

Samples Received

The testing service screened only 81 samples in 2023 well below the average of 260 sample per year since the service started in 1991. This was a similar number supplied in 2020 but most likely for a different reason. In NSW 2019 was a year of below average rainfall which always results in less samples for the subsequent resistance testing. This year the very wet year and harvest period in southern NSW may have resulted in less sample collection. Samples were supplied by 34 different stores or companies with an additional eight samples supplied directly from farmers.

As usually occurs the majority of samples were ryegrass with lower numbers of wild oats and wild radish. The only other species sent in was one Phalaris sample (Table 1)

Table 1: Total number of samples received since 2020

	2020	2021	2022	2023
Annual ryegrass	52	141	111	59
Wild oats	19	139	99	15
Wild radish	6	10	19	6
Brome grass	0	0	1	0
Barley grass	1	3	0	0
Phalaris	0	4	0	1
Sow thistle	0	2	0	0
Indian hedge mustard	0	0	1	0
Charlock	1	1	0	0
Paterson's curse	0	1	0	0
Total	79	301	231	81

Summary of Results

The results obtained from the 2023 resistance screening are similar in the majority of cases to the results from previous years.

Annual ryegrass

This year, 59 annual ryegrass samples were received of which 56 were tested to five or more herbicides resulting in a total of 348 individual herbicide tests (Table 2). However, for the second year in a row and third overall, none of these were tested to the standard cross-resistance test (Hoegrass, Select, Glean, simazine and trifluralin) with no additions or changes. The most commonly requested herbicides for testing were Select and Roundup, screened to all but three and seven samples respectively, followed

by trifluralin (45 samples) and Intervix (28 samples). In total 23 different herbicides were screened showing the customisation of testing by growers or agronomists. Eight samples were tested to a mix of Roundup and Select. One sample was tested to only one herbicide (Roundup), one to two herbicides and a third to three. Eight samples were tested to the standard cross resistance test number of five herbicides with 32 tested to six herbicides. Two samples were tested to seven, 13 to eight and one sample was tested to 16 herbicides.

Table 2: Number of samples tested to each of seven herbicide groups since 2020

Group	2020	2021	2022	2023
1 (fops)	13	54	19	20
1 (dims)	71	166	151	73
1 (dens)	6	38	13	12
2 (SU)	17	61	10	23
2 (Imi)	14	22	25	28
2 (SA)	0	18	0	3
3	47	122	97	45
5	28	88	96	36
9	51	137	110	52
15	42	103	106	38
22	13	13	47	13

Despite the reduction in samples received a similar number of samples as last year were tested to a 'fop' herbicide with all classed as resistant or developing resistance to those herbicides, in most years this has been above 90% (Table 3). As in usually the case in recent years, many samples were not tested to the 'fop', or Group 2 herbicides unless specifically requested by the client (Table 2). 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 2 test whereas clients from areas with lower resistance incidence are still confirming if the herbicides are still effective. This has extended to the GRDC funded resistance surveys in which ryegrass samples are no longer screened for resistance to a Group 1 fop or chlorsulfuron.

Thirteen percent of samples tested to a 'dim' herbicide were resistant, lower than the last three 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 lower than for the other 'dim' herbicides tested. This year no samples were resistant or developing resistance to Factor and three (2 – Resist; 1 - DR) to Select

compared to 85% to Achieve (71% - Resist; 14% - DR) (Table 5). Of the 12 samples screened to Axial all were resistant or developing resistance.

Seventy eight percent of samples were resistant to a sulfonylurea herbicide and 68% to an imidazolinone, a similar level to the majority of previous years (Table 3). As mentioned previously the proportion of samples being tested to the sulfonylureas is decreasing.

Table 3: Percentage of samples resistant or developing resistance to each herbicide groups since 2020

	2020	2021	2022	2023
1 (fops)	92	96	95	100
1 (dims)	45	19	10	13
1 (dens)	100	71	92	100
2 (SU)	77	77	90	78
2 (Imi)	86	73	88	68
3	11	6	19	4
5	1	0	0	0
9	24	41	31	21
15	0	0	0	0
22	0	8	2	0

No samples were resistant to Group 5, 15 or 22 herbicides this year. In previous years samples resistant to Groups 5 or 22 or developing resistance to Group 15 have been received. Two samples were developing resistance to trifluralin (Group 3), lower than most previous years (Table 3).

Probably the most concerning finding is the continued significant proportion of samples resistant to Roundup (Table 3; 7). For the sixth consecutive year over 20% of samples were resistant or developing resistance to this herbicide, one of, if not the most important herbicides available. Some of these samples have been provided from non-agricultural settings (eg. roadsides, firebreaks) which will increase the risk profile for resistance

Cross and Multiple Resistance

Forty one samples were screened to five or more herbicide groups. However, only eight samples were sprayed to the five standard selective herbicide groups ('fop', 'dim', 2, 3 and 5). Of these, none were susceptible to all groups, one was resistant to one group, six to two and one to three groups. Seventeen samples were tested to less than five herbicide groups, some of which were tested to more than five herbicides (1 – 1 herbicide; 2 – 2; 4 – 4; 3 – 5; 5 - 6 and 2 – 7 herbicides) of these three were susceptible to all tested groups, five to one group, six to two groups and three to three groups (Table 4).

Of the 41 samples tested to five or more groups 11 were susceptible to all herbicide groups, 13 resistant to only one group while nine were resistant to two and eight to three groups (Table 4).

The limited testing of the Group 1 'fops' and/or 2 which have the highest level of resistance (Table 3) suggests that the farmers or their agronomists are acknowledging populations are resistant to these groups and are investigating the susceptibility of alternative herbicide groups. With only 15 of the 57 samples that were screened to two or more herbicide groups tested to both 'fop' and Group 2 herbicides and 16 to neither, it is probable that many of the 42 samples not tested to both would be resistant to an additional one or two herbicide groups.

Table 4: Number of herbicide groups tested and the number of resistant groups for ryegrass samples

Resistant groups	1	2	3	4	5	6	7
0	0	1	0	2	5	5	1
1	1	0	0	4	6	7	0
2	0	1	1	4	1	5	3
3	0	0	0	3	0	5	3
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
Total	1	2	1	13	12	22	7

Herbicide Groups

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

Group 1 herbicides

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

Table 5: Results for ryegrass samples showing percentage resistant (Res) or developing resistance (DR) to individual Group 1 herbicides.

	Tested	Res	DR	%	Susc
<i>'fops'</i>					
Hoegrass	8	6	2	100	0
Verdict	5	5	0	100	0
Topik	6	6	0	100	0
Fusilade Forte	1	1	0	100	0
<i>'dims'</i>					
Select	56	2	1	6	53
Achieve	7	5	1	86	1
Factor	10	0	0	0	10
<i>'den'</i>					
Axial	12	9	3	100	0

Group 2 herbicides

While most of the samples screened to Group 2 herbicides were screened to Intervix, samples were also screened to Glean, Logran, Atlantis, Hussar and Crusader (Table 6).

Table 6: Results for ryegrass samples screened to individual Group 2 herbicides

	Tested	Res	DR	%	Susc
<i>Sulfonylureas</i>					
Glean	10	9	0	90	1
Logran	5	4	0	80	1
Atlantis	2	2	0	100	0
Hussar	6	2	1	50	3
<i>Imidazolinones</i>					
Intervix	28	16	3	68	9
<i>Sulfonamides</i>					
Crusader	3	1	0	33	2

Other herbicides

Annual ryegrass samples were screened to 14 other herbicides; trifluralin, Kerb, simazine, atrazine, Avadex Xtra, Arcade, Boxer Gold, Sakura, Overwatch, Luximax, Ultro, Mateno Complete, Gramoxone and Roundup. Except for, as previously mentioned for Roundup, the observed incidence of resistance to these herbicides was lower than the resistance to the higher risk Group 1 and 2 herbicides (Table 7).

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

	Tested	Res	DR	%	Susc
<i>Group 3</i>					
Trifluralin	45	0	2	4	43
Kerb	2	0	0	0	2
<i>Group 5</i>					
Simazine	16	0	0	0	16
Atrazine	20	0	0	0	20
<i>Group 9</i>					
Roundup	52	7	4	21	41
<i>Group 15</i>					
Avadex Xtra	3	0	0	0	2
Arcade	9	0	0	0	9
Boxer Gold	7	0	0	0	7
Sakura	19	0	0	0	19
<i>Group 22</i>					
Gramoxone	13	0	0	0	13

Eleven of the 52 samples tested to Roundup were found to be resistant or developing resistance. This herbicide needs to be treated carefully due to its importance in Australian agriculture. Neither of the two samples screened to Kerb were resistant. A single sample was screened to Overwatch, Luximax, Ultro and Mateno Complete and was susceptible to

all these herbicides. With significant levels of resistance to other herbicides these herbicides are very important, and need to be managed well, through crop and herbicide rotations in conjunction with non-chemical weed control to maintain their effectiveness for as long as possible.

State by State

New South Wales and Western Australia supplied the most samples with one sample received from Tasmania and South Australia (Table 8).

Table 8: Number of ryegrass samples received from each state since 2019.

	2019	2020	2021	2022	2023
NSW	21	14	101	48	38
Vic	2	3	2	5	0
SA	5	8	6	2	1
WA	69	22	29	56	19
Tas	0	5	2	1	1

With only one sample received from South Australia and Tasmania only the data for New South Wales and Western Australia has been analysed separately (Figure 1) and then only for the herbicide groups where more than 10 samples were tested for each state and resistance was detected (1 'dim' Select, 3 and 9). No WA samples were resistant to Select but two NSW samples were and different to previous years trifluralin resistance was higher in WA samples resistant but this is most likely a result of the low number of samples screened overall (Figure 1).

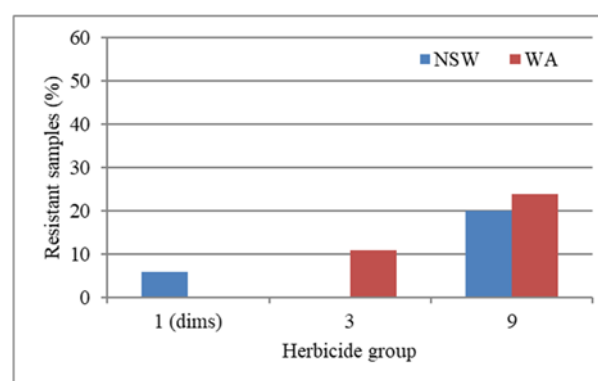


Figure 1: Percentage of ryegrass samples from NSW and WA resistant and developing resistance to selected herbicide groups

Wild Oats

The number of wild oat samples (15) received was as a percentage lower than the last two years when wild oats resistance screening had been sponsored by Corteva but within the range of the years before then (Table 9). All wild oat samples were received from New South Wales (12) and Queensland (3).

The level of 'fop' resistance among the samples was 45%, lower than previous years (Table 10). Eight samples were tested to Topik (4 resistant) and three to Verdict (1 resistant). For the 'dim' herbicides, none of the 14 samples tested to Select were resistant. Eleven samples were tested to Axial with two of these resistant (Table 10).

Table 9: Number of wild oat samples received and percentage of total samples since 2019

	2019	2020	2021	2022	2023
Total	142	78	301	232	81
Wild oats	23	19	139	99	15
Percentage	16.2	24.4	46.2	42.9	18.5

No samples tested to Atlantis (13), Intervix (1), Avadex (7), Mataven (2), Roundup (9) or Gramoxone (1) were resistant.

Table 10: Percentage of wild oat samples found to be resistant since 2020 (number tested in brackets)

	2020	2021	2022	2023
	% (no.)	% (no.)	% (no.)	% (no.)
1 'fops'	68 (19)	71 (142)	56 (95)	45 (11)
1 'dims'	13 (16)	4 (137)	1 (95)	0 (14)
1 'dens'	50 (8)	23 (112)	13 (87)	18 (11)
2	0 (21)	1 (125)	16 (76)	0 (14)

Broadleaf species

Six wild radish samples were provided for resistance screening with two from Western Australia and four from NSW.

Resistance was detected to Glean (1/1), MCPA Amine (1/1), and Brodal (2/5). No samples were resistant to Logran (1 tested), Intervix (4), 2,4-D Amine (3), MCPA LVE 570 (2), atrazine (6), bromoxynil (2) or Roundup (2) (Table 11).

Table 11: Percentage of wild radish samples found to be resistant since 2020 (no. of tests in brackets)

	2020	2021	2022	2023
	% (no.)	% (no.)	% (no.)	% (no.)
2	33 (3)	67 (6)	5 (19)	17 (6)
4	0 (7)	33 (12)	0 (22)	17 (6)
5	0 (4)	0 (5)	12 (16)	0 (6)
6	0 (1)	0 (4)	0 (10)	0 (2)
9	0 (4)	0 (2)	0 (15)	0 (2)
12	0 (6)	100 (9)	50 (18)	40 (5)

Other species

One phalaris sample was received, this was resistant to Elantra Xtreme, Foxtrot and Achieve but not Atlantis, Intervix or Crusader.

Final Observations

- As normal NSW and WA supplied the most annual ryegrass samples and all wild oats samples were received from either NSW or Qld.
- For ryegrass samples the level of resistance remained similar to previous years for the major herbicide groups.
- For the sixth consecutive year over 20% of ryegrass samples were resistant or developing resistance to Roundup. This is a major concern.
- Wild oat resistance for all groups was within the range experienced in previous years.
- Resistance incidence of the wild radish samples decreased this year, but this is likely a result of sample source not indicative of the species as a whole.

For further information contact:

Charles Sturt University
Locked Bag 588
Wagga Wagga NSW 2678

John Broster 02 6933 4001
0457 272 075
jbroster@csu.edu.au

Testing forms and annual reports are available at:

<https://science-health.csu.edu.au/eal/herbicide-resistance-testing>

Note:

The use of material contained in this report for commercial gain is not permitted without prior approval of the author and Charles Sturt University