

### Samples Received

The testing service screened 142 samples in 2019. This was a smaller number than every year since 2011 when only 62 samples were received. This included 48 samples supplied by the Stirlings to Coast farmer group, without these this would have been only the second year since 1997 with less than 100 samples received.

As is always the case the majority of these samples were annual ryegrass (97) with samples of wild oats, wild radish and sow thistle also received (Table 1). Despite collected numerous sow thistle samples in the resistance surveys this was the first year a sow thistle sample was received for testing. For the first year since 2012 no barley grass or brome grass samples were received.

Table 1: Total number of samples received since 2016

	2016	2017	2018	2019
Annual ryegrass	152	438	115	97
Wild oats	37	31	37	23
Wild radish	41	22	13	21
Brome grass	1	2	3	0
Barley grass	4	0	2	0
Sow thistle	0	0	0	1
Total	235	496	171	142

### Summary of Results

The results obtained from the 2019 resistance screening are similar in the majority of cases to the results from previous years.

#### Annual ryegrass

This year, 97 annual ryegrass samples were received, of which 88 were tested to five or more herbicides (Table 2). However, none of these were tested to the standard cross-resistance test (Hoegrass, Select, Glean, simazine and trifluralin). The most commonly requested herbicide for testing was Roundup, requested for all but one sample, followed by Select (90 samples) and trifluralin (88 samples). Thirty seven samples were also tested to a sixth herbicide, 39 to seven and one sample was tested to 11 herbicides.

Ninety four percent of all samples tested to a 'fop' herbicide were classed as either resistant or developing resistance to that herbicide (Table 3). This is similar to that of most previous years. As in the previous two years, many samples were not

tested to the 'fop' or Group B herbicides unless specifically requested by the client (Table 2).

Table 2: Number of samples tested to each of seven herbicide groups

	2015	2016	2017	2018	2019
A (fops)	61	46	63	41	16
A (dims)	480	201	259	131	137
A (dens)	45	30	336	32	7
B	99	93	104	81	25
C	394	143	117	83	46
D	396	181	414	107	104
L	312	91	356	31	53
M	393	140	159	109	96

Twenty six percent of samples tested to a 'dim' herbicide were resistant, similar to most previous years (Table 3). The samples screened to 'dim' herbicides were screened to Select, Achieve and/or Factor. As is usually the case the proportion of samples resistant to Select and Factor was much lower than for the other 'dim' herbicides tested. This year 21% of samples were resistant to Select and 19% to Factor, compared to 90% to Achieve (Table 5).

Table 3: Percentage of samples resistant or developing resistance to each herbicide groups

	2015	2016	2017	2018	2019
A (fops)	97	87	75	92	94
A (dims)	24	15	20	40	26
A (dens)	84	55	75	94	100
B	84	92	85	84	68
C	0	4	0	0	2
D	5	6	9	24	5

All seven samples screened to Axial were resistant, higher than all previous years.

Sixty eight percent of samples were resistant to Group B herbicides, a lower than the previous four years. This may be the result of those clients from areas with a higher incidence of resistance requesting changes to the standard test to look for susceptible options and dropping the 'fop' and Group B test whereas clients from areas with lower resistance incidence are still confirming if the herbicides are still effective.

One sample was developing resistance to atrazine or simazine (Group C), and 5% were resistant to trifluralin. After last year's higher than normal the extent of trifluralin resistance returned to a similar level as previous years (Table 3).

## Cross and Multiple Resistance

Eighty eight were screened to five or more herbicides with 86 of these screened to five or more herbicide groups. However, as many clients are now customising the testing to suit their circumstances only seven samples were sprayed to the five standard selective herbicide groups ('fop', 'dim', B, C and D). Of these seven two were resistant to three groups, three to two groups and two to one group (Table 4).

Table 4: Results of cross resistance screening showing percentage of samples tested to the five standard herbicide groups resistant or developing resistance to the different groups.

No. of groups	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)
5	0	0	0	0	0
4	0	0	0	21.0	0
3	37.7	15.9	25.6	47.4	28.6
2	52.8	54.5	46.2	15.8	42.8
1	7.5	25.0	25.6	15.8	28.6
0	1.9	4.5	2.6	0	0
No. of samples	53	44	39	19	7

Eleven samples were screened to less than five herbicide groups, eight of these were susceptible to all tested groups while the other three could not be screened due to negligible germination.

Of the remaining 79 samples 36 (45.5%) were susceptible to all herbicide groups. Twelve (15.2%) samples were resistant to only one group while 18 (22.7%) were resistant to two, ten (12.7%) to three groups, two (2.5%) to four and one sample was resistant to five herbicide groups, this sample was tested to seven groups and was resistant to Group A 'fop', 'dim', B, D and J herbicides.

The level of cross and/or multiple resistance is much lower in these samples as in most cases the herbicide groups not tested are the A 'fops' and/or B. These groups have the highest level of resistance (Table 3) suggesting that the farmers or their agronomists are acknowledging these populations are resistant to these groups and are investigating the susceptibility of alternative herbicide groups. With only 11 of the 88 samples that were screened to five herbicide groups tested to both 'fop' and B herbicides, it is probable that some of the other 77 samples would be resistant to an additional one or two herbicide groups.

## Herbicide Groups

Among all samples there were major differences between the various groups and in some cases within the different herbicide groups.

## Group A herbicides

While Select and Factor were the main herbicides tested, samples were also screened to Hoegrass, Topik and Achieve (Table 5). Two samples were also tested to Decision (a 'fop' and 'dim' mix).

Table 5: Results for ryegrass samples showing percentage resistant (Res) or developing resistance (DR) to individual Group A herbicides.

	Tested	Res	DR	%	Susc
<i>'fops'</i>					
Hoegrass	12	10	1	<b>91</b>	1
Topik	4	4	0	<b>100</b>	0
<i>'dims'</i>					
Select	90	10	9	<b>21</b>	71
Achieve	10	7	2	<b>90</b>	1
Factor	37	5	2	<b>19</b>	30
<i>'fop' &amp; 'dim'</i>					
Decision	2	0	0	<b>0</b>	2
<i>'den'</i>					
Axial	7	7	0	<b>100</b>	0

## Group B herbicides

While most of the samples screened to Group B herbicides were screened Glean or Intervix, samples were also screened to Logran, Atlantis and Hussar (Table 6).

Table 6: Results for ryegrass samples screened to individual Group B herbicides

	Tested	Res	DR	%	Susc
<i>Sulfonylureas</i>					
Glean	8	1	3	<b>50</b>	4
Logran	3	0	0	<b>0</b>	3
Atlantis	1	1	0	<b>100</b>	0
Hussar	1	0	0	<b>100</b>	0
<i>Imidazolinones</i>					
Intervix	12	10	1	<b>92</b>	1

## Other herbicides

Annual ryegrass samples were screened to ten other herbicides, simazine, atrazine, trifluralin, Kerb, Avadex Xtra, Arcade, Boxer Gold, Sakura, Roundup and Gramoxone. The observed incidence of resistance to these herbicides was lower than the resistance to the higher risk Group A and B herbicides (Table 7).

Nineteen of the 93 samples tested to Roundup (3 samples could not be tested due to negligible germination) were found to be resistant or developing resistance. This adds to the more than 350 confirmed cases of annual ryegrass resistance to Roundup in Australia and this herbicide needs to be treated carefully due to its importance in Australian

agriculture. No samples were found to be resistant to Gramoxone this year (Table 7). For the first time some samples (three) were assessed as developing resistance to Avadex Xtra, these samples while not showing the same level of increased growth as the trifluralin resistant samples had grown differently to the other samples tested to Avadex Xtra.

Table 7: Results for ryegrass samples screened to other herbicide groups.

	Tested	Res	DR	%	Susc
<i>Group C</i>					
Simazine	8	0	1	<b>13</b>	7
Atrazine	38	0	0	<b>0</b>	38
<i>Group D</i>					
Trifluralin	88	2	3	<b>6</b>	83
Kerb	16	0	0	<b>0</b>	16
<i>Group J</i>					
Avadex Xtra	8	0	3	<b>38</b>	5
Arcade	21	0	0	<b>0</b>	21
<i>Group J/K</i>					
Boxer Gold	49	0	0	<b>0</b>	49
<i>Group K</i>					
Sakura	16	0	0	<b>0</b>	16
<i>Group L</i>					
Gramoxone	53	0	0	<b>0</b>	53
<i>Group M</i>					
Roundup	93	14	5	<b>20</b>	74

#### State by State

Western Australia and New South Wales supplied the most samples with samples also received from Victoria and South Australia (Table 8). The larger number of samples from Victoria and South Australia in 2017 was the result of the Syngenta Boxer Gold stewardship package with only two and five samples respectively from these states this year. The lower number of samples from New South Wales is an indication of the drought conditions experienced across that state in 2018.

Table 8: Number of ryegrass samples received from each state.

	2015	2016	2017	2018	2019
NSW	83	30	109	52	21
Vic	1	2	65	3	2
SA	1	0	70	1	5
WA	323	115	188	56	69
Tas	0	5	6	3	0

With only limited samples received from each of Victoria and Tasmania only the data for New South Wales and Western Australia has been analysed separately (Figure 1).

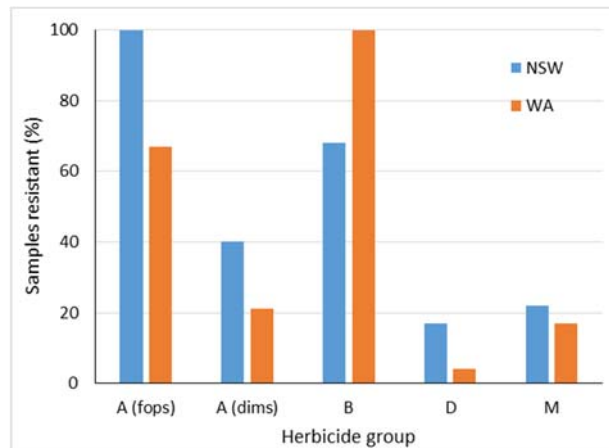


Figure 1: Percentage of ryegrass samples resistant and developing resistance for NSW and WA

#### Wild Oats

The number of wild oat samples (23) received was lower than previous years due in part to the decrease in total samples received. On a percentage basis the number of samples was slightly higher than the overall average of 12.6% (Table 9). As normally occurs the vast majority of wild oat samples (21) were received from New South Wales with one sample from each of Western Australia and Queensland.

Table 9: Number of wild oat samples received and percentage of total samples

	2015	2016	2017	2018	2019
Total	558	235	498	170	142
Wild oats	58	37	31	37	23
Percentage	10.4	15.7	6.2	21.8	16.2

The level of 'fop' resistance among the samples was 78%, similar to previous years (Table 10). Fifteen samples were tested to Topik (12 resistant) and three to Verdict (2 resistant).

For the 'dim' herbicides, two of 20 samples tested to Select were developing resistance while two out of three were resistant to Achieve. Fourteen samples were tested to Axial with five of these resistant (Table 10).

Twenty three samples were tested to Atlantis with one developing resistance while no samples were resistant to Intervix (4 tested).

Ten samples were tested to Mataven (Group Z), with two resistant and one developing resistance (Table 10). All samples tested to Avadex (16), Boxer Gold (1) or Roundup (6) were susceptible.

Table 10: Percentage of wild oat samples found to be resistant since 2016 (number tested in brackets)

	2016	2017	2018	2019
	% (no.)	% (no.)	% (no.)	% (no.)
'fops'	78 (37)	75 (28)	76 (29)	78 (18)
'dims'	6 (35)	9 (33)	6 (34)	18 (23)
'dens'	16 (25)	17 (23)	36 (25)	36 (14)
B	21 (33)	11 (27)	9 (36)	4 (27)
Z	43 (7)	17 (6)	6 (18)	30 (10)

#### Broadleaf species

Twenty one wild radish samples were provided for resistance screening with all of these coming from Western Australia.

Of the wild radish samples only 21% of samples were resistant to Group B herbicides with three screened to Glean (all resistant) and 16 to Intervix (1 resistant) (Table 11). A significant level of resistance was also found to the Group I herbicides with samples resistant to 2,4-D Amine (4/19), Ester 680 (1/2) and MCPA LVE 570 (1/2).

Ninety percent of the samples were resistant to Brodal (20 tested) and 11% to atrazine (19 tested). No samples were resistant to bromoxynil (16), Jaguar (2) or Roundup (19) as developing resistance (Table 11).

Table 11: Percentage of wild radish samples found to be resistant since 2015 (number tested in brackets)

	2016	2017	2018	2019
	% (no.)	% (no.)	% (no.)	% (no.)
B	47 (41)	80 (12)	38 (8)	21 (19)
C	7 (72)	25 (28)	16 (18)	6 (35)
F	60 (40)	78 (22)	33 (12)	90 (20)
I	8 (40)	59 (22)	53 (15)	26 (23)
M	0 (38)	0 (20)	0 (10)	0 (19)

#### Other species

The only other species received this year was one sow thistle sample. This sample was resistant to the Group B SU herbicide metsulfuron but susceptible to atrazine, 2,4-D amine and Roundup.

#### **Final Observations**

- NSW and WA supplied the most annual ryegrass samples, with wild oats mainly received from NSW and wild radish from WA.
- For ryegrass samples the level of resistance remained similar to previous years for the major herbicide groups. Resistance levels to 'fops' which were slightly lower last year returned to a similar level to the years before last year.
- Several samples were classified as developing resistance to Avadex Xtra for the first time
- Wild oat resistance for all groups was within the range experienced in previous years.
- Wild radish samples were resistant to four herbicide groups (B, C, F and I), the same as the last two years.

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Testing forms and annual reports are available at:

<http://www.csu.edu.au/research/grahamcentre/>

and click on Herbicide Resistance in the Quicklinks box

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