# HERBICIDE TESTING RESULTS – WESTERN AUSTRALIA

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**Summary** Annual ryegrass (*Lolium rigidum* Gaud.) has developed resistance to a range of widely used herbicides in the cereal cropping region of Western Australia (WA). As the plant can develop multiple resistances, accurately determining which herbicide still can be used is an important part of managing the problem.

For the last five years a testing service has been available to farmers in Western Australia. The results of these tests are summarized. The results reflect the usage of the products and demonstrate the need to accurately determine the actual resistance in each paddock to plan for the management of the weed.

Recently, wild radish (*Raphanus raphanistrum*) has been shown to be resistant to the Group B herbicides.

## INTRODUCTION

Herbicide resistance in annual ryegrass has been observed in WA since 1984. The first suggestions that resistance had developed were made in 1983 and confirmed by glasshouse trials in 1984 (Holmes, 1984, unpublished).

The primary resistances that have appeared are to the aryloxyphenoxypropionate (fop and dim) and sulfonylurea (SU) herbicides. Since 1993 large scale herbicide resistance testing has been carried out in WA. Initially this was managed by Dr. G. Gill, 1993–94, with the AgWest Seed Lab providing the service since then. The testing was initially subsidised by the GRDC.

Initially the testing was a service that was provided to the farming community with the data also being used to determine the types of resistances occurring, the paddock histories that gave rise to the development of resistance, and of its distribution. This was achieved and became part of the basis of the herbicide resistance extension program in WA (Gill 1995).

Wild radish resistance has thought to be present in WA but has not been previously confirmed by testing.

## MATERIALS AND METHODS

A herbicide resistance kit for annual ryegrass was developed and sold through major resellers. Samples were then returned to the Lab and tested in the glass house in January to March. Samples were then cleaned, soaked in water for 24 hours, and then stored at 4°C for one week before planting into small pots in the glass house (at 18°C/12°C day/night). At the appropriate time, immediately after planting for triasulfuron (Logran®) at 35 g $ha^{-1}$ 714 g $kg^{-1}$ product, and sulfometuron (Oust®) at 200 g $ha^{-1}$ 750 g $kg^{-1}$ product, both SU herbicides. Diclofop (Hoegrass® ) at 1 L $ha^{-1}$ of 375 g $L^{-1}$ product a fop, sethoxydim (Sertin®) at 1 L $ha^{-1}$ 186.8 g $L^{-1}$ of product, a dim. Oust was not used in all years. Appropriate wetters or crop oils were added to the products at rates recommended on the labels. The rates chosen were at the maximum label rate.

Resistance was determined by the method outlined in Gill (1995). The client was then advised of the results. Similarly wild radish has been tested using similar methods using chlorsulfuron at 20 g $ha^{-1}$ of a 750 g $kg^{-1}$ product, metsulfuron at 5 g $ha^{-1}$ of 600 g $kg^{-1}$, and metosulam (Eclipse®) at 7 g $ha^{-1}$ of 714 g $kg^{-1}$ product.

**Data summary** The data presented to the farmer has the resistance of his sample presented as either none, or early or late resistance. The data presented has been summarized by classing both the early and late resistance categories as resistant. Populations that have more than 5% resistance for fop and dim, and more than 10% for SU are classed as resistant. While this could be considered to over state the level of resistance, it reduces the complexity of the data.

## RESULTS

All the results from this period have been collected and summarized. While resistance to trifluralin and simazine was tested for, the data is not presented. Oust was included in the last three years, and Select in the last two after it was observed that Sertin resistant populations could in many cases be controlled by the use of Select. The data for Oust is set out in Tables 4 and 5.

The tests have been sorted into resistance combinations for each year and are set out in Tables 1 and 2. Table 1 has the number of tests that fall into each combination of resistance for fop (Hoegrass), dim (Sertin) and SU (Logran). Table 2 is the data expressed as a percentage of all tests for each year.

Where possible, the locations of the paddocks from which the seed was collected and then assigned to the rainfall and climatic zones based on crop zones as used in the 'The Crop Variety Sowing Guide 1996' (1995). Sorted data is presented in Table 3 with number of tests and percentages of tests that originated within each zone.

**Table 1.** Summary of resistance combinations in five years of testing.

| Herbicide combination | Number of tests | | | | | |
|---|---|---|---|---|---|---|
| | Year | | | | | Total |
| | 1992 | 1993 | 1994 | 1995 | 1996 | All tests |
| Nil | 44 | 107 | 43 | 4 | 2 | 200 |
| Dim only | | | | 2 | | 2 |
| Fop only | 27 | 86 | 48 | 19 | | 180 |
| Fop and dim | 14 | 30 | 13 | 33 | 3 | 93 |
| SU only | 99 | 158 | 139 | 37 | 62 | 495 |
| SU and dim | | 2 | | 3 | 17 | 22 |
| Fop and SU | 78 | 68 | 164 | 60 | 64 | 434 |
| Fop and dim and SU | 25 | 38 | 56 | 131 | 117 | 367 |
| Number of samples | 287 | 489 | 463 | 289 | 265 | 1793 |

**Table 2.** Summary of resistance combinations in five years of testing.

| Herbicide combination | Percentage of each test | | | | | |
|---|---|---|---|---|---|---|
| | Year | | | | | Total |
| | 1992 | 1993 | 1994 | 1995 | 1996 | All tests |
| Nil | 15 | 22 | 9 | 1 | 1 | 11 |
| Dim only | 0 | 0 | 0 | 1 | 0 | 0 |
| Fop only | 9 | 18 | 10 | 7 | 0 | 10 |
| Fop and dim | 5 | 6 | 3 | 11 | 1 | 5 |
| SU only | 34 | 32 | 30 | 13 | 23 | 28 |
| SU and dim | 0 | 0 | 0 | 1 | 6 | 1 |
| Fop and SU | 27 | 14 | 35 | 21 | 24 | 24 |
| Fop and dim and SU | 9 | 8 | 12 | 45 | 44 | 20 |

In Tables 3 and 4 the climatic zones have been grouped into the low, medium and high rainfall areas.

Tables 4 and 5 are the actual number of tests and the percentage of resistant group of the tests where Logran and Oust were compared. The rainfall zones are the same as for Table 3. The climatic zones in Table 4 are those which are used in the sowing guide.

The wild radish tests were conducted in April–May 1996, on 10 samples of seed collected from areas where suspect populations existed. Several showed good tolerance to the herbicides tested.

## DISCUSSION

The number of tests is quite small compared with the number of paddocks in the Western Australian wheat belt. A simple estimate suggests that only 1–2% of paddocks have been tested. This estimate was calculated from the basis that there are approximately 10 000 cereal farms in Western Australia with 10 paddocks each. From Tables 1 and 2 it can be seen that at the proportion of tests resistant to dims is much less than for the fops and SUs. In WA, the first dim herbicide was released for commercial use in 1988 while Hoegrass was released in 1979, and the SU Glean® in 1984.

A general trend has been the decline in single resistances and the corresponding rise in multiple resistances. This would be expected where farmers change herbicides to accommodate the appearance of resistance. This is most obvious with the SUs. As fop resistance take longer to develop than SU, multiple resistances will take longer to appear (Gill 1995).

The distribution of resistance profiles over the different rainfall zones mirrors the herbicide usage typical of those areas. In the lower rainfall areas, with a less variable farming system, SUs have been widely used. SUs have been and are low cost broad spectrum efficient herbicides, which have been used in the cereal phase of the rotation.

In the medium to higher rainfall zones, there has been a greater use of fops and dims. This has been a response to using these products for grass removal from pulse crops to achieve cereal disease control for the subsequent cereal crop.

A major benefit of testing has been the identification of metabolic and site of action resistance in ryegrass for the SUs. With a herbicide use history that has been primarily SU, the population tends to have slight of action resistance. With a history of various herbicides, fops and dims as well as SUs, the population tends to be dominated by plants with the metabolic mode of resistance. In practice, treatment of a population that has metabolic SU resistance with Logran will result in a considerable yield increase, but the ryegrass will not be killed. Seed set by these plants can be a problem in subsequent crops. The mixture of trifluralin with Logran will improve the ryegrass control. Knowing which type of resistance predominates in a paddock allows managers to exploit this advantage and avoid costly errors. Plants that have high Oust resistance are not affected by Logran at commercial rates. In Table 5, climatic Zone 4 was the area where SU use has been greatest. Consequently the ratio of Logran resistance with Oust susceptibility has been lowest in Western Australia. In the last two years of testing, very few SU resistant tests from that Zone are susceptible to Oust. This limits farmers options.

This resistance testing has provided the basis from which extension messages have been developed. The very large data base that has been developed, has assisted in minimizing problems with inconstant messages. Extension messages in WA have been consistent across the whole industry.

With wild radish, more work is needed to define the herbicide use histories that develops resistance. In one case, 8 applications of an ALS inhibitor (Group B herbicides – see standard herbicide label groupings) were used in five years. Farmers need to be aware not to follow a failure in control with products of the same mode of action. SBS testing of samples from the same source confirmed the presence of resistance in those samples. This development further highlights the need for both laboratory and in-field testing to confirm if populations have become resistance and to which products or groups of herbicides.

The major change in the use for herbicides by Western Australian farmers that appears to be a response to the development of herbicide resistance, has been the change in the use of trifluralin. This has increased from approximately 90 000 litres in 1990 (Agricultural Western Australia records) to an estimated 2 000 000 litres in 1996. This estimate was based on comments from sales persons in major agricultural chemical resellers in WA.

**Table 3.** Resistance distribution as grouped by the rainfall zones, as number of tests and as a percentage (%).

| | Rainfall zone[A] | | | | | |
|---|---|---|---|---|---|---|
| | L | | M | | H | |
| | Count | % | Count | % | Count | % |
| Nil | 44 | 14 | 108 | 10 | 47 | 16 |
| Dim only | 0 | 0 | 0 | 0 | 2 | 1 |
| Fop only | 21 | 7 | 118 | 10 | 40 | 13 |
| SU only | 127 | 41 | 291 | 26 | 56 | 19 |
| Fop and dim | 11 | 4 | 63 | 6 | 16 | 5 |
| Fop and SU | 67 | 22 | 299 | 27 | 54 | 18 |
| SU and dim | 2 | 1 | 11 | 1 | 9 | 3 |
| Fop and dim and SU | 38 | 12 | 234 | 21 | 75 | 25 |
| Total number of tests | 310 | | 1124 | | 299 | |

[A] L – low rainfall zone less than 325 mm, M – medium zone, 325 to 450 mm, H – high rainfall zone, 450 to 750 mm.

**Table 4.** Distribution of Logran and Oust resistances mapped against rainfall zone.

| | Rainfall Zone[A] | | | | | |
|---|---|---|---|---|---|---|
| | L | | M | | H | |
| | No. | % | No. | % | No. | % |
| Oust only | 1 | 1 | 3 | 1 | 0 | 0 |
| Logran only | 51 | 37 | 185 | 36 | 98 | 63 |
| Logran and Oust | 86 | 62 | 321 | 63 | 58 | 37 |
| Number of tests | 138 | | 509 | | 156 | |

[A] Rainfall zones as for Table 3.


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## REFERENCES


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'The Crop Variety Sowing Guide' (1996). Bulletin 4314, Agriculture Western Australia 1995.


**Table 5.** Distribution of Logran and Oust resistances mapped against climatic zones.

| | Climatic Zone[A] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Zone 1 | | Zone 2 | | Zone 3 | | Zone 4 | | Zone 5 | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Oust only | 1 | 1 | 39 | 1 | 0 | 0 | 0 | 0 | 2 | 3 |
| Logran only | 88 | 56 | 1 | 52 | 97 | 63 | 34 | 18 | 35 | 51 |
| Logran and Oust | 69 | 44 | 80 | 102 | 58 | 37 | 150 | 82 | 32 | 46 |
| Number of tests | 158 | | 158 | | 155 | | 184 | | 69 | |

[A] Zones are numbers north to south. Zone 1 northern wheat belt, Zone 3 central wheat belt, Zone 5 south coast.