Herbicide resistance testing of *Lolium rigidum* by commercial institutions

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Summary  Herbicide resistance in broad-acre cereal farming is a major issue confronting farmers today. The most significant weed species that has developed resistance is annual ryegrass (*Lolium rigidum* Gaudin).

Knowledge of the herbicide resistance status of a paddock allows for strategic farm planning and correct herbicide choice. As resistance increases, more farmers are electing to have their paddocks tested for herbicide resistance using herbicide resistance testing facilities.

The findings from the testing facilities have shown high levels of resistance to aryloxyphenoxypropionate (FOP) and sulfonylurea (SU) herbicides. There is increasing resistance to the cyclohexanedione (DIM) herbicides and trifluralin, which have been used to combat FOP and SU herbicide resistant ryegrass. This is a concern for many farmers as their herbicide options are greatly reduced. The objective of this paper is to summarise the findings of annual ryegrass resistance testing that has been conducted by Charles Sturt University and Plant Science Consulting in the last two seasons.

Keywords  Herbicide resistance testing, annual ryegrass, *Lolium rigidum*.

INTRODUCTION

Widespread herbicide resistance in several weed species including *Lolium rigidum* Gaudin (ryegrass), *Raphanus raphanistrum* L. (wild radish) and *Avena* spp. (wild oats) can lead to complete herbicide failures. A herbicide failure can result in loss of profitability through increased cost of herbicides, yield reductions, and increased weed control problems for the following season. The availability of information in advance on the herbicide resistance status of a paddock can be crucial for strategic planning by identifying which herbicides remain effective.

Herbicide resistance testing is being adopted by the agricultural community as an important component of planning for the following season’s weed control and crop management strategies. Two commercial herbicide resistance testing methods are currently available: seed testing and the Syngenta Quick-Test (QT). Both tests are biased as to the resistance level in fields, as seeds or plants collected are likely to originate from herbicide survivors. However, the ultimate goal of a resistance test is to confirm whether resistance is present in a field.

MATERIALS AND METHODS

Seed testing involves testing seedlings grown from seeds that have been collected from weeds in the paddock for herbicide resistance. Testing is usually conducted over summer-autumn with feedback available to farmers in early autumn in time to plan for the next season’s weed control program.

Testing of annual ryegrass seed involves breaking dormancy to allow germination to occur (Steadman 2004). Seedlings or seeds (in the case of a pre-emergence herbicide) are sprayed in a herbicide cabinet delivering an accurate dose of herbicide. Tests are conducted in greenhouses or shade houses. This methodology is used by both Plant Science Consulting (PSC) and Charles Sturt University (CSU) in their herbicide resistance testing services (www.plantscienceconsulting.com, Boutsalis *et al.* 2006, Broster and Pratley in press).

Recently, an in-season test, the Syngenta Quick-Test (QT) has become available commercially (Boutsalis 2001, www.plantscienceconsulting.com). This test is a supplementary herbicide resistance tool for situations where the need to test for resistance during the growing season arises and is utilised by Plant Science Consulting in resistance testing.

The QT involves collecting whole plants from the field during the growing season. Plants are trimmed to produce short cuttings consisting of 1 cm root and 2–3 cm shoot in the case of grasses. Tilled grasses are split to create 1–2 tilled cuttings, which are transplanted into pots. After regeneration of fresh leaf tissue, which takes approximately one week for grasses, the plants are sprayed. Plants are assessed as for seed testing. Pre-emergence herbicides cannot be tested with the QT.

The QT enables a fast turnaround of 4–6 weeks often allowing: (1) follow-up treatments to be conducted in the case of resistance confirmation; and (2)
information to be available enabling an effective weed control program to be planned months before the start of the following cropping season.

A critical factor for all resistance testing is to include known susceptible and, where possible, resistant plants to enable accurate assessment of the samples. Assessment involves recording variables such as germination, survival and herbicide damage (Broster and Pratley in press).

**FINDINGS**

While this data has been presented on the basis of herbicide groups, the suppliers of the samples can specify the herbicides they wish to have tested. This then assists them into making more informed decisions with regards to their planned cropping program and herbicide use.

Less than 10% of samples received are sent in direct from farmers, the vast majority are provided by agronomists. However, it is not known what proportion of the agronomist supplied samples are provided at the request of the farmer. The supply of samples via an agronomist has been encouraged as it allows for discussion of the results between the farmer and an advisor with local knowledge.

Most seed or plant samples sent in for herbicide resistance testing show resistance to aryloxyphe-noxypropionate (FOP) herbicides and sulfonylurea (SU) herbicides. Intensive use of these herbicides has resulted in resistance with little difference in the percentage of samples that are resistant between states.

Strong resistance to FOP and SU herbicides has resulted in increased use of cyclohexanedione (DIM) herbicides for weed control. In turn, resistance to the DIM herbicides is increasing (Figure 1, Table 1).

The highest levels of trifluralin (Group D) resistance were detected in South Australian samples at almost 60%, with 30% of the Victorian samples sent in for testing also confirmed resistant (Figure 1). This trend is well supported by random ryegrass field surveys (Boutsalis 2006).

Glyphosate resistance (Group M) was detected in samples from SA, Vic and NSW (Figure 1, Table 1) and is of concern as the number of cases of glyphosate resistance increases (Preston, 2006).

Random field surveys of annual ryegrass in NSW, SA, Vic and WA have highlighted high levels of resistance to FOP and SU herbicides (C. Preston – a 2003 survey pers. comm., Llewellyn and Powles 2001, Pratley et al. 1995, Henskens et al. 1996). Seed or plants

![Figure 1](image-url)

**Figure 1.** Percentage and number of annual ryegrass samples resistant to herbicides in six chemical groups according to Australian state distribution. Seed samples were tested by CSU or PSC and originated from the 2004 and 2005 season. The figure represents resistant samples as a percentage of the total number of samples tested with that Herbicide Group. Not all samples received were tested with all the herbicide groups.
received for resistance testing support the high levels of resistance detected to these herbicide groups.

Knowledge of the herbicide resistance status of a field is important for planning the following season’s crop and herbicide strategy. Where resistance has been confirmed through the seed or Quick-Test, those herbicides should be avoided. Only herbicides that are identified as effective should be used as part of a management plan. Assuming resistance to a herbicide or a chemical group can often require the use of alternative and more expensive herbicides and adoption of less productive management practices.

The increased adoption of herbicide resistance testing as identified by increased resistance testing by PSC and CSU suggests that more farmers are using the herbicide resistance information to plan effective integrated weed management strategies (Table 2).

### Table 1. Percentage and number (in brackets) of annual samples resistant to herbicide groups detected using the Syngenta Quick-Test during the 2004 and 2005 seasons (Plant Science Consulting). The numbers represent resistant samples as a percentage of the total number of samples tested with that herbicide group. Not all samples received were tested with herbicides from every group.

<table>
<thead>
<tr>
<th>State</th>
<th>FOP %</th>
<th>DIM %</th>
<th>SU %</th>
<th>Glyphosate %</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW</td>
<td>100</td>
<td>81</td>
<td>83</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(14)</td>
<td>(7)</td>
<td>(10)</td>
<td>(0)</td>
</tr>
<tr>
<td>Vic</td>
<td>97</td>
<td>72</td>
<td>72</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>(35)</td>
<td>(60)</td>
<td>(36)</td>
<td>(3)</td>
</tr>
<tr>
<td>SA</td>
<td>95</td>
<td>76</td>
<td>76</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(87)</td>
<td>(141)</td>
<td>(110)</td>
<td>(2)</td>
</tr>
<tr>
<td>WA</td>
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<td>85</td>
<td>85</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(23)</td>
<td>(18)</td>
<td>(22)</td>
<td>(0)</td>
</tr>
</tbody>
</table>

### Table 2. Number of herbicide resistance tests conducted by Charles Sturt University and Plant Science Consulting.

<table>
<thead>
<tr>
<th>Year</th>
<th>Seed Testing</th>
<th>Syngenta Quick-Test</th>
</tr>
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<tbody>
<tr>
<td>1991</td>
<td>7</td>
<td>–</td>
</tr>
<tr>
<td>1994</td>
<td>41</td>
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</tr>
<tr>
<td>1998</td>
<td>171</td>
<td>–</td>
</tr>
<tr>
<td>2004</td>
<td>388</td>
<td>113</td>
</tr>
<tr>
<td>2005</td>
<td>358(^a)</td>
<td>149</td>
</tr>
<tr>
<td>2006</td>
<td>498(^a)</td>
<td>Not available</td>
</tr>
</tbody>
</table>

\(^a\) CSU and PSC combined.


REFERENCES
