Double knockdown to combat annual ryegrass (*Lolium rigidum* Gaudin) resistance to glyphosate

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**Summary** In the Western Australian wheat belt, four populations of annual ryegrass (*Lolium rigidum* Gaudin) have evolved resistance to glyphosate. Resistance to paraquat in annual ryegrass has been reported from South Africa. It is important to develop management strategies to manage annual ryegrass resistance to the two most important knockdown herbicides – glyphosate and a mixture of paraquat and diquat. The double knockdown strategy (glyphosate followed by paraquat + diquat or the reverse sequence, preferably on the same cohort of weeds) is recommended to minimise the risk of already resistant ryegrass or to delay the development of resistance. Although glyphosate followed by paraquat + diquat is considered to be an effective sequence, the effect of the reverse sequence (paraquat + diquat followed by glyphosate) is not well understood. The stage of ryegrass at the time of applying herbicides and the time interval to be allowed between two knockdowns may also affect the efficacy of the herbicides and consequently may influence the time of sowing of the crop. Herbicide uptake and translocation within plants may be affected by the diurnal application time.

The aims of this study were to determine the optimal sequence of double knockdown herbicide applications, time interval to be allowed between two knockdown applications, ryegrass stage at which to spray for maximum efficacy and diurnal application time.

One glasshouse trial was conducted in Merredin during October to December 2002. Ryegrass seed was sown in pots and the plants were sprayed with glyphosate or paraquat + diquat alone or in sequence, at the one, three and six leaf stages of the same cohort. The herbicides were applied at three diurnal times (10 am, 1 pm and 4 pm) and with varying time intervals between the application of both herbicides when in sequence (1 hour, 6 hours, 1 day, 2 days, 5 days or 10 days). This trial was conducted under field conditions in 2003 with reduced treatments.

Two field trials on the sequence and stage of ryegrass to apply herbicides were conducted at Merredin and Beverley, Western Australia, in the 2002 and 2003 seasons. Ryegrass plants were sprayed with glyphosate or paraquat + diquat alone or in sequence, at the one, three and six leaf stages of the same cohort. A constant five day interval was allowed between herbicides when applied in sequence. Weed control was assessed two weeks after herbicide application. Wheat was sown after the completion of weed mortality assessments in these two trials.

Results showed that applying glyphosate followed by paraquat + diquat provided 98 to 100% control of ryegrass plants in 2002 when applied at the three or six leaf stage. In 2003, a similar control level was achieved from this sequence when sprayed at the one or three leaf stage. However, on average, double knockdown was more effective when applied at the three or six leaf stage of ryegrass. The effect of herbicide sequence did not significantly differ in field trials, except in 2002 at the one leaf stage.

An interval of 2 to 5 days between the application of knockdowns achieved optimal weed control, although a one day interval between two knockdowns did not show any antagonistic effect. However, the traditional longer interval between knockdowns may allow growers to kill more of the late emerging weeds, even though it causes a delay to seeding.

When applying double knockdown herbicides, the time of day when knockdown herbicides are applied did not significantly affect their ability to control ryegrass. However, applying glyphosate alone in the morning provided a significantly higher level of ryegrass control than in the afternoon. At Merredin, the highest wheat grain yield was obtained in plots where ryegrass was effectively controlled at early stages (one to three leaf), which also allowed for earlier sowing of wheat, than controlling ryegrass at the six leaf stage.