Weed control strategies for glyphosate tolerant crops

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KEY MESSAGES

At least two varieties of Roundup Ready canola will tolerate high rates of isopropyl amine or potassium salt formulations of glyphosate at the 1 to 4 leaf stage but these will require registration before field use.

Annual Ryegrass control with glyphosate at label rates is marginal when applied within 15 days of the break of the season due to staggered emergence of the ryegrass and poor efficacy on very young seedlings.

Glyphosate in combination with metolachlor (Dual® Gold) provided good control of Annual Ryegrass when applied 10 days after the break. This provides a potentially new technique for weed control in Roundup Ready crops as metolachlor doesn't require mechanical incorporation but it does require registration for post-emergence applications before field use.

BACKGROUND AND AIMS

The introduction of glyphosate tolerant crops will require a range of new agronomic practices to ensure maximum short term and long term profits from the new technology. Practices to reduce the build up of glyphosate resistance are required. Recent work (Gaines *et al*. 2009) has indicated that while glyphosate resistance appears to be based on a single gene, multiple copies or gene amplification could result in increasing tolerance with multiple applications of low rates in *Amaranthus*. If this same phenomenon occurs in Annual Ryegrass and/or Wild Radish then higher levels of control may be warranted to delay resistance. This could be achieved by higher rates of glyphosate, later timings of application, multiple applications, use of other herbicides and the incorporation of other practices that provide weed suppression.

Staggered germination of both Annual Ryegrass and Wild Radish have been a problem in glyphosate tolerant canola. This has been compounded by the requirement to apply post-emergence glyphosate before the 6 leaf stage in the current set of canola varieties.

The two trials reported here investigated the dose response of alternative formulations of glyphosate in glyphosate tolerant canola and the use of pre-emergence herbicides in combination with glyphosate to achieve higher levels of Annual Ryegrass control. These results and other observations have been used to suggest potentially new practices and the research required to have them approved and adopted.

Trial 1.

METHOD

An isopropyl amine (Roundup Biactive®) and a potassium salt (Roundup PowerMAX®) formulation of glyphosate were applied at rates ranging from 500 to 5000 g.a.i./ha on two varieties (502 and 601) of Roundup Ready canola at the 1 to 4 leaf stage (July 15). This was compared to the normal application of 900 g/ha Roundup Ready Herbicide (mono ammonium salt) applied on July 14 and repeated on August 4 in the bulk crop and over the trial area. The canola was planted on June 15 with 1450 mL/ha Triflur Xcel, 80 kg/ha Cropstar fertilizer and had 60 kg urea on July 24 and August 14.

RESULTS

Both varieties of Roundup Ready canola tolerated high rates of the two formulations tested (Figure 1).

The yields of the surrounding bulk crop were 1.7 t/ha for 502 and 2.1 t/ha for 601 variety. The slightly higher yields in the trial area are probably due to paddock variation and reduced losses due to hand harvesting of the trial plots. Weed control was excellent in the plot and bulk areas.

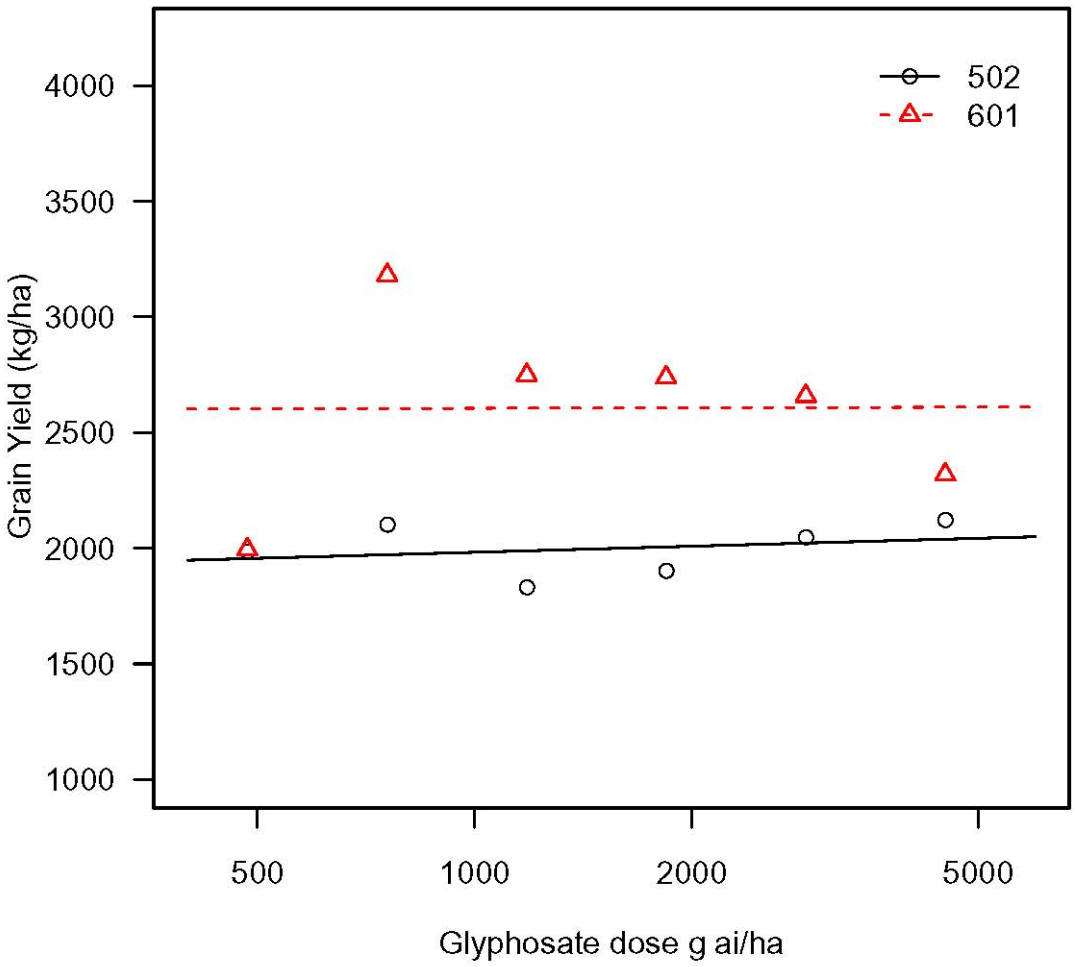

Figure 1: The grain yield response of 502 and 601 varieties of Roundup Ready Canola to doses of IPA (Roundup Biactive) or K salt (Roundup PowerMAX) formulations of glyphosate applied at the 1 to 4 leaf stage.

Trial 2.

METHOD

Approximately 100 kg/ha of Annual Ryegrass seed was lightly cultivated into an infested paddock at the break of the season to produce a high density Annual Ryegrass infestation.

Glyphosate (Roundup PowerMAX®) at 125 to 2500 mL /ha was applied with a logarithmic sprayer at 4 times (10, 15, 23 and 42 days after planting Annual Ryegrass). At the first time of spraying Dual Gold (metolachlor) was applied at 200 to 4000 mL/ha by itself and in a mixture with PowerMAX with rates ranging from 125 mL PowerMAX plus 200 mL/ha Dual Gold to 2500 mL/ha PowerMAX plus 4000 mL/ha Dual Gold.

RESULTS

The control of Annual Ryegrass at normal rates of glyphosate applied 10-15 days after planting was poor. This was due to both poor efficacy on very young ryegrass and staggered germination of the seed. By 23 days after planting, control with glyphosate was acceptable and by 42 days after planting control with low rates of glyphosate was excellent (Figure 2).

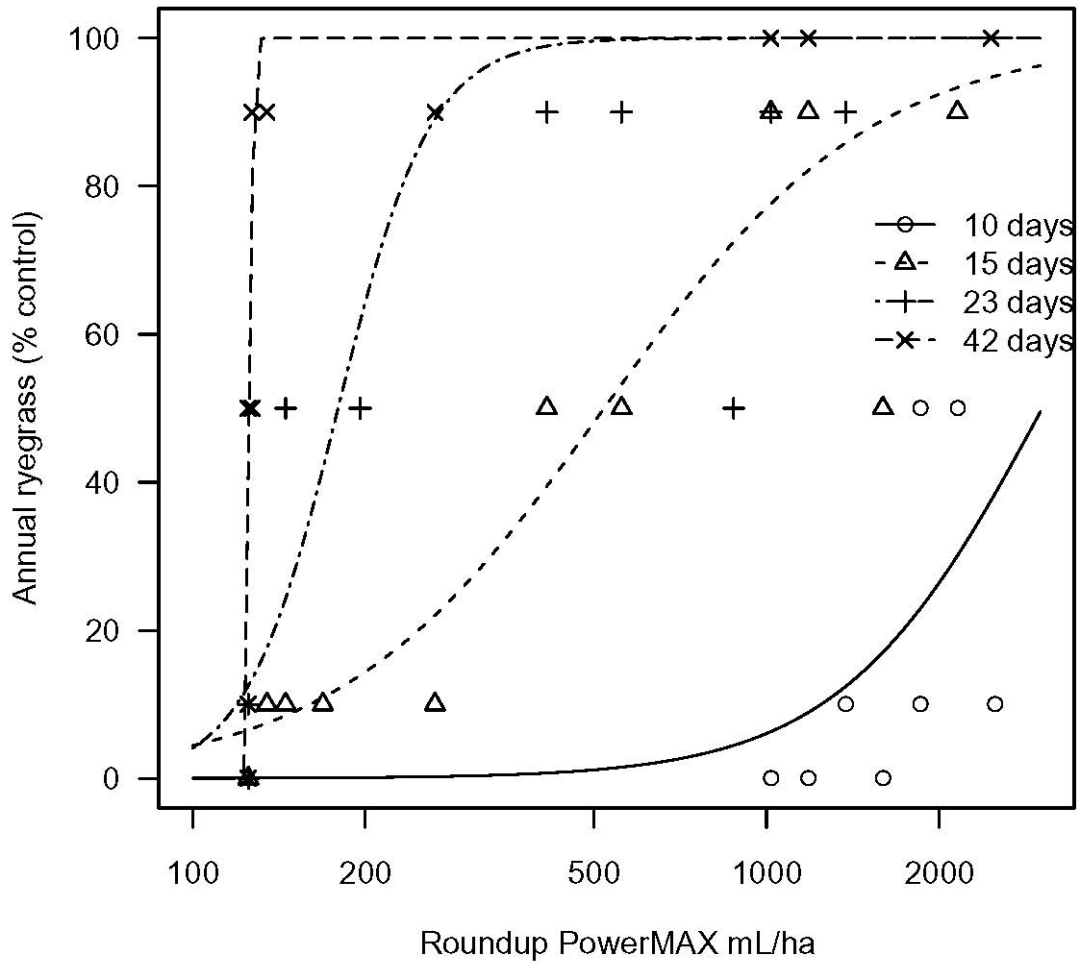

Figure 2: The apparent control of Annual Ryegrass sprayed with various rates of Roundup PowerMAX (glyphosate 540g/L) 10, 15, 23 and 42 days after planting Annual Ryegrass.

Glyphosate reduced Annual Ryegrass density by less than 50% when applied 10 days after planting regardless of the rate. Metolachlor provided good control at rates above 2 L/ha but some plants that emerged before spraying escaped control. Better control was achieved with the mixture at rates

greater than 625 mL/ha of Roundup PowerMAX with 1 L/ha Dual Gold (Figure 3).

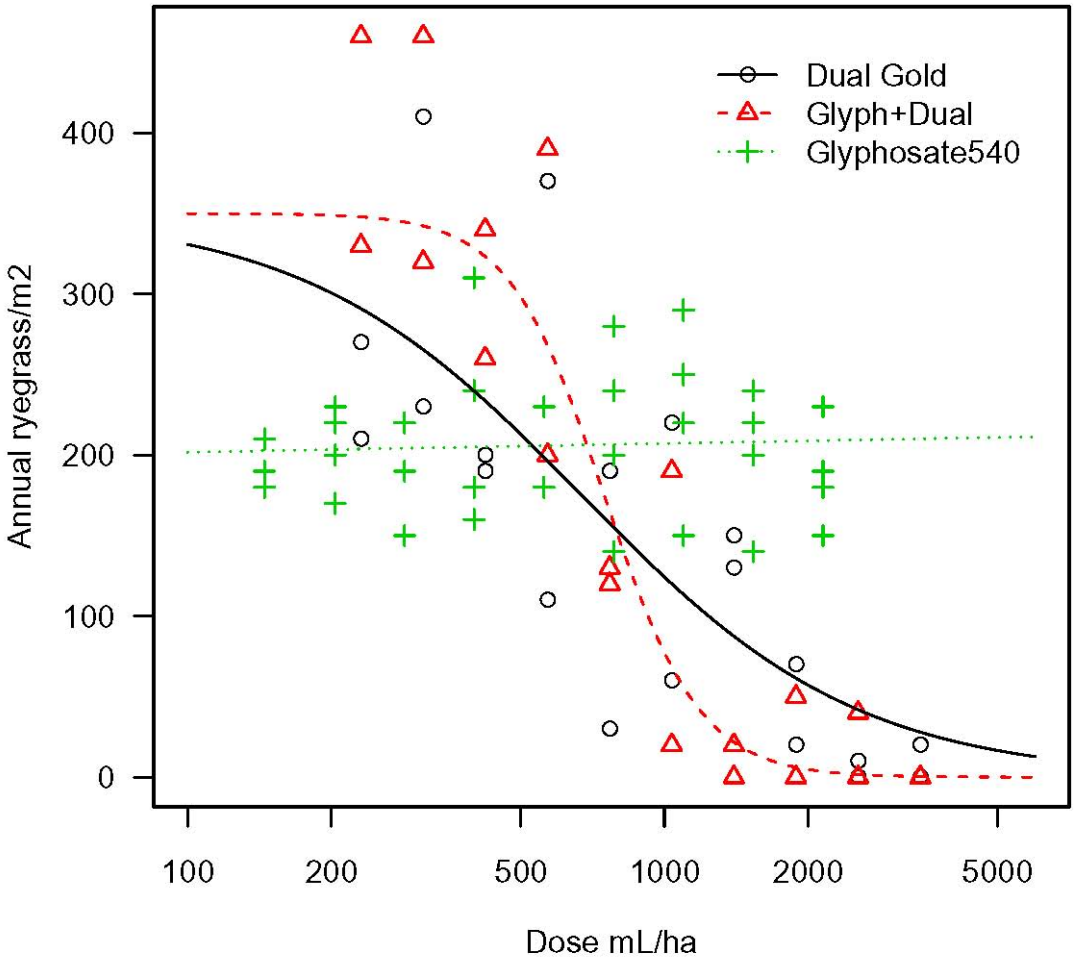

Figure 3: Annual Ryegrass density after application of various rates of glyphosate (Roundup PowerMAX), metolachlor (Dual Gold) and a mixture of glyphosate and metolachlor. (Doses on the x axis are the rates of glyphosate or metolachlor in the single and mixture treatment).

CONCLUSION

There is scope to use high rates and alternative formulations of glyphosate in Roundup Ready canola varieties. These will require registration before farmers may use them and may require more trial work. The tolerance to glyphosate demonstrated here suggests that multiple applications or applications at other growth stages using lower rates may be possible and should be investigated. New varieties are also expected to be more tolerant to late applications. The need for later application timings has been confirmed this year where Annual Ryegrass and Wild Radish emerged after the last application of glyphosate resulting in weed seed production at some sites in the GM trial program. Selective crop topping is another technique that relies on late applications of herbicide and has been effectively used to run down Wild Oat seed banks (Medd *et al.* 1992). This technology could be transferred to Annual Ryegrass using glyphosate providing sufficient tolerance is demonstrated.

The ability of Annual Ryegrass to flourish after glyphosate applications within 3 weeks of the break of the season dictates that pre-emergence herbicides or late post-emergence weed control will be required for adequate control. Glyphosate tolerant crops allow the application of glyphosate later in the season when Annual Ryegrass is susceptible the low rates shown in figure 2. Alternatively, mixtures with pre-emergence herbicides such as metolachlor that don't require mechanical incorporation allow the use of glyphosate to control a range of weeds without compromising Annual Ryegrass control as shown in figure 2. In old trials using old varieties, canola has tolerated post-emergence applications of metolachlor (Moore, 2000), so the mixture has potential for use in Roundup Ready canola. Again this requires further trial work to obtain registration and measurements of the levels of residues in the crop for this novel timing of application.

In broadacre production systems, there is often a compromise between the time of sowing, waiting for weeds to emerge, early weed control to reduce competitive effects, late weed control to reduce grain contamination and weed seed banks and optimising herbicide use to reduce the risk of resistance. Glyphosate tolerant crops allow the application of glyphosate after the bulk of the Annual Ryegrass has emerged and reached a size where it is susceptible to low rates of glyphosate (or very high levels of control at label rates). Application of glyphosate up to 3 weeks after planting will require a follow up sprays or mixtures with pre-emergence herbicides. In dense infestations of Annual Ryegrass this delay may result in a grain yield loss due to early competition. One could envisage early spraying with herbicide mixtures in heavily infested, early planted paddocks and delayed spraying in lightly infested or late planted paddocks. Very late applications of glyphosate allow better manipulation of seed set control for following crops and running down Annual Ryegrass seed banks. For intractable weeds such as Wild Radish in canola, the use of alternative herbicides is limited because of the close affinity between the weed and crop. Herbicide tolerant crops will be an essential tool to achieve the required selectivity for effective herbicidal weed control. New varieties with greater tolerance to late applications and research to confirm efficacy, tolerance and residue levels will be required to obtain registration.

Glyphosate tolerant crops will allow the producer more flexibility in their weed control and logistical operations. Strategies involving the use of alternative formulations (which is driven mainly by price), higher rates or multiple applications (which is driven mainly by the lack of alternative control measures) and mixtures with residual herbicides or later timings of application (which is driven mainly by the weed germination pattern and crop tolerance) are all potentially useful but require further validation and registration. Overlaying this is the risk of resistance which could be significantly influenced if Annual Ryegrass or Wild Radish is able to implement the gene amplification demonstrated in *Amaranthus* last year in the USA.

KEY WORDS

Annual Ryegrass, glyphosate, GM Canola, *Lolium rigidum*, metolachlor, resistance, logarithmic sprayer, Roundup, Roundup Ready Canola.

ACKNOWLEDGMENTS

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