

Samples Received

The testing service screened 496 samples in 2017. This was a similar number to 2014 and 2015 and over double what was received in 2016 making it the sixth most samples received annually since the service commenced in 1991. The majority of samples (340 or 69%) were provided as part of the Syngenta Boxer Gold stewardship program while the Stirlings to Coast Farmer Group provided 18 samples for a total of 120 samples over three years.

As is always the case the majority of these samples were annual ryegrass (438) with samples of wild oats, wild radish, sow thistle, brome grass and phalaris also received (Table 1).

Table 1: Total number of samples received since 2014

	2014	2015	2016	2017
Annual ryegrass	462	408	152	438
Wild oats	58	58	37	31
Wild radish	128	89	41	22
Brome grass	5	2	1	2
Others	2	1	4	3
Total	655	558	235	496

Summary of Results

The results obtained from the 2017 resistance screening are similar in the majority of cases to the results from previous years.

Annual ryegrass

This year, 438 annual ryegrass samples were received, of which 426 were tested to five or more herbicides (Table 2). However, only one of these were tested to the standard cross-resistance test (Groups A 'fop', A 'dim', B, C and D). Of the remaining 437 samples, 338 were received through Syngenta's Boxer Gold stewardship package. As a standard these samples had four herbicides substituted from the standard resistance test (all but Group D) but some also had requested the testing of additional herbicides. Roundup was the most commonly requested additional herbicide, with 161 samples tested to it. Select was also requested for testing in 92 of the Boxer Gold stewardship test in which it was not a standard herbicide. Eighty four samples were also tested to a sixth herbicide, 63 to seven, 23 to eight, 19 to nine, 3 to 10 herbicides and two samples were tested to 11 herbicides.

Seventy five percent of all samples tested to a 'fop' herbicide were classed as either resistant or developing resistance to that herbicide (Table 3). This is lower than experienced in most previous years. The most likely reason for this is that 19 of the samples (30%) tested to a 'fop' herbicide were provided as part of the Boxer Gold stewardship testing and may have come from a region of lower resistance incidence and provided samples to meet the contractual obligations. Additionally with many clients requesting changes to the standard test those from areas with a higher incidence of resistance may be using the testing to look for susceptible options and are dropping the 'fop' test whereas clients from areas with lower resistance incidence are still confirming if the herbicides are still effective.

As in the previous two years many samples were not tested to the 'fop' or Group B herbicides unless specifically requested by the client, these two herbicide groups were not included in the Boxer Gold stewardship testing.

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

	2013	2014	2015	2016	2017
A (fops)	190	123	61	46	63
A (dims)	255	552	480	201	259
A (dens)	43	33	45	30	336
B	190	127	99	93	104
C	190	452	394	143	117
D	212	729	396	181	414
L	1	65	312	91	356
M	167	403	393	140	159

Twenty percent of samples tested to a 'dim' herbicide within the range of previous years (Table 3). The samples screened to 'dim' herbicides were screened to Select, Achieve and/or Factor with a higher proportion of samples screened to Achieve than some of the previous years. This year 16% of 'dim' tests were to Achieve. Last year only 11 (6%) of the 199 'dim' tests were to a herbicide other than Select or Factor. The proportion of samples resistant to Select and Factor is always much lower than for most of the other 'dim' herbicides. This year 13% of samples were resistant to Select and none to Factor, compared to 68% to Achieve (Table 5). Of the 336 samples screened to Axial 75% were resistant or developing resistance, similar to most previous years.

Eighty five percent of samples were resistant to Group B herbicides, a similar level to the previous four years. No samples were developing resistance to atrazine or simazine (Group C), and 9% were resistant to trifluralin (Group D slightly higher than

the last few years possibly due to more samples from Victoria and South Australia (Table 3).

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

	2013	2014	2015	2016	2017
A (fops)	90	84	97	87	75
A (dims)	12	14	24	15	20
A (dens)	84	69	84	55	75
B	93	70	84	92	85
C	0	0.4	0	4	0
D	3	2	5	6	9

Cross and Multiple Resistance

Of the 424 samples screened to five or more herbicides 417 were screened to five or more herbicide groups. However with the majority of these samples received as part of the Syngenta Boxer Gold stewardship program only 39 samples were sprayed to the five standard selective herbicide groups ('fop', 'dim', B, C and D). The Syngenta Boxer Gold stewardship program samples were screened to Groups 'den', D, J/K, K and L plus additional tests as requested by the client.

The proportion of samples resistant to zero, one, two or three herbicide groups was within the range experienced in previous years (Table 4).

As stated previously many samples were not tested to all five of the standard groups with 396 tested to between one and four of the selective herbicide groups (1 group – 5; 2 groups – 230; 3 groups 61; 4 groups – 100), of these 111 (25.52%) were susceptible to all groups and 212 (48.7%) were resistant to one group. Eighty eight samples were resistant to two groups and 24 to three groups and one sample was resistant to all four selective groups to which it was tested (A 'fop', A 'dim' B and D).

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	2013 (%)	2014 (%)	2015 (%)	2016 (%)	2017 (%)
5	0	0	0	0	0
4	0.5	0	0	0	0
3	10.8	11.1	37.7	15.9	25.6
2	68.6	50.0	52.8	54.5	46.2
1	16.8	28.6	7.5	25.0	25.6
0	3.2	10.3	1.9	4.5	2.6
No. of samples	185	126	53	44	39

With only 39 of the 417 samples that were screened to five herbicide groups tested to both 'fop' and B herbicides, it is probable that some of the other 378

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 Axial and Select were the main herbicides tested, samples were also screened to Hoegrass, Verdict, Topik Achieve, and Factor (Table 5).

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	44	33	3	75	8
Verdict	18	9	2	61	7
Topik	1	0	0	0	1
<i>'dims'</i>					
Select	194	9	16	13	169
Achieve	41	23	5	68	13
Factor	24	0	0	0	24
<i>'den'</i>					
Axial	336	215	37	75	84

Group B herbicides

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

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

	Tested	Res	DR	%	Susc
<i>Sulfonylureas</i>					
Glean	37	23	8	84	6
Logran	10	9	1	100	0
Hussar	11	8	3	100	0
<i>Imidazolinones</i>					
Intervix	35	22	7	83	6
<i>Sulfonamides</i>					
Crusader	11	6	2	73	3

Other herbicides

Annual ryegrass samples were screened to nine other herbicides, simazine, atrazine, trifluralin, Kerb, Avadex Xtra, Boxer Gold, Dual 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).

Twenty five of the 159 samples were found to be resistant or developing resistance to Roundup. 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. Also two samples were found to be resistant to Gramoxone (Table 7).

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

	Tested	Res	DR	%	Susc
<i>Group C</i>					
Simazine	39	0	0	0	39
Atrazine	78	0	0	0	78
<i>Group D</i>					
Trifluralin	414	25	12	9	377
<u>Kerb</u>	5	0	0	0	5
<i>Group J</i>					
Avadex Xtra	7	0	0	0	7
<i>Group J/K</i>					
Boxer Gold	357	0	0	0	357
<i>Group K</i>					
Sakura	338	0	0	0	338
Dual Gold	1	0	0	0	1
<i>Group L</i>					
Gramoxone	356	2	0	1	354
<i>Group M</i>					
Roundup	159	18	7	16	134

State by State

Western Australia and New South Wales supplied the most samples with significant numbers also received from Victoria and South Australia with a small number of samples received from Tasmania (Table 8). The increase in numbers from Victoria and South Australia is the result of the Syngenta Boxer Gold stewardship package with only three samples from each of these states supplied outside of this program.

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

	2013	2014	2015	2016	2017
NSW	93	88	83	30	109
Vic	7	1	1	2	65
SA	0	1	1	0	70
WA	126	371	323	115	188
Tas	10	1	0	5	6

With only limited samples received from and Tasmania limited 'fop' tests conducted from South Australian and Victorian samples data have only been presented where greater than 15 samples were tested for that group from the state. (Figure 1).

Similar results were found for samples from all states except for Group A 'dims' and D. Samples from South Australia had the highest incidence of Group D and lowest 'dim' resistance with New South Wales having the reverse, lowest (0%) Group D resistance and highest 'dim' resistance. For these herbicide groups the incidence recorded for Western Australian and Victorian samples was midway between the other two states (Figure 1).

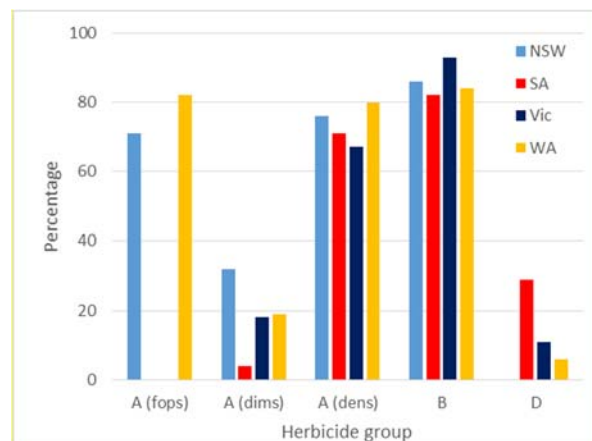


Figure 1: Percentage of ryegrass samples resistant and developing resistance for the different states (no data for SA and Vic for A 'fops')

Wild Oats

The number of wild oat samples (31) received was slightly lower than last year. On a percentage basis the number of samples was lower than most previous years (Table 9). All but one of the wild oat samples came from New South Wales, the other sample was received from Victoria.

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

	2013	2014	2015	2016	2017
Total	305	655	558	235	498
Wild oats	51	58	58	37	31
Percentage	16.7	8.8	10.4	15.7	6.2

The level of 'fop' resistance among the samples was 75%, similar to previous years (Table 10). Twenty samples were tested to Topik (16 resistant), 7 to Verdict (4 resistant) and one to Hoegrass (resistant).

For the 'dim' herbicides, one of 27 samples tested was developing resistance to Select and two out of six were resistant to Achieve. Twenty three samples were tested to Axial with four of these resistant (Table 10).

Nineteen samples were tested to Atlantis with two resistant and three tested to Crusader with one resistant while no samples were resistant to Intervix (5 tested). Six samples were tested to Mataven

(Group Z), with one resistant (Table 10). All samples tested to Avadex (14), trifluralin (7), Boxer Gold (7), Sakura (7), Roundup (5) or atrazine (5) were susceptible.

Table 10: Percentage of wild oat samples found to be resistant since 2014 (number tested in brackets)

	2014	2015	2016	2017
	% (no.)	% (no.)	% (no.)	% (no.)
'fops'	78 (53)	69 (55)	78 (37)	75 (28)
'dims'	10 (61)	2 (56)	6 (35)	9 (33)
'dens'	47 (30)	27 (29)	16 (25)	17 (23)
B	20 (54)	8 (51)	21 (33)	11 (27)
Z	11 (9)	47 (15)	43 (7)	17 (6)

Broadleaf species

Twenty two wild radish samples were provided for resistance screening with 21 coming from Western Australia one from New South. The two sow thistle samples both came from New South Wales.

Of the wild radish samples 80% of samples were resistant to Group B herbicides with seven screened to Glean (6 resistant) two to Logran (1 resistant), six to Intervix (5 resistant) (Table 11). A significant level of resistance was also found to Brodal (17/22). Resistant samples were also found to atrazine (1/22), MCPA Amine (7/10) and Ester 680 (6/8), while no samples were found to be resistant to Velocity (2), Jaguar (1), 24D Amine (3), MCPA LVE 570 (1) or Roundup (20) (Table 11).

All six samples screened to bromoxynil were classed as resistant. These were not retested but last year after a number of resistant were retested under colder weather conditions many of these samples were controlled by the herbicide suggesting a possible link between control and temperature (Table 11).

Both sow thistle samples were resistant to Glean but susceptible to atrazine, 24D Amine and Roundup.

Table 11: Percentage of wild radish samples found to be resistant since 2013 (number tested in brackets)

	2014	2015	2016	2017
	% (no.)	% (no.)	% (no.)	% (no.)
B	88 (130)	67 (15)	47 (41)	80 (12)
C	11 (158)	0 (27)	7 (72)	25 (28)
F	46 (128)	20 (84)	60 (40)	78 (22)
I	16 (129)	5 (91)	8 (40)	59 (22)
M	0 (122)	0 (86)	0 (38)	0 (20)

Other species

Two brome grass samples (Victoria and WA) and one phalaris sample (NSW), were received this year. One brome grass sample was screened to Gramoxone (susceptible) while the other was found to be susceptible to Elantra Xtreme, Intervix, Monza

and Roundup. The phalaris sample was resistant to Verdict but susceptible to Select, Axial, Logran and Roundup.

Final Observations

- NSW and WA supplied the most annual ryegrass samples although a significant number of samples were also received from Victoria and SA, with wild oats mainly received from NSW and wild radish from WA.
- For ryegrass samples the level of resistance remained similar to last year for all herbicide groups with the exception of the 'fops' which were slightly lower.
- Wild oat resistance for all groups was within the range experienced in previous years.
- Wild radish samples were resistant to three herbicide groups (B, C, F and I) compared to three last year, and four in 2014. In Group C samples were resistant to both atrazine and bromoxynil.

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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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