2018 Herbicide Resistance Testing Service Report

Samples Received

The testing service screened 170 samples in 2018. This was a smaller number than every year since 2011 when only 62 samples were received. A major reason for this decline was that there were no samples supplied as part of a farmer group monitoring program or a company sponsorship, unlike many of the last few years.

As is always the case the majority of these samples were annual ryegrass (115) with samples of wild oats, wild radish, brome grass and barley grass also received (Table 1).

Table 1: Total number of samples received since 2014

	2015	2016	2017	2018
Annual ryegrass	408	152	438	115
Wild oats	58	37	31	37
Wild radish	89	41	22	13
Brome grass	2	1	2	3
Barley grass	0	4	0	2
Total	558	235	496	171

Summary of Results

The results obtained from the 2018 resistance screening are similar in the majority of cases to the results from previous years.

Annual ryegrass

This year, 115 annual ryegrass samples were received, of which 110 were tested to five or more herbicides (Table 2). However, only two of these were tested to the standard cross-resistance test (Hoegrass, Select, Glean, simazine and trifluralin). Roundup was the most commonly requested non-standard herbicide, with 111 samples tested to it, either as an alternative herbicide or an additional herbicide. Forty nine samples were also tested to a sixth herbicide, nine to seven, 10 to eight, three to nine, and one sample was tested to 12 herbicides.

Ninety two percent of all samples tested to a 'fop' herbicide were classed as either resistant or developing resistance to that herbicide (Table 3). This is higher than last year but similar to that of most years before then. Last year 30% of the samples 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.

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

	2014	2015	2016	2017	2018
A (fops)	123	61	46	63	41
A (dims)	552	480	201	259	131
A (dens)	33	45	30	336	32
B	127	99	93	104	81
C	452	394	143	117	83
D	729	396	181	414	107
L	65	312	91	356	31
M	403	393	140	159	109

Forty percent of samples tested to a 'dim' herbicide were resistant, much higher than 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 35% of samples were resistant to Select (double that of last year) and none to Factor, compared to 100% to Achieve (Table 5). The higher level of resistance to Select may be the result of all samples being provided to confirm their resistance status and none provided as part of a company sponsorship or farmer group monitoring program.

Of the 32 samples screened to Axial, 94% were resistant or developing resistance, higher than most previous years.

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

	2014	2015	2016	2017	2018
A (fops)	84	97	87	75	92
A (dims)	14	24	15	20	40
A (dens)	69	84	55	75	94
B	70	84	92	85	84
C	0.4	0	4	0	0
D	2	5	6	9	24

Eighty four 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 24% were

resistant to trifluralin. The level of trifluralin resistance was also higher than previous years possibly for the same reason as the increase observed in the proportion of samples resistant to Select (Table 3).

Cross and Multiple Resistance

One hundred and ten samples were screened to five or more herbicides with 98 of these screened to five or more herbicide groups. However, as many clients are now customising the testing to suit their circumstances only 19 samples were sprayed to the five standard selective herbicide groups ('fop', 'dim', B, C and D).

This year there was an increase in the proportion of samples that were resistant to three or four standard groups rather than one or two. For the first time since 2011 no sample tested to the five standard groups was susceptible to all of these groups (Table 4).

As stated previously many samples were not tested to all five of the standard groups with 96 tested to between one and four of the selective herbicide groups (1 group – 2; 2 groups – 14; 3 groups 29; 4 groups – 51). Of these 18 (18.75%) were susceptible to all tested groups and 40 (41.67%) were resistant to one group. Thirty one samples were resistant to two groups and 7 to three groups.

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	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)
5	0	0	0	0	0
4	0	0	0	0	21.0
3	11.1	37.7	15.9	25.6	47.4
2	50.0	52.8	54.5	46.2	15.8
1	28.6	7.5	25.0	25.6	15.8
0	10.3	1.9	4.5	2.6	0
No. of samples	126	53	44	39	19

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 31 of the 98 samples that were screened to five herbicide groups tested to both 'fop' and B herbicides, it is probable that some of the other 67 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, Elantra Xtreme, Achieve, and Factor (Table 5). Seven 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
'fops'					
Hoegrass	21	19	0	**90**	2
Verdict	9	8	0	**89**	1
Topik	9	8	1	**100**	0
Elantra Xtreme	2	2	0	**100**	0
'dims'					
Select	112	26	13	**35**	73
Achieve	13	13	0	**100**	0
Factor	6	0	0	**0**	6
'fop' & 'dim'					
Decision	7	6	1	**100**	0
'den'					
Axial	32	28	2	**94**	2

Group B herbicides

While most of the samples screened to Group B herbicides were screened Glean or Intervix, samples were also screened to Logran and Hussar (Table 6). The proportion of resistant samples was similar for all four of these herbicides.

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

	Tested	Res	DR	%	Susc
Sulfonylureas					
Glean	18	14	1	**83**	3
Logran	30	19	6	**83**	5
Hussar	7	6	0	**86**	1
Imidazolinones					
Intervix	26	17	5	**85**	4

Other herbicides

Annual ryegrass samples were screened to twelve other herbicides, simazine, atrazine, Terbyne, diuron, 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).

Twenty six of the 109 samples tested to Roundup 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).

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

	Tested	Res	DR	%	Susc
Group C					
Simazine	19	0	0	**0**	19
Atrazine	64	0	0	**0**	64
Terbyne	1	0	0	**0**	1
Diuron	1	0	0	**0**	1
Group D					
Trifluralin	107	14	12	**24**	81
Kerb	5	0	0	**0**	5
Group J					
Avadex Xtra	3	0	0	**0**	3
Arcade	2	0	0	**0**	2
Group J/K					
Boxer Gold	20	0	0	**0**	20
Group K					
Sakura	18	0	0	**0**	18
Group L					
Gramoxone	31	0	0	**0**	31
Group M					
Roundup	109	19	7	**24**	83

State by State

Western Australia and New South Wales supplied the most samples with samples also received from Victoria, South Australia and Tasmania (Table 8). The large number of samples from Victoria and South Australia last year was the result of the Syngenta Boxer Gold stewardship package with only three samples from each of these states supplied outside of this program last year, similar to this year.

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

	2014	2015	2016	2017	2018
NSW	88	83	30	109	52
Vic	1	1	2	65	3
SA	1	1	0	70	1
WA	371	323	115	188	56
Tas	1	0	5	6	3

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).

Similar results were found for all herbicide groups from both states (Figure 1).

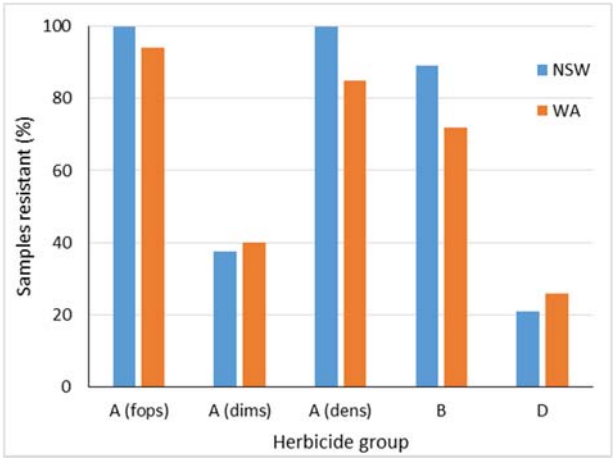

Figure 1: Percentage of ryegrass samples resistant and developing resistance for NSW and WA

Wild Oats

The number of wild oat samples (37) received was slightly higher than last year despite the major decrease in total samples received. On a percentage basis the number of samples was higher than all but two previous years since wild oats were first received in 1994 and well above the overall average of 12.5% (Table 9). As normally occurs the vast majority of wild oat samples (34) were received from New South Wales with two samples from Western Australia and one from South Australia.

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

	2014	2015	2016	2017	2018
Total	655	558	235	498	170
Wild oats	58	58	37	31	37
Percentage	8.8	10.4	15.7	6.2	21.8

The level of ‘fop’ resistance among the samples was 76%, similar to previous years (Table 10). Twenty four samples were tested to Topik (20 resistant) and 5 to Verdict (2 resistant).

For the 'dim' herbicides, none of 30 samples tested to Select were resistant while two out of four were resistant to Achieve. Twenty five samples were tested to Axial with nine of these resistant (Table 10).

Twenty one samples were tested to Atlantis with one resistant and one developing resistance. The only sample tested to Hussar was resistant while no samples were resistant to either Intervix (10 tested) or Crusader (4 tested).

Eighteen samples were tested to Mataven (Group Z), with one resistant (Table 10). All samples tested to Avadex (25) or Roundup (5) were susceptible.

Table 10: Percentage of wild oat samples found to be resistant since 2015 (number tested in brackets)

	2015 % (no.)	2016 % (no.)	2017 % (no.)	2018 % (no.)
'fops'	69 (55)	78 (37)	75 (28)	76 (29)
'dims'	2 (56)	6 (35)	9 (33)	6 (34)
'dens'	27 (29)	16 (25)	17 (23)	36 (25)
B	8 (51)	21 (33)	11 (27)	9 (36)
Z	47 (15)	43 (7)	17 (6)	6 (18)

Broadleaf species

Thirteen wild radish samples were provided for resistance screening with 12 coming from Western Australia and one from New South Wales.

Of the wild radish samples only 38% of samples were resistant to Group B herbicides with six screened to Logran (3 resistant) and two to Intervix (0 resistant) (Table 11). A significant level of resistance was also found to the Group I herbicides with samples resistant to MCPA Amine (5/9) 24D Amine (2/3) and Ester 680 (1/2). The only sample tested to MCPA LVE 570 was susceptible.

Of the four samples tested to bromoxynil three were classed as developing resistance. In previous years when a number of resistant samples were retested under colder weather conditions these samples were controlled by the herbicide suggesting a possible link between control and temperature. While these samples may not be resistant the differential response between, and within, samples to this herbicide in the warmer weather suggests some plants are more tolerant of this herbicide and this could lead to resistance developing in these populations if care is not taken with this herbicide. (Table 11).

Resistant samples were also found to Brodal (4/12), while no samples were found to be resistant to atrazine (13), Sencor (1) or Roundup (10) (Table 11).

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

	2015 % (no.)	2016 % (no.)	2017 % (no.)	2018 % (no.)
B	67 (15)	47 (41)	80 (12)	38 (8)
C	0 (27)	7 (72)	25 (28)	16 (18)
F	20 (84)	60 (40)	78 (22)	33 (12)
I	5 (91)	8 (40)	59 (22)	53 (15)
M	0 (86)	0 (38)	0 (20)	0 (10)

Other species

Three brome grass samples (WA) and two barley grass samples (NSW), were received this year. The brome grass samples were susceptible to all screened herbicides; Verdict (2 samples), Select (3), Glean (1), Atlantis (1), Crusader (1), simazine (1), trifluralin (2), Gramoxone (1) and Roundup (2). Similarly, the two barley grass samples were susceptible to all screened herbicides; Verdict (2 samples), Select (2), Shogun (1), Monza (1) and simazine (1).

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 all herbicide groups. Resistance levels to 'fops' which were slightly lower last year returned to a similar level to the years before last year.
- 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.
- The differential responses found to bromoxynil between and within populations and between times needs further investigation.

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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

Note: