sulphur active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Brussels sprouts**		**Cabbages**		**Calabrese**		**Other brassicas**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Azoxystrobin	929	43	248	83	659	39	437	84	**2,273**	532
Boscalid	695	73	264	54	262	16	0	0	**1,221**	308
Chlorothalonil	21	3	0	0	0	0	0	0	**21**	16
Copper oxychloride	0	0	0	0	5,258	99	0	0	**5,258**	1,980
Difenoconazole	952	43	226	53	0	0	0	0	**1,178**	124
Fluopicolide	0	0	0	0	376	22	0	0	**376**	38
Iprodione	822	87	0	0	0	0	0	0	**822**	389
Metalaxyl-M	21	3	0	0	0	0	0	0	**21**	1
Propamocarb hydrochloride	0	0	0	0	376	22	0	0	**376**	376
Prothioconazole	1,356	91	0	0	0	0	0	0	**1,356**	260
Pyraclostrobin	695	73	264	54	262	16	0	0	**1,221**	77
Tebuconazole	1,785	100	200	37	0	0	0	0	**1,985**	375
Trifloxystrobin	1,785	100	200	37	0	0	0	0	**1,985**	187
All fungicides	**9,062**	**100**	**1,402**	**84**	**7,194**	**99**	**437**	**84**	**18,095**	**4,664**
Sulphur	**0**	**0**	**0**	**0**	**1,276**	**40**	**0**	**0**	**1,276**	**1,215**
Area grown	777		299		1,688		260		3,025	

Table 23 Leaf brassica herbicide active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	**Brussels sprouts**		**Cabbages**		**Calabrese**		**Other brassicas**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Clomazone	417	54	272	91	344	20	2	1	**1,035**	62
Clopyralid	16	2	0	0	343	15	0	0	**359**	39
Glyphosate	0	0	0	0	2,060	90	437	84	**2,497**	2,446
Metazachlor	417	54	272	91	1,595	94	221	85	**2,504**	1,832
Pendimethalin	776	100	194	65	556	33	0	0	**1,526**	1,791
Tepraloxydim	0	0	0	0	15	1	0	0	**15**	1
All herbicides	**1,626**	**100**	**738**	**91**	**4,914**	**100**	**660**	**85**	**7,938**	**6,170**
Area grown	777		299		1,688		260		**3,025**	

Table 24 Leaf brassica biopesticide active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Biopesticides	**Brussels sprouts**		**Cabbages**		**Calabrese**		**Other brassicas**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Bacillus thuringiensis var. *kurstaki*	1	0	17	6	0	0	0	0	**18**	0.4
All biopesticides	**1**	**<0.5**	**17**	**6**	**0**	**0**	**0**	**0**	**18**	0.4
Area grown	777		299		1,688		260		**3,025**	

Note: *Bacillus thuringiensis* var. *kurstaki* is a bio-insecticide.

Table 25 Vegetables (excluding legumes and leaf brassicas) seed treatment active substances

Area treated (ha), percentage of crop treated and grown from transplants and quantity (kg) of active ingredients for all crops

Seed treatments	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Bacillus subtilis	0	0	30	2	0	0	**30**	N/K
Cymoxanil	2,312	80	0	0	433	59	**2,745**	2
Fludioxonil	2,312	80	0	0	433	59	**2,745**	1
Iprodione	0	0	0	0	2	<0.5	**2**	<0.5
Metalaxyl-M	2,629	90	0	0	433	59	**3,062**	3
Tefluthrin	1,465	50	0	0	9	1	**1,474**	72
Thiamethoxam	317	11	407	27	0	0	**724**	66
Thiram	317	11	979	65	60	8	**1,356**	4
Unspecified seed treatment(2)	0	0	229	15	0	0	**229**	N/K
All seed treatments	**9,354**	**93**	**1,645**	**100**	**1,370**	**65**	**12,368**	**148**(1)
Crop grown from transplant	0	0	0	0	141	19	**141**	N/A
No seed treatment	216	7	0	0	37	5	**252**	N/A
Area grown	2,908		1,503		730		**5,142**	

(1) The total weight of seed treatments excludes unspecified seed treatments as their weight is unknown.
(2) Refer to Appendix 3 for definition.
N/K = Not known.
N/A = Not applicable.

Table 26 Vegetables (excluding legumes and leaf brassicas) insecticide and molluscicide active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Insecticides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Acetamiprid	0	0	0	0	77	10	**77**	2
Cypermethrin	0	0	0	0	19	3	**19**	<0.5
Deltamethrin	1,808	29	1,059	53	631	43	**3,498**	24
Lambda-cyhalothrin	8,207	81	986	44	974	65	**10,166**	115
Oxamyl	802	28	0	0	199	27	**1,001**	1,764
Pirimicarb	1,516	41	632	33	0	0	**2,148**	344
Pymetrozine	0	0	295	20	0	0	**295**	44
Thiacloprid	108	4	132	9	0	0	**240**	23
All insecticides	**12,441**	**92**	**3,104**	**88**	**1,900**	**82**	**17,445**	**2,317**
Molluscicides								
Metaldehyde	0	0	728	44	119	16	847	188
All molluscicides	**0**	**0**	**728**	**44**	**119**	**16**	**847**	**188**
Area grown	2,908		1,503		730		5,142	

Table 27 Vegetables (excluding legumes and leaf brassicas) fungicide and sulphur active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Azoxystrobin	3,661	69	1,768	98	506	54	**5,935**	1,248
Boscalid	2,947	81	433	29	325	36	**3,705**	1,001
Copper oxychloride	0	0	151	10	0	0	**151**	68
Cyprodinil	2,169	67	0	0	101	14	**2,271**	680
Difenoconazole	1,652	57	0	0	431	48	**2,083**	234
Dimethomorph	0	0	0	0	392	11	**392**	64
Fenhexamid	0	0	0	0	11	2	**11**	8
Fenpropimorph	3,140	72	0	0	0	0	**3,140**	1,984
Fludioxonil	2,169	67	0	0	101	14	**2,271**	454
Iprodione	635	13	0	0	0	0	**635**	212
Mancozeb	0	0	0	0	555	47	**555**	777
Mandipropamid	0	0	0	0	81	11	**81**	12
Metalaxyl-M	2,143	74	0	0	161	20	**2,304**	1,188
Prothioconazole	3,211	60	2,063	98	743	66	**6,017**	1,154

Cont…

Table 27 Vegetables (excluding legumes and leaf brassicas) fungicide and sulphur active substances continued

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Fungicides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Pyraclostrobin	2,947	81	433	29	325	36	**3,705**	251
Tebuconazole	2,798	73	151	10	360	47	**3,310**	612
Thiophanate-methyl	635	13	0	0	0	0	**635**	212
Trifloxystrobin	789	23	0	0	360	47	**1,149**	88
All fungicides	**28,898**	**81**	**4,999**	**98**	**4,454**	**83**	**38,351**	**10,248**
Sulphur	**0**	**0**	**0**	**0**	**211**	**29**	**211**	**842**
Area grown	2,908		1,503		730		**5,142**	

Table 28 Vegetables (excluding legumes and leaf brassicas) herbicide and growth regulator active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Bentazone	0	0	0	0	43	6	**43**	11
Chloridazon	0	0	0	0	73	5	**73**	29
Clomazone	2,691	93	1,346	90	2	0	**4,039**	290
Clopyralid	0	0	512	31	0	0	**512**	85
Cycloxydim	0	0	132	9	0	0	**132**	33
Dimethenamid-P	0	0	0	0	125	17	**125**	38
Diquat	110	4	0	0	293	40	**403**	78
Ethofumesate	0	0	0	0	21	3	**21**	21
Fluroxypyr	0	0	0	0	13	1	**13**	1
Glyphosate	0	0	66	4	0	0	**66**	35
Ioxynil	0	0	0	0	146	7	**146**	8
Lenacil	0	0	0	0	21	3	**21**	12
Linuron	7,542	93	0	0	1,229	61	**8,771**	2,404
Metamitron	0	0	0	0	330	45	**330**	692
Metazachlor	0	0	1,352	90	0	0	**1,352**	995
Metribuzin	2,623	57	0	0	0	0	**2,623**	423

Cont…

Table 28 Vegetables (excluding legumes and leaf brassicas) herbicide and growth regulator active substances continued

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Herbicides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Pendimethalin	3,268	93	0	0	575	75	**3,843**	5,157
Propaquizafop	733	25	373	25	28	4	**1,134**	169
Propyzamide	0	0	0	0	81	11	**81**	61
Prosulfocarb	2,029	40	0	0	482	48	**2,511**	4,367
S-metolachlor	0	0	378	25	0	0	**378**	508
Tepraloxydim	2,116	70	0	0	136	19	**2,252**	168
All herbicides	**21,114**	**93**	**4,159**	**100**	**3,597**	**84**	**28,870**	**15,586**
Growth regulators								
Maleic hydrazide	0	0	0	0	104	14	**104**	500
All growth regulators	**0**	**0**	**0**	**0**	**104**	**14**	**104**	**500**
Area grown	2,908		1,503		730		**5,142**	

Table 29 Vegetables (excluding legumes and leaf brassicas) biopesticide active substances

Area treated (ha), percentage of crop treated and quantity (kg) of active substances for all crops

Biopesticides	**Carrots**		**Turnips & swedes**		**Other vegetable crops**		**Total**	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	**(ha)**	(kg)
Bacillus subtilis	0	0	0	0	63	8	**63**	2
All biopesticides	**0**	**0**	**0**	**0**	**63**	**8**	**63**	**2**
Area grown	2,908		1,503		730		**5,142**	

Note: *Bacillus subtilis* is a bio-fungicide.

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

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

Mode of Action	Active Substance	Chemical Group	IRAC Group	Total Vegetables	Total Vegetables
				(ha)	(kg)
Acetylcholinesterase (AChE) inhibitors	Oxamyl	Carbamate	1A	1,001	1,764
	Pirimicarb	Carbamate	1A	12,990	1,793
All Ache inhibitors				**13,991**	**3,557**
Sodium channel modulators	Alpha-Cypermethrin	Pyrethroid	3A	761	11
	Cypermethrin	Pyrethroid	3A	19	<0.5
	Deltamethrin	Pyrethroid	3A	5,086	36
	Lambda-Cyhalothrin	Pyrethroid	3A	18,622	167
All sodium channel modulators				**24,489**	**214**
Nicotinic acetylcholine receptor (nAChR) competitive modulators	Acetamiprid	Neonicotinoid	4A	77	2
	Thiacloprid	Neonicotinoid	4A	1,327	127
All nAChR competitive modulators				**1,405**	**130**
Voltage-dependent sodium channel blockers	Indoxacarb	Oxadiazines	22A	2,331	60
Chordotonal organ TRPV channel modulators	Pymetrozine	Pyridine azomethine derivative	9B	987	183
Inhibitors of acetyl COA carboxylase	Spirotetramat	Tetramic acid	23	1,265	95
All others				**4,583**	**338**
All insecticides				**44,468**	**4,239**
Area grown				16,671	

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 31 Mode of action/chemical group of fungicide active substances

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

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	Total Vegetables	Total Vegetables
					(ha)	(kg)
Amino acids & protein synthesis	Cyprodinil	Anilino-pyrimidine	Anilino-pyrimidine	9	4,227	1,336
All amino acids & protein synthesis					**4,227**	**1,336**
Cell wall biosynthesis	Dimethomorph	Carboxylic acid amide	Morpholine	40	392	64
	Mandipropamid	Carboxylic acid amide	Mandelic acid amides	40	81	12
All cell wall biosynthesis					**473**	**76**
Cytoskeleton and motor proteins	Thiophanate-Methyl	Methyl Benzimidazole Carbamate	Thiophanate	1	635	212
	Fluopicolide	benzamide	Pyridinylmethyl-benzamide	43	376	38
All cytoskeleton and motor proteins					**1,011**	**250**
Lipid synthesis and membrane integrity	Propamocarb Hydrochloride	Carbamate	Carbamate	28	376	376
All lipid synthesis and membrane integrity					**376**	**376**

Cont…

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

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

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	Total Vegetables	Total Vegetables
					(ha)	(kg)
Multi-site contact activity	Copper Oxychloride	Inorganic	Inorganic	M1	5,409	2,047
	Mancozeb	Dithio-carbamate	Dithio-carbamate	M3	555	777
	Chlorothalonil	Chloronitrile	Chloronitrile	M5	2,198	1,812
All multi-site contact activity					**8,162**	**4,636**
Nucleic Acid Synthesis	Metalaxyl-M	Phenylamide	Acylalanine	4	4,502	1,324
All nucleic Acid Synthesis					**4,502**	**1,324**
Respiration	Boscalid	SDHI	pyridine-carboxamide	7	9,528	2,291
	Azoxystrobin	Qo inhibitors	Strobilurin	11	12,786	2,571
	Pyraclostrobin	Qo inhibitors	Strobilurin	11	9,528	575
	Trifloxystrobin	Qo inhibitors	Strobilurin	11	3,134	276
All respiration					**34,976**	**5,713**
Signal transduction	Iprodione	Dicarboximide	Dicarboximide	2	1,457	601
	Fludioxonil	Phenylpyrroles	Phenylpyrroles	12	4,227	891
All Signal transduction					**5,684**	**1,492**

Cont…

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

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

Mode of action	Active Substance	Group Name	Chemical Group	FRAC Group	Total Vegetables	Total Vegetables
					(ha)	(kg)
Sterol biosynthesis in membranes	Difenoconazole	DeMethylation Inhibitor	Triazole	3	3,261	358
	Prothioconazole	DeMethylation Inhibitor	Triazolinthione	3	7,373	1,414
	Tebuconazole	DeMethylation Inhibitor	Triazole	3	8,694	1,463
	Fenpropimorph	Morpholine	Morpholine	5	3,140	1,984
	Fenhexamid	Hydroxyanilide	Hydroxyanilide	17	11	8
All sterol biosynthesis in membranes					**22,479**	**5,227**
All fungicides					**81,890**	**20,429**
Sulphur					2,556	6,335
Area grown					16,671	

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 32 Mode of action/chemical group of herbicide active substances

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

Mode of Action	Active Substance	Chemical Group	HRAC Group	Total Vegetables	Total Vegetables
				(ha)	(kg)
Inhibition of acetyl CoA carboxylase	Cycloxydim	Cyclohexanedione	A	132	33
	Propaquizafop	Aryloxyphenoxy-propionate	A	1,134	169
	Tepraloxydim	Cyclohexanedione	A	2,268	169
All Inhibition of acetyl CoA carboxylase				**3,534**	**371**
Inhibition of acetolactate synthase ALS	Imazamox	Imidazolinone	B	7,768	443
All inhibition of acetolactate synthase ALS				**7,768**	**443**
Inhibition of photosynthesis at photosystem II	Chloridazon	Pyridazinone	C1	73	29
	Lenacil	Uracil	C1	21	12
	Metamitron	Triazinone	C1	330	692
	Metribuzin	Triazinone	C1	2,623	423
	Linuron	Urea	C2	9,500	2,769
	Bentazone	Benzothiadiazinone	C3	2,433	1,661
	Ioxynil	Nitrile	C3	146	8
All Inhibition of photosynthesis at photosystem II				**15,126**	**5,594**

Cont…

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

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

Mode of Action	Active Substance	Chemical Group	HRAC Group	Total Vegetables	Total Vegetables
				(ha)	(kg)
Photosystem-I-electron diversion	Diquat	Bipyridylium	D	403	78
All Photosystem-I-electron diversion				**403**	**78**
Inhibition of EPSP synthase	Glyphosate	Glycine	G	4,265	3,900
All Inhibition of EPSP synthase				**4,265**	**3,900**
Microtubule assembly inhibition	Pendimethalin	Dinitroaniline	K1	13,138	13,574
	Propyzamide	Benzamide	K1	81	61
All Microtubule assembly inhibition				**13,219**	**13,635**
Inhibition of VLCFAs	Metazachlor	Chloroacetamide	K3	3,856	2,826
	Dimethenamid-P	Chloroacetamide	K3	125	38
	S-metolachlor	Chloroacetamide	K3	378	508
Inhibition of VLCFAs				**4,359**	**3,372**
Inhibition of lipid synthesis	Ethofumesate	Benzofuran	N	21	21
	Prosulfocarb	Thiocarbamate	N	2,511	4,367
All Inhibition of lipid synthesis				**2,532**	**4,389**

Cont…

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

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

Mode of Action	Active Substance	Chemical Group	HRAC Group	Total Vegetables	Total Vegetables
				(ha)	(kg)
Action like indole acetic acid	Clopyralid	Pyridine carboxylic acid	O	872	124
	Fluroxypyr	Pyridine carboxylic acid	O	13	1
	MCPB	Phenoxy-carboxylic-acid	O	807	1,190
All Action like indole acetic acid				**1,691**	**1,314**
All herbicides				**58,701**	**33,513**
Area grown				16,671	

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

Table 33 Principal active substances by area treated

Area treated (hectares) with the 20 most used active substances on all vegetable crops surveyed

	Active substance	Type(1)	2015	2013	% change
1	Lambda-cyhalothrin	I	**18,622**	16,277	14
2	Metalaxyl-M	F/S	**15,433**	13,240	17
3	Fludioxonil	F/S	**14,762**	11,180	32
4	Pendimethalin	H	**13,138**	11,272	17
5	Pirimicarb	I	**12,990**	8,706	49
6	Azoxystrobin	F	**12,786**	9,224	39
7	Cymoxanil	S	**10,535**	9,259	14
8	Boscalid	F	**9,528**	6,021	58
9	Pyraclostrobin	F	**9,528**	6,021	58
10	Linuron	H	**9,500**	6,137	55
11	Tebuconazole	F	**8,694**	6,146	41
12	Imazamox	H	**7,768**	5,008	55
13	Prothioconazole	F	**7,373**	7,634	-3
14	Clomazone	H	**5,804**	4,190	39
15	Copper oxychloride	F	**5,409**	2,831	91
16	Deltamethrin	I	**5,086**	6,623	-23
17	Glyphosate	H	**4,265**	2,027	110
18	Metaldehyde	M	**4,250**	3,124	36
19	Cyprodinil	F	**4,227**	1,920	120
20	Metazachlor	H	**3,856**	3,921	-2

(1) Pesticide type = F: Fungicide, H: Herbicide, I: Insecticide, M: Molluscicide, S: Seed treatment

Table 34 Principal active substances by weight

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

	Active substance	Type[(1)]	2015	2013	% change
1	Pendimethalin	H	**13,574**	10,847	25
2	Sulphur	SU	**6,335**	5,341	19
3	Prosulfocarb	H	**4,367**	2,186	100
4	Glyphosate	H	**3,900**	2,222	76
5	Metazachlor	H	**2,826**	2,787	1
6	Linuron	H	**2,769**	1,641	69
7	Azoxystrobin	F	**2,571**	2,060	25
8	Boscalid	F	**2,291**	1,486	54
9	Copper oxychloride	F	**2,047**	1,015	102
10	Fenpropimorph	F	**1,984**	1,446	37
11	Chlorothalonil	F	**1,812**	1,291	40
12	Pirimicarb	I	**1,793**	1,190	51
13	Metalaxyl-M	F/S	**1,778**	1,446	23
14	Oxamyl	I	**1,764**	1,895	-7
15	Bentazone	H	**1,661**	1,074	55
16	Tebuconazole	F	**1,463**	1,044	40
17	Prothioconazole	F	**1,414**	1,462	-3
18	Cyprodinil	F	**1,336**	631	112
19	MCPB	H	**1,190**	880	35
20	Fludioxonil	F/S	**1,020**	558	83

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

Table 35 Total vegetable crop, comparison with previous years

Pesticide usage in 2011, 2013 and 2015, area treated with formulations and active substances (a.s.) and the quantities (kg) applied

	2011			2013			2015		
	Formulations (ha)	**a.s. (ha)**	**kg**	**Formulations (ha)**	**a.s. (ha)**	**kg**	**Formulations (ha)**	**a.s. (ha)**	**kg**
Insecticides	32,701	33,949	2,612	41,273	41,273	3,992	44,468	44,468	4,240
Molluscicides	8,692	8,692	2,136	7,589	7,589	1,313	6,589	6,589	1,081
Biological agents(1)	314	314	N/A	154	154	N/A	0	0	0
Biopesticides	25	25	1	0	0	0	82	82	2
Fungicides	45,711	62,263	18,892	42,753	58,228	13,796	58,702	81,890	20,429
Sulphur	1,645	1,645	3,751	1,495	1,495	5,341	2,556	2,556	6,335
Herbicides	37,124	44,480	24,061	41,424	48,880	26,379	50,079	58,701	33,513
Growth regulators	0	0	0	0	0	0	104	104	500
Physical control	0	0	0	312	312	1,048	0	0	0
Seed treatments(1)	12,292	31,043	1,049	14,622	33,141	1,153	16,373	37,444	1,203
All pesticides	**138,504**	**182,411**	**52,500**	**149,623**	**191,073**	**53,022**	**178,953**	**231,834**	**67,303**
Area grown	15,318(2)			15,968(3)			16,672(4)		

(1) No weights can be calculated for biological control agents and biological seed treatments.
(2) Includes 72 hectares of multi-cropping.
(3) Includes 66 hectares of multi-cropping.
(4) No multi-cropping was encountered in 2015.

Appendix 2 – Survey statistics

Census and sample information

Table 36 Census crop areas 2015

Census area (ha) of vegetable crops grown in Scotland

	Scotland 2015	Scotland 2013	% change
Vining Peas	7,029	6,559	7%
Broad Beans	1,469	1,153	27%
Brussels Sprouts	776	813	-5%
Cabbage	204	188	8%
Calabrese	1,513	1,325	14%
Cauliflower	218	152	44%
Carrots	2,877	2,836	1%
Leeks	84	92	-9%
Lettuce	87	62	40%
Turnips & Swedes	1,479	1,644	-10%
Rhubarb	71	75	-5%
All vegetable crops(1)	**16,672**	**15,902**	**5%**

(1) Includes other vegetable crops
Note: Data taken from the 2015 and 2013 June Agricultural Census. All areas exclude multi-cropping.

Table 37 Distribution of vegetable sample (excluding holdings growing only peas)

Number of holdings surveyed in each region and size group

Size[(1)](ha)	Highlands & Islands	Caithness & Orkney	Moray Firth	Aberdeen	Angus	East Fife	Lothian	Central Lowlands	Tweed Valley	Scotland
0.1-9.9	3	2	1	1	2	1	0	1	0	**11**
10-19.9	0	0	2	1	13	4	2	2	0	**24**
20-29.9	0	0	1	2	3	3	0	1	1	**11**
30-39.9	0	0	1	0	3	1	2	1	0	**8**
>40	0	0	1	0	6	1	1	2	1	**12**
All sizes	**3**	**2**	**6**	**4**	**27**	**10**	**5**	**7**	**2**	**66**

(1) Refers to the area of vegetable crops (excluding vining peas) grown on holding

Table 38 Distribution of pea sample

Number of holdings surveyed in each region and size group

Size[(1)](ha)	Highlands & Islands	Angus	East Fife	Lothian	Central Lowlands	Tweed Valley	Scotland
0.1-9.9	0	3	0	0	0	0	**3**
10-19.9	0	7	1	0	1	1	**10**
20-29.9	0	3	0	1	1	1	**6**
30-39.9	0	0	0	1	1	1	**3**
>40	0	5	0	0	1	2	**8**
All sizes	**0**	**18**	**1**	**2**	**4**	**5**	**30**

(1) Refers to the area of vining peas grown on holding

Table 39 Sampled areas

Areas (ha) of vegetable crops (excluding peas) grown in sample

Size[1](ha)	Scotland[2]
0.1-9.9	59
10-19.9	244
20-29.9	148
30-39.9	236
>40	381
All sizes	**1,068**

Table 40 Census areas

Areas (ha) of vegetable crops (excluding peas) grown in Scotland

Size[1](ha)	Scotland[2]
0.1-9.9	1,839
10-19.9	3,141
20-29.9	1,838
30-39.9	831
>40	1,994
All sizes	**9,643**

(1) Size refers to area of vegetable crops (excluding peas) grown on holding.
(2) Regional data have not been provided in order to prevent disclosure of information relating to fewer than five holdings.

Table 41 Sampled areas (peas)

Areas (ha) of peas grown in sample

Size[1] (ha)	Scotland[2]
0.1-9.9	23
10-19.9	217
20-29.9	146
30-39.9	105
>40	557
All sizes	**1,048**

Table 42 Census areas (peas)

Areas (ha) of peas grown in Scotland

Size[1] (ha)	Scotland[2]
0.1-9.9	763
10-19.9	2,604
20-29.9	1,310
30-39.9	760
>40	1,593
All sizes	**7,029**

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

Table 43 Raising factors (vegetable crops excluding peas)

Size[1] (ha)	Highlands & Islands	Caithness & Orkney	Moray Firth	Aberdeen	Angus	East Fife	Lothian	Central Lowlands	Tweed Valley
0.1-9.9	7.21	2.97	60.55	25.43	28.45	38.61	N/A	62.09	N/A
10-19.9	N/A	N/A	10.19	12.96	11.20	10.91	14.98	13.59	N/A
20-29.9	N/A	N/A	29.86	4.49	11.93	10.67	N/A	11.59	14.01
30-39.9	N/A	N/A	2.82	N/A	4.51	5.00	1.33	1.00	N/A
>40	N/A	N/A	1.41	N/A	3.66	13.00	8.87	3.68	6.77

(1) Size refers to area of vegetable crops (excluding peas) grown on holding.
N/A = not applicable.

Table 44 Raising factors (peas)

Size[1] (ha)	Angus	East Fife	Lothian	Central Lowlands	Tweed Valley
0.1-9.9	23.87	N/A	N/A	N/A	N/A
10-19.9	10.12	27.07	N/A	18.45	10.42
20-29.9	11.04	N/A	2.00	8.94	6.11
30-39.9	N/A	N/A	4.84	3.98	5.00
>40	2.07	N/A	N/A	4.45	2.84

(1) Size refers to area of peas grown on holding.
N/A = not applicable.
Note: raising factors are calculated by comparing the sampled crop area to the census crop area. Please see Appendix 4 for a full explanation.

Table 45 First and second adjustment factors

	Highlands & Islands	Caithness & Orkney	Moray Firth	Aberdeen	Angus	East Fife	Lothian	Central Lowlands	Tweed Valley	Adj 2
Vining Peas	N/A	N/A	N/A	N/A	1.07	2.00	1.44	1.13	1.01	1.00
Broad Beans	N/A	N/A	N/A	N/A	0.88	N/A	N/A	1.08	N/A	1.54
Brussels Sprouts	N/A	N/A	N/A	N/A	N/A	0.17	1.11	N/A	1.03	1.20
Total Cabbage	1.78	N/A	N/A	N/A	N/A	N/A	1.24	N/A	0.02	1.86
Calabrese	N/A	N/A	N/A	N/A	1.50	1.12	N/A	N/A	0.15	1.09
Carrots	N/A	0.39	0.87	1.07	0.92	1.03	N/A	6.81	N/A	1.04
Cauliflower	N/A	N/A	N/A	N/A	0.95	N/A	N/A	N/A	N/A	5.48
Leeks	N/A	N/A	N/A	N/A	N/A	N/A	0.42	N/A	N/A	1.81
Total Lettuce	N/A	N/A	N/A	N/A	N/A	N/A	0.13	N/A	N/A	6.34
Total Other Veg	7.06	0.77	N/A	N/A	0.97	0.66	4.35	0.60	N/A	1.29
Rhubarb	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.15	N/A	1.18
Turnips & Swedes	0.48	N/A	N/A	1.07	0.84	1.11	5.58	1.53	1.06	1.04

N/A = not applicable

Response rates

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

Table 46 Response rate

	2015	% total
Target sample vegetables	60	100
Target sample vining peas	30	100
Total achieved vegetables	**60**	**100**
Total achieved vining peas	**30**	**100**
Total number of refusals/non-contact	20	
Total number of farms approached	**110**	

Financial burden to farmers

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

To determine the total burden that the 2015 Outdoor Vegetable Crop Survey and the Integrated Pest Management Survey placed on those providing the information, the surveyors recorded the time that 71 respondents spent providing the data during the surveys. This sample represents 79 per cent of growers surveyed. Information was recorded from all strata of the sample to ensure that the overall estimate of burden was representative. The median time taken to provide the information was 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 £13.45)[9]

The total financial burden to all growers resulting from participation in the 2015 Outdoor Vegetable Crop Survey and the Integrated Pest Management Survey was calculated to be £159.

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 biopesticides were included in the biological control agent category.

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

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

7) A **growth regulator** is a pesticide used to regulate the growth of the plant, for example to prevent the crop from growing too tall.

8) An **insecticide** is a pesticide used to control unwanted insects.

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

10) A **physical control agent** is a substance, preparation or organism designed or used for destroying or controlling pests if their principal mode of action does not involve chemical or biological action.

11) A **seed treatment** is a pesticide applied to seed before planting to protect that plant against diseases and pests from the earliest stage of development. The pesticide can be a fungicide, an insecticide or a biological control agent.

12) Information about pesticides applied as seed treatments was only collected for field sown crops, not for transplanted crops. Pesticides applied

to transplants in nurseries before going to the grower are included in the Protected Edible Crops survey.

13) In the pesticide tables, some pesticide treatments are 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 quantity of pesticide used since the exact pesticide is unknown.

14) **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.

15) **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.

16) 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.

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

18) 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 control weeds at the field margins.

19) 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 growers growing the relevant crops to participate in the survey

20) 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.

21) 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 crop recorded in the June Agricultural Census. This is referred to throughout the report as **multi-cropping**.

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

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

24) Data from the 2013[(3)] and 2011[(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 take into account that there may be changes in the area of crop grown. In order to take this into account, comparisons have been made on a per hectare grown basis, i.e. the number of hectares that have been sprayed (treated hectares) has been divided by the area of crop grown for each survey, and the weight (kilograms) applied has also been divided by the area of crop grown. This is to enable like for like comparisons between surveys, so that changes in pesticide use patterns are not masked by changes in crop area.

25) When leaf brassicas are referred to in the text, this includes Brussels sprouts, cabbage, calabrese and cauliflower. Other brassicas includes cauliflower, broccoli and kale. Crops encountered in the 'other vegetable' category in the 2015 survey were beetroot, curly parsley, garlic, leeks, lettuce, onions, parsnips, podded peas, radish, rocket and runner beans. For reporting purposes, the data for leeks, lettuce and rhubarb have also been presented under the 'other vegetable' category.

26) **Integrated pest management** The sustainable use directive[(11)] 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."

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

Appendix 4 – Survey methodology

Sampling and data collection

Using the June 2015 Agricultural Census [10], a sample was drawn representing vegetable cultivation in Scotland. The first sample was selected from holdings growing any vegetable crops excluding vining peas, and the second from holdings known to have grown vining peas. Two samples were taken to achieve a better representation of all vegetable crops, as most vining pea crops are grown on farms growing arable crops rather than vegetable crops.

The country was divided into 11 land-use regions (Figure 39). 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 either vegetable or vining peas 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.

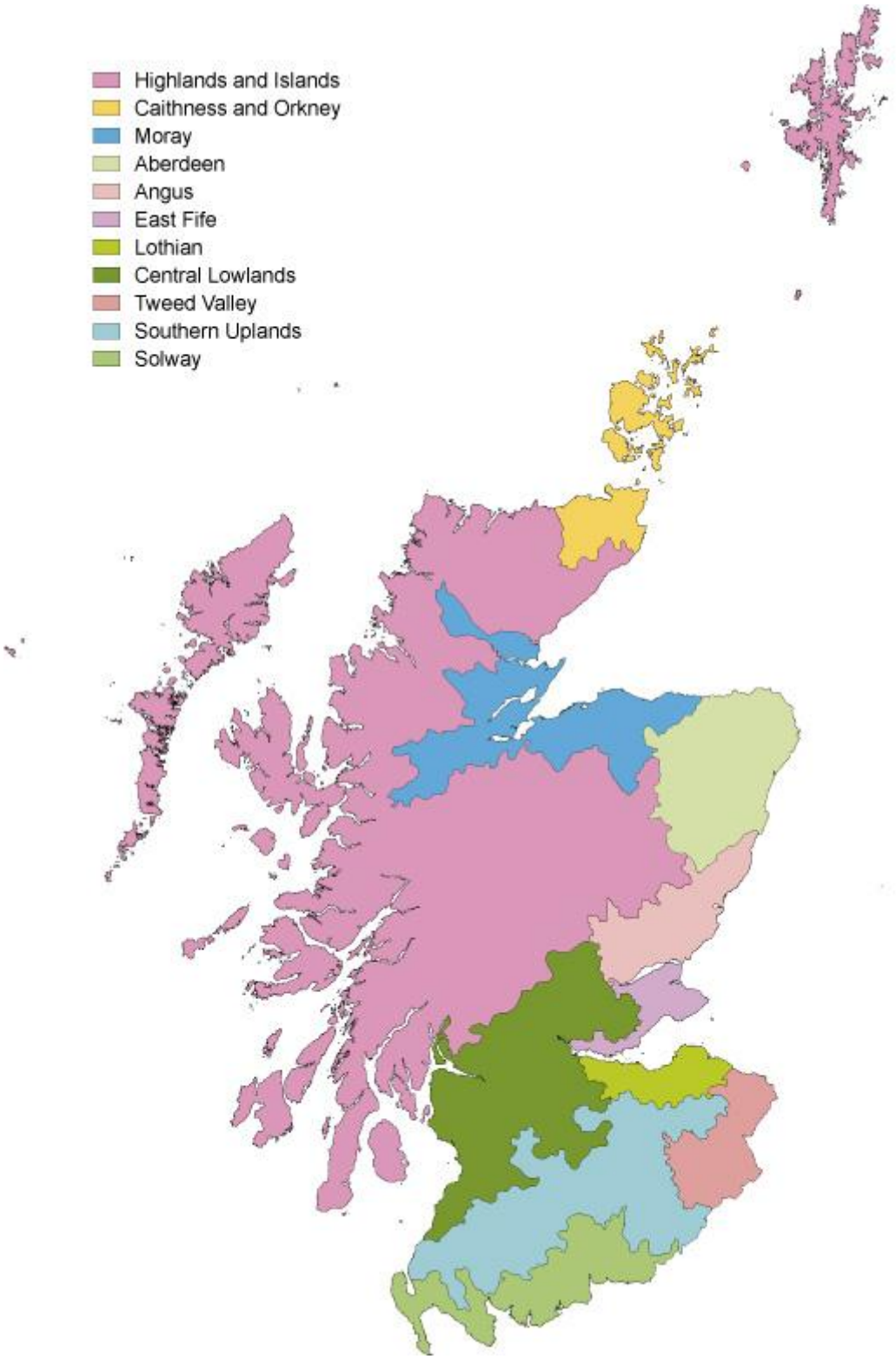
The survey covered pesticide applications to vegetable crops where all or the majority of the growing season was in 2015. As well as recording treatments applied directly to the crop, data was also collected on land preparation treatments prior to sowing or planting the crop.

Following an introductory letter and phone call, data were collected by either personal interview during a visit to the holding or during a phone interview or by email. Where necessary, information was also collected from agronomists and contractors. In total, information was collected from 60 holdings growing vegetable crops and 30 holdings growing only peas (Tables 37 & 38). These 90 holdings represent 13 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 (Tables 43 & 44). These factors were calculated by comparing the sampled area to the areas recorded in the Agricultural Census within each region and size group. An adjustment (Table 45) 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 was necessary for some crops which were present in the population, but were not encountered in the sample in some strata.

Figure 39 Land use regions of Scotland[12]



Changes from previous years

There are a number of changes which should be noted when comparing the 2015 data with the previous survey.

The term active substance is now used instead of active ingredient which appeared in previous reports. These changes make the Scottish reports consistent with the UK pesticide usage reports.

In 2015, all biopesticides have been grouped separately. In previous reports, these were presented under the category of biological control agents within the insecticides and molluscicides table. However, as biopesticides require to be authorised like other pesticides, they can have a range of different functions including fungicides and insecticides and their rates of application can be collected, they are now being treated separately. Biopesticide values have been re-calculated separately from biological control agents for the previous reports to allow for accurate comparisons. No biological control agents were recorded in 2015.

Another change to note is that sulphur was previously reported as a fungicide. It is now reported in a category on its own to acknowledge that as well as being used as a fungicide, it has other functions in some crops. In order to allow comparison with previous surveys, fungicide data from the 2013 and 2011 surveys included in this report have been recalculated to exclude sulphur.

The 2015 report contains a number of new details to help improve data quality for users. Data relating to the average number of applications for each crop and type of pesticide have been included in Table 1 and Figures 11 and 12. Details relating to pesticide application timings for each crop have been included in the pesticide usage section. Fungicides and herbicides have been classified into groups according to their mode of action in Tables 30-32. Data on Integrated Pest Management activities (i.e. non-chemical methods to control pests, weeds and diseases) has been collected from the growers and is reported in Appendix 6.

Data quality assurance

The dataset undergoes several validation processes as follows; (i) checking for any obvious errors upon data receipt (ii) checking and identifying inconsistencies with use and pesticide approval conditions once entered into the database (iii) 100 per cent checking of data held in the database against the raw data. Where inconsistencies are found these are checked against the records and with the grower if necessary. Additional quality assurance is provided by sending reports for review to members of the Working Party on Pesticide Usage Surveys and other agricultural experts. In addition, the Scottish pesticide survey unit is accredited to ISO 9001:2008. 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 47). 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 47) 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 pesticides among holdings.

The RSE for estimates of total pesticide use on vegetable crops was seven per cent for area and eight per cent for quantity (Table 47). For constituent crop groups, the RSE varied from one to 18 per cent for area and one to 14 per cent for weight, varying with sample size and uniformity of pesticide regime encountered. For cauliflower, leeks, lettuce, other vegetables and rhubarb, a standard error could not be calculated due to too few active ingredients being recorded; therefore pesticide estimates for these crops should be treated with caution.

Table 47 Relative standard errors

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

Crops	Area SE (%)	Weight SE (%)
Broad beans[1]	7	4
Brussels sprouts[1]	18	11
Cabbages[1]	1	1
Calabrese[1]	8	6
Carrots[1]	14	14
Cauliflower[2]	NC	NC
Leeks[2]	NC	NC
Lettuce[2]	NC	NC
Other vegetables[2]	NC	NC
Peas[1]	4	3
Rhubarb[2]	NC	NC
Turnips & swedes[1]	14	11
All vegetable crops	**7**	**8**

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

(2) Standard errors could not be calculated (NC) for cauliflower, leeks, lettuce, other vegetables and rhubarb because there were too few active ingredients recorded. Therefore estimates for these crops should be treated with caution

Appendix 6 – Integrated pest management

It is a requirement of the EU Sustainable use of Pesticides Directive (2009/128/EC)[11] that member states should promote low pesticide input pest management, in particular Integrated Pest Management (IPM).

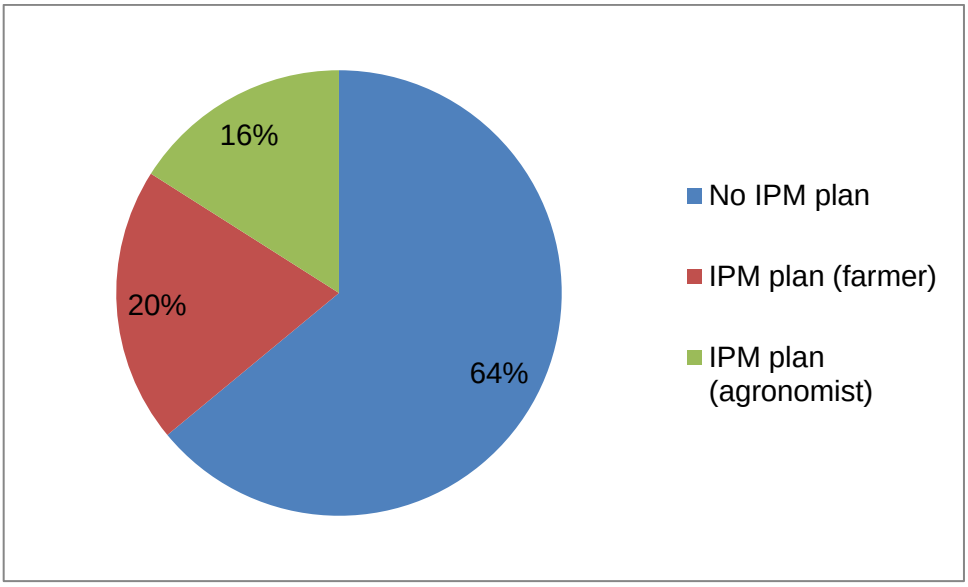
The Directive defines IPM as follows "'integrated pest management' means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products 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."

Therefore, for the first time in this series of surveys, additional data collection was conducted in relation to grower adoption of Integrated Pest Management (IPM) measures. The term 'pest' is used to denote diseases, weeds and pests. This data collection was designed to inform the Scottish Government about the current adoption of IPM in the main crop sectors and will be collected for all subsequent surveys to allow analysis of changes in uptake over time.

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

In total IPM data was collected from 25 growers and grower groups, representing 84 holdings and 84 per cent of the sampled outdoor vegetable crop area. Of these growers, 64 per cent did not have an IPM plan, 20 per cent of growers completed their own IPM plan and 16 per cent had a plan completed by their agronomist (Figure 40).

Figure 40 Percentage of respondents with an IPM plan



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

Risk management

IPM programs aim to prevent or reduce the risk of pests becoming a threat by minimising the risk of damage occurring that will require subsequent control. Table 48 presents an overview of the risk management measures adopted by the growers surveyed.

Practically all growers (96 per cent) used crop rotation to manage the risk of pest damage. Rotation is a basic principle of farming breaking the link between pathogen and host and reducing pest population build-up. It can also improve soil fertility and structure consequently increasing the vigour of subsequent crops.

The majority of growers (88 per cent) also tested their soils in order to tailor inputs to improve crop performance. Eighty four per cent tested soil nutrient levels with lower proportions testing for disease, nematodes and other soil health parameters (Figure 41). By pre-emptively testing for nutritional and pest status farmers' can make informed decisions about inputs required and optimal crop choice for that field.

Just over three quarters of growers managed their seed bed agronomy to reduce risk. Around half increased organic matter to improve soil quality while a smaller proportion implemented other measures such as using a stale seed bed (44 per cent) and considering pest management when planning irrigation (Figure 42).

Just over half of growers amended cultivation methods at sowing to try to increase crop success. Over a third varied sowing dates and 20 per cent varied seed rates to mitigate for potential pest damage. Some growers also used pest free growing media such as coir (Figure 43).

Almost ninety per cent of the growers surveyed also considered risk management when selecting seeds and/or varieties. Sixty per cent of growers selected pest resistant varieties, where available, to reduce damage. Some growers (24 per cent) also confirmed that they chose to adopt varietal diversification (using a range of different varieties) to increase overall resistance to pests and environmental stresses. Some growers (8 per cent) also reported that they used certified seed which has been tested to ensure it meets quality standards. Just over a third of growers used seed treatments to protect seedlings at crop emergence (Figure 44).

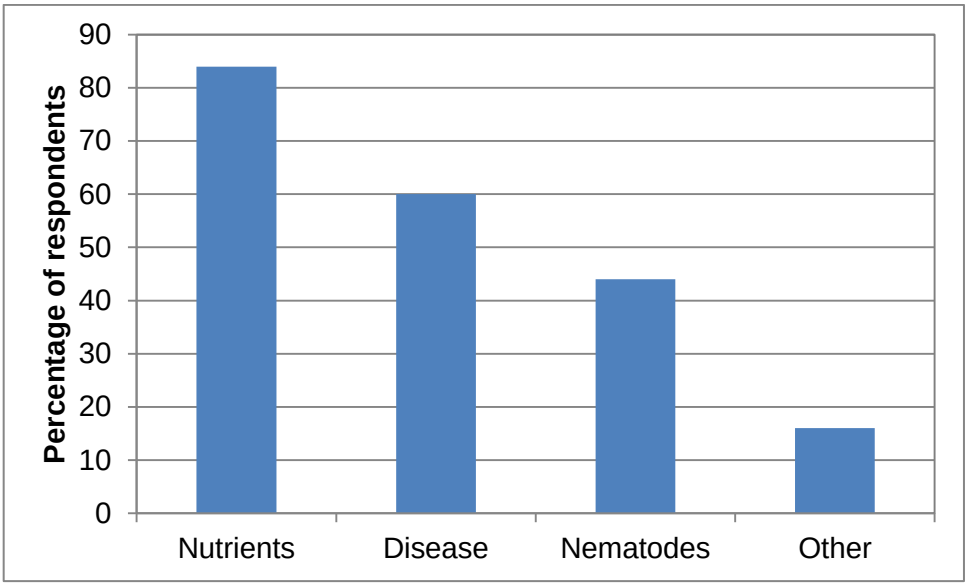
Over a third of respondents (36 per cent) sowed catch or cover crops as part of their crop production cycle. These crops were cultivated to improve soil quality (28 per cent), manage pests and disease (8 per cent) and suppress weeds (8 per cent). Others (8 per cent) used these crops for biofumgation and to prevent soil erosion.

Finally, 72 per cent of the growers sampled adopted techniques to protect or enhance populations of beneficial insects. Over half left uncultivated strips and 32 per cent planted wild flower strips. Twenty per cent planted pollen sources and 12 per cent took part in agri-environment schemes (Figure 45).

Table 48 Summary of responses to risk management questions

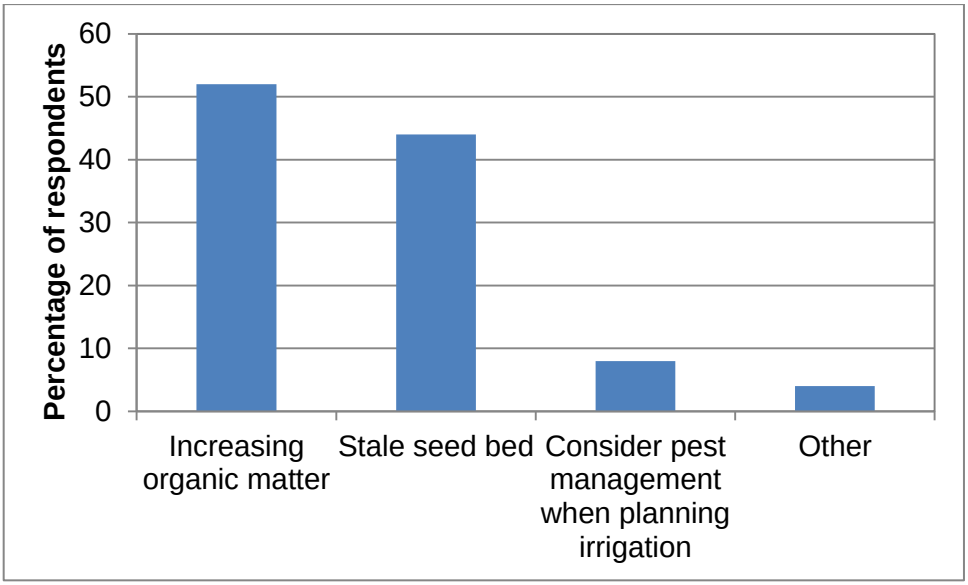
Risk management activity	Percentage yes response
Crop rotation	96
Soil testing	88
Cultivation of seed bed	76
Cultivations at sowing	52
Varietal or seed choice	88
Catch and cover cropping	36
Protection or enhancement of beneficial organism populations	72

Figure 41 Types of soil testing recorded (percentage of respondents)



Note: 'other' includes texture, pH, and conductivity.

Figure 42 Methods of cultivating seed bed to reduce pest risk (percentage of respondents)



Note: 'other' includes deep ploughing.

Figure 43 Methods of cultivating at sowing to reduce pest risk (percentage of respondents)

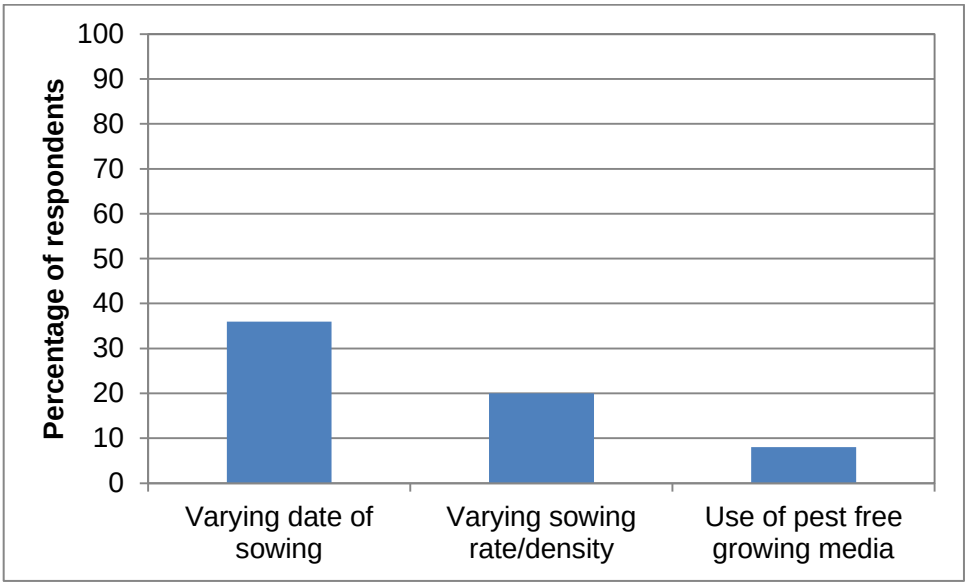


Figure 44 Variety and seed choice to reduce pest risk (percentage of respondents)

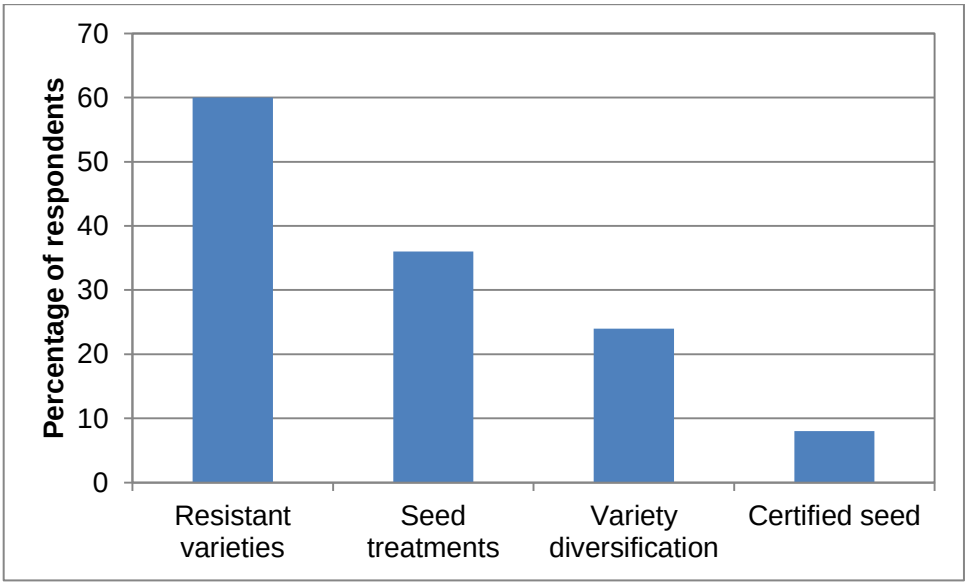
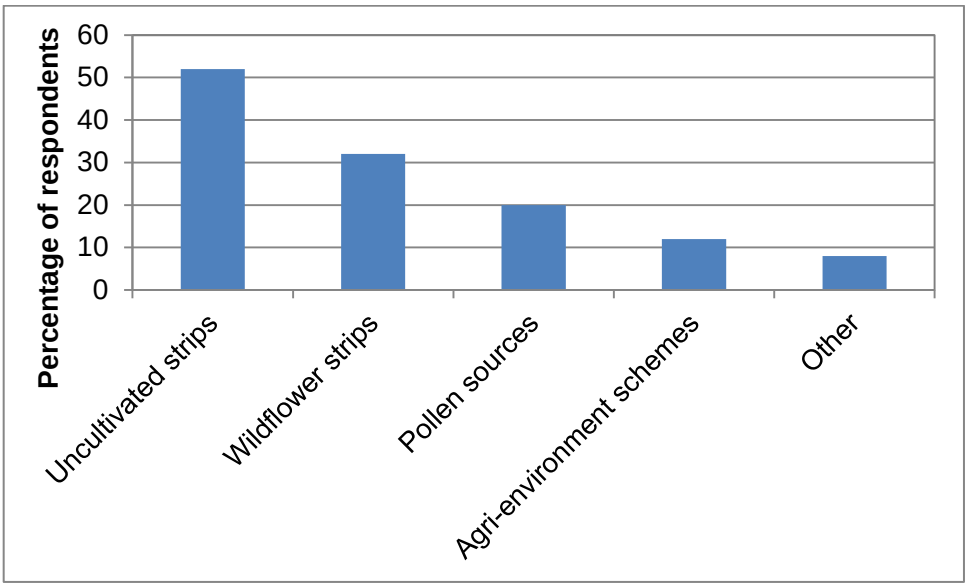


Figure 45 Methods for protecting and enhancing beneficial organism populations (percentage of respondents)



Note: 'other' includes habitat refuges and beetle banks

Pest monitoring

In IPM pests are monitored to determine whether control is economically justified and to be able to effectively target control options. IPM programs aim to monitor and identify pests, so that appropriate control decisions can be made in conjunction with action thresholds. Table 49 presents an overview of the pest monitoring measures adopted by the growers surveyed.

Ninety six per cent of growers regularly monitored crop growth stages and also monitored and identified pests on their crops. Most growers (88 per cent) also used action thresholds when monitoring pest populations. Pest monitoring was by conducted primarily by agronomist inspection (84 per cent) but also by trapping (40 per cent) and by self-inspection (28 per cent). In addition, some growers used risk warnings and technical bulletins to assess pest pressure (Figure 46).

The majority of respondents (60 per cent) also used specialist diagnostics when dealing with pests that were more problematic to identify or monitor Over half 52 per cent used tissue testing to monitor nutritional deficiencies, 44 per cent used field or pest mapping and 24 per cent used clinic services to identify unknown pests (Figure 47).

Table 49 Summary of responses to pest monitoring questions

Pest monitoring activity	Percentage yes response
Setting action thresholds for crops	88
Monitor and identify pests	96
Use of specialist diagnostics	60
Regular monitoring of crop growth stage	96

Figure 46 Methods of monitoring and identifying pests (percentage of respondents)

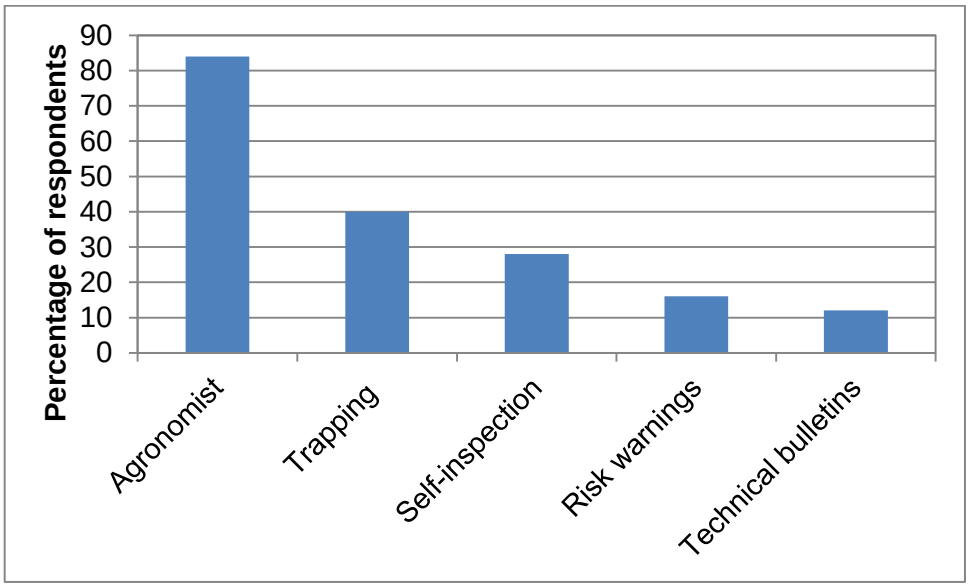
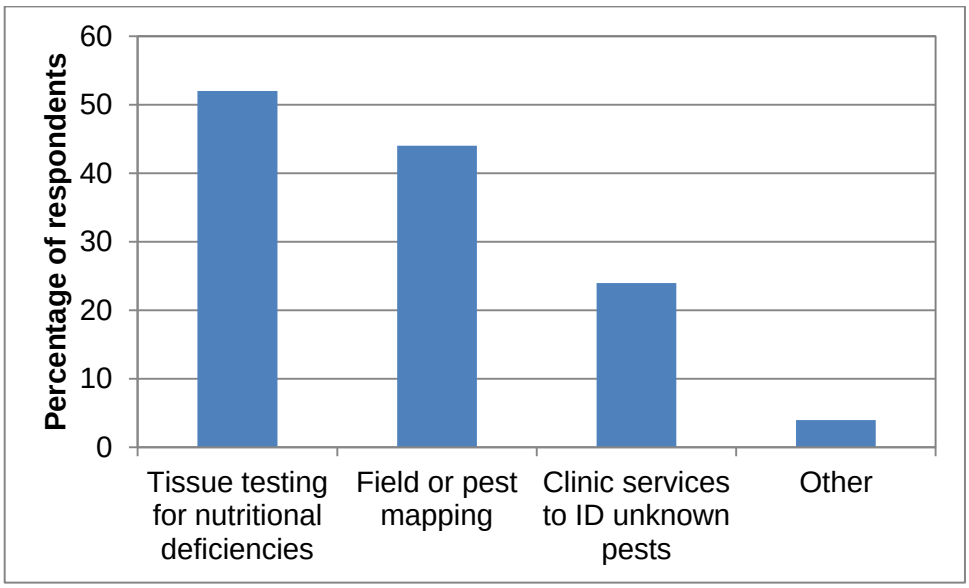


Figure 47 Use of specialist diagnostics (percentage of respondents)



Note: 'other' includes testing for chlorophyll levels

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 50 presents an overview of the pest control measures adopted by the growers surveyed.

The majority of growers (76 per cent) used non-chemical control in partnership or instead of chemical control. A range of control methods were adopted, including use of physical control measures such as using netting (48 per cent), fleece (16 per cent) and mulches (4 per cent) to prevent pest access to the crop and utilising mechanical weeding (36 per cent) as well has chemical control (Figure 48). Some growers (8 per cent) also used biological control methods.

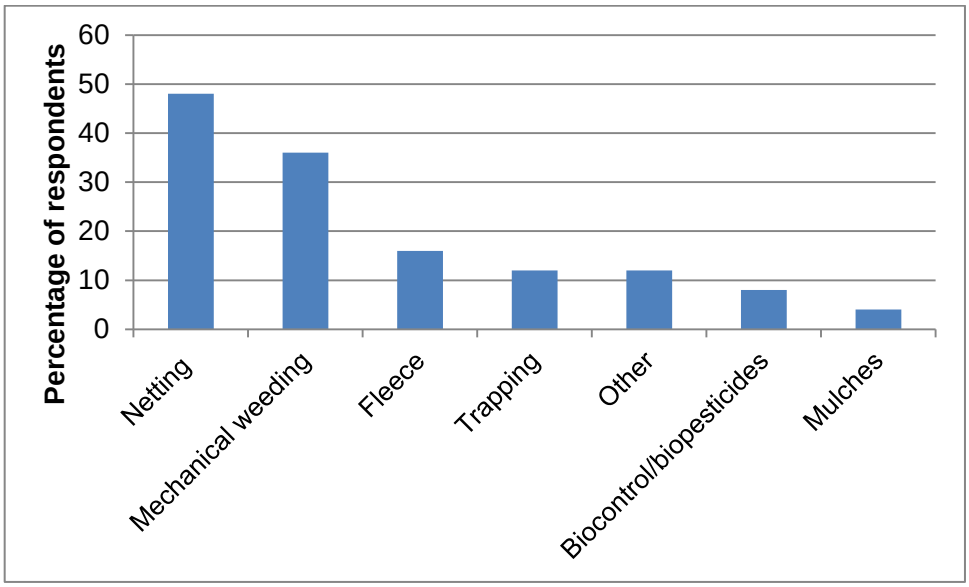
Seventy six per cent of growers stated that they targeted their pesticide applications using monitoring data. Forty per cent reduced their dosage or frequency of applications where possible, 36 per cent used weed wiping, 20 per cent used spot treatments and 32 per cent used precision application to reduce use (Figure 49). In addition, 80 per cent of growers stated that they followed anti-resistance strategies. These included 60 per cent both minimising the number of applications and using pesticides with multiple modes of action and 28 percent using pesticides with multi-site modes of action (Figure 50).

All respondents stated that they monitored the success of their crop protection measures. The methods used included 84 per cent having a regular review by their agronomist, 32 per cent had a seasonal review of practice and 28 per cent used regular self-inspection. Growers also investigated poor pesticide efficacy, used traps to investigate the success of their control methods and received feedback on crop quality from processors and packers (Figure 51).

Table 50 Summary of responses to pest control questions

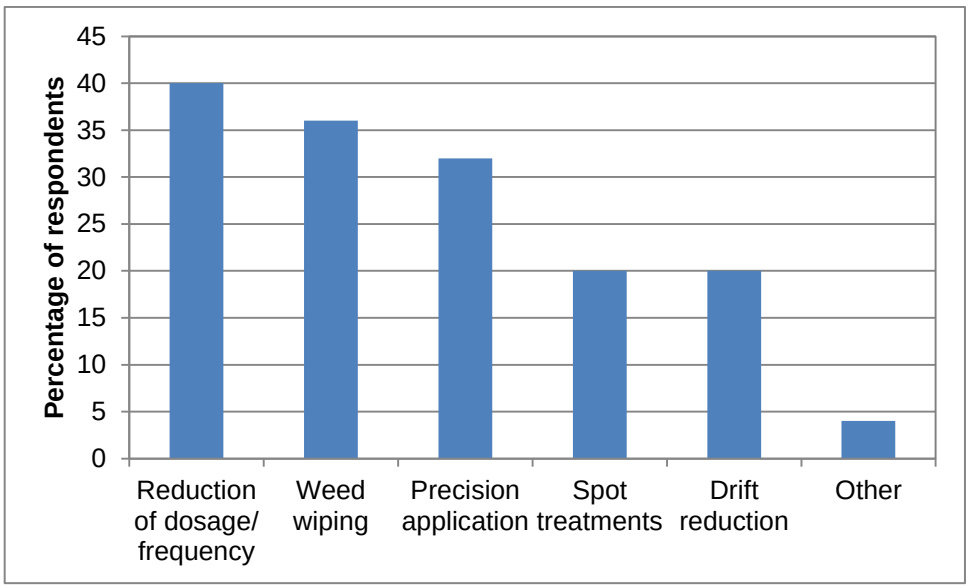
Pest control activity	Percentage yes response
Non-chemical control used in partnership or instead of chemical control	76
Targeted pesticide application	76
Follow anti-resistance strategies	80
Monitor success of crop protection measures	100

Figure 48 Types of non-chemical control used (percentage of respondents)



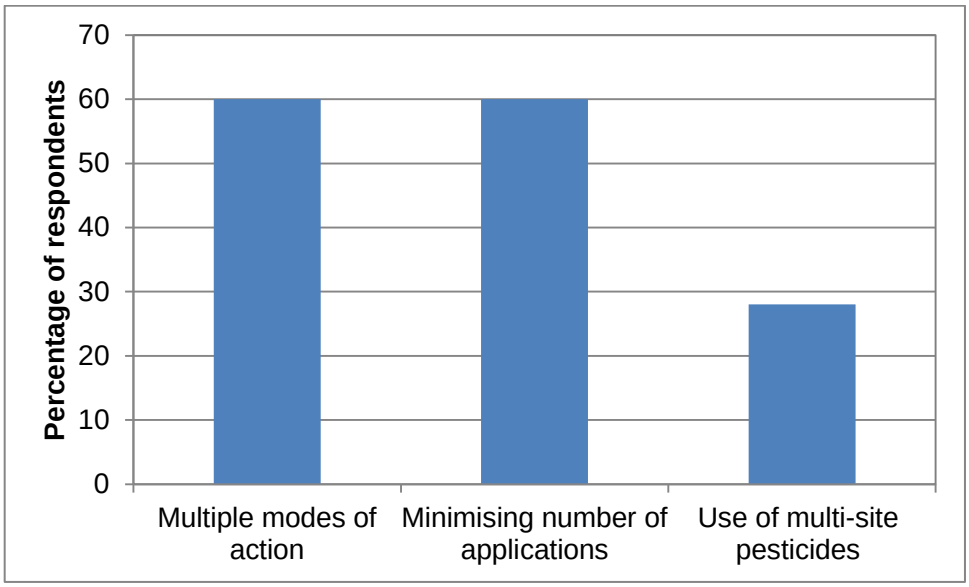
Note: 'other' includes physical controls such as garlic, salt water and vinegar.

Figure 49 Methods of targeting pesticide applications using monitoring data (percentage of respondents)



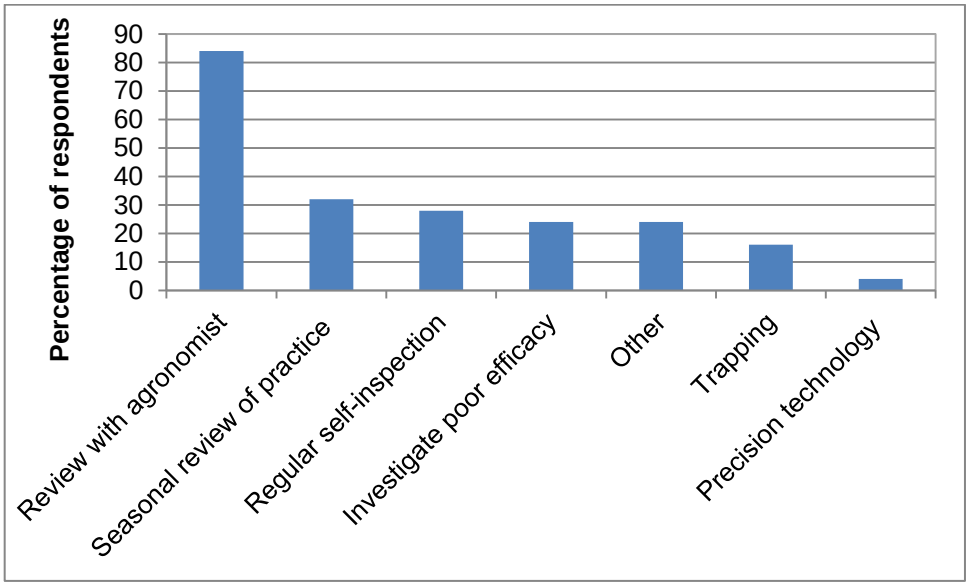
Note: 'other' includes cultivating weeds inter-row.

Figure 50 Types of anti-resistance strategies (percentage of respondents)



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

Figure 51 Methods for monitoring success of crop protection measures (percentage of respondents)



Note: 'other' includes feedback from processors and packers.

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Correspondence and enquiries

For enquiries about this publication please contact:
Gillian Reay,
Science and Advice for Scottish Agriculture (SASA),
Telephone: 0131 244 8808,
e-mail: psu@sasa.gsi.gov.uk

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