Getting the best from Clethodim in canola – nozzle type and timing of application

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KEY MESSAGES

- Clethodim sprayed with medium droplets provided better control of annual ryegrass (ARG) than very coarse droplets when at the 4 leaf growth stage of the weed
- Clethodim effectively controlled ARG at mid-tiller and late-tiller growth stage, irrespective of nozzle type
- Delaying spraying until ARG is at late-tiller stage may compromise canola yield

BACKGROUND AND AIM

Clethodim is commonly used in canola to control annual ryegrass (ARG, Lolium rigidum), one of the most pervasive weeds threatening the productivity of cropping systems in southern Australia. As a Group A systemic herbicide, it is taken up through the foliage and travels to the growing points of the weed. Group A herbicides are thought to be more effective on smaller weeds, partly due to the smaller travel distance to the growing region. However achieving good herbicide contact with young ARG can be problematic due to its small size, form and orientation. At an early growth stage, ARG is narrow and is orientated pointing upright. In addition, the efficacy of targeting ARG can be further hindered by the canola crop canopy shielding the weeds.

It is common practise to apply clethodim with a nozzle which deposits the herbicide at 90° to the crop canopy. This trial evaluates if changing the angle at which clethodim is sprayed could result in better herbicide coverage when targeting ARG. That is, if the herbicide is delivered across the crop canopy at a 40° angle, will it have a better chance of intercepting ARG and increase its efficacy?

The aim of this trial was to compare two nozzles, a 90° vs. a 45° spray angle nozzle, in their efficacy in controlling ARG in canola. The 90° angled nozzle was tested at two droplet sizes, (i) medium and (ii) very coarse. The 40° angled nozzle was tested at a medium droplet size and oriented two ways (i) all nozzles facing forward and (ii) nozzles alternating forward and backward along the boom. These nozzles were tested at four growth intervals of the ARG: 2 leaf, 4 leaf, mid-tiller and late-tiller.

METHOD

Site details and trial management

The trial was situated at the SFS Westmere site. Plots (10 m x 1.6 m) were sown with Hyola® 559TT on the 4th of May 2015 on 200 mm row spacings and using 25 mm knife points. One week after sowing, tetraploid annual ryegrass seed was broadcasted with a hand spinner across the trial at 60 g/plot. Metaldehyde, bifenthrin and chlorpyrifos were used to control slugs and red legged earth mite. Urea was broadcasted at 150 kg/ha at the beginning of stem elongation on the 5th of July.

Treatments

Clethodim (Select®) was applied at 0.5 L/ha with 1 L/ha of Spraymate™ Liase and 0.5 L/ha of Uptake™, using 100 L/ha of water. The nozzle tips were spaced 50 cm apart and four spray patterns were tested (table 1). Each of the four spray patterns were tested at four growth phases of the ARG: 2 leaf, 4 leaf, mid-tiller and late-tiller.

Table 1. Specifications of the two nozzles and the four spray treatments tested

Treatment key	Nozzle	Drop size	Spray angle	Fan angle	Boom height	Spray pressure	Travel speed
Vertical [med]	Teejet® AIXR110015	Medium	90°	110°	50 cm	5 bar	9.1 km/hr
Vertical [v coarse]		Very coarse	90°	110°	50 cm	2 bar	5.8 km/hr
40° [fwd &back]	Syngenta® SPE 83-03	Medium	40° alternating forward and backward along boom	83°	70 cm	2 bar	12 km/hr
40° [fwd]		Medium	40° forward	83°	70 cm	2 bar	12 km/hr

DATA COLLECTION

The ARG population was determined by counting the number of weeds in a four 50 x 50 cm quadrat randomly placed in each plot. Canola establishment was also recorded simultaneously by counting two rows within each quadrat.

Four locations were marked in each plot with a bamboo stick. These were situated across the centre four rows to ensure potential drift from neighbouring plots did not confound the results. While facing east, a 25 x 25 cm quadrat was placed in each of these locations so that the bamboo was nestled in the bottom left hand corner. The number of ARG weeds were counted and recorded in the quadrat. Approximately 5 – 7 weeks after each spray interval, the remaining alive ARG weeds were counted in each plot in the same four marked locations. The plots were also assessed and given an efficacy of weed kill according to the European Weed Research Council rating (1= complete kill, 2 = excellent, 3 = very good, 4 = good-acceptable, 5 = moderate but not generally acceptable, 6 = fair, 7 = poor, 8 = very poor, 9 = none). The plot edges (25 – 35 cm) were not considered in each score due to the potential for contamination during the spraying of adjacent plots.

Water sensitive paper was used to estimate if there were any differences in spray coverage between nozzle treatments. The paper was used in two plots of every treatment when they were sprayed at the 2 leaf, 4 leaf and mid-tiller growth stage of the ARG. Two pieces of the paper were stuck back-to-back in a portrait orientation on a bamboo stick, and were set up the in path of the oncoming boom spray.

The plots were harvested by direct heading on the 5th of December 2015. Plot yields were recorded on the plot harvester weight scale. The canola grain was tested for moisture, protein and oil content.

RESULTS

Canola and ARG establishment

There were no significant differences in ARG establishment counts between treatments. The average weed burden was calculated at 324 weeds/m2. This demonstrated that the ARG had been broadcasted and distributed evenly across the trial site.

The average canola establishment was 56 plant/m2, with no significant differences between any of the treatments. This means that any potential confounding effects of the canola, such as shading the weeds from sunlight or blocking the weeds from spray coverage, would be consistent between plots.

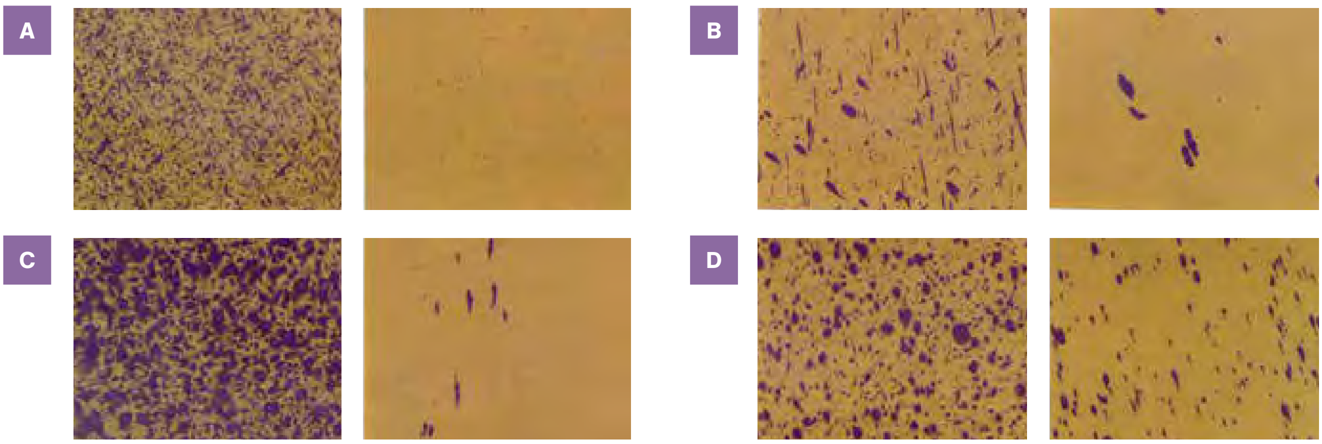

Figure 1. Water sensitive paper used during spraying at 4 leaf timing of ARG. In each of the four images, the left and the right represent the sides facing towards and away from the oncoming boom respectively. Images represent differences in spray coverage between (A) vertical[med] (B) vertical[vcoarse] (C) 40°[fwd] and (D) 40°[fwd & back] nozzle treatments.

Spray coverage

There were notable differences in spray coverage as estimated by the use of water sensitive paper (figure 1). Coverage appears heaviest on the side facing the oncoming boom in the 40°[fwd] treatment, followed by Vertical[med], 40°[fwd & back], and Vertical[v coarse]. It is apparent that 40°[fwd & back] was the only nozzle treatment to spray both the front and back of sides of the paper.

Nozzle type

Regarding nozzle type in isolation, 40°[fwd] provided the best control of ARG reducing the weed burden by 92% (table 2). There was no significant difference between 40°[fwd & back], Vertical[med] and Vertical[v coarse] which provided 79 – 84% control of ARG. This trend was also observed in the efficacy of kill scores, with 40°[fwd] receiving an average score of very good, and 40°[fwd & back], Vertical[med] and Vertical[v coarse] receiving an average score of good-acceptable to moderate.

It is important to note that an interaction effect between nozzle type and timing of application was found in this trial. This means that the performance of the nozzles also needed to be assessed at each timing interval (see interaction between nozzle and timing).

Timing of application

With respect to timing of application, the greatest reduction in ARG numbers was seen in treatments sprayed at mid-tiller and late-tiller stage (table 2). The ARG decreased by 95-99% in these treatments. This was followed by 4 leaf timing in which a 87% decrease in ARG was observed. However on a plot scale mid-tiller timing received the best efficacy of kill score of excellent, followed equally by 4 leaf and late-tiller timings, where very-good to good-acceptable ARG control was observed. Overall spraying at 2 leaf resulted in the least effective control of ARG, with a 60% reduction in ARG numbers and an efficacy of kill score of fair to poor. Canola yields were also influenced by timing of application (table 3). Yields were lower at 2 leaf and late-tiller timings (0.5 t/ha) than at 4 leaf and mid-tiller timings (0.7 t/ha).

The results for weed control at 2 leaf may have been confounded by the rain shower which happened shortly after spraying. This may have contributed to the overall low ARG control.

Table 2. Effect of nozzle type and timing of application on ARG control. Efficacy of kill was determined visually on a scale of 1 to 9 (1= complete kill, 9= no control)

	Reduction in ARG (%)	Efficacy of kill (1-9)
Factor 1 – Nozzle type		
Vertical [med]	79.3 b	4.7 a
Vertical [v coarse]	84.8 b	4.4 a
40° [fwd & back]	84.4 b	4.2 a
40° [fwd]	92.0 a	3.3 b
Factor 2 – Timing of application		
2 leaf	59.7 c	6.8 a
4 leaf	87.1 b	3.9 b
Mid-tiller	98.5 a	2.3 c
Late-tiller	95.1 a	3.4 b
LSD (p=0.05)	*5.8*	*0.7*
CV(%)	*9.6*	*24.9*

Means followed by the same letter do not significantly differ.

Interaction between nozzle and timing

At the 2 leaf time of application, Vertical[v coarse] provided the best control of ARG, reducing numbers by 87% and receiving a score of good-acceptable control (figures 2 & 3). It also produced the greatest yield (0.7 t/ha). 40°[fwd] provided less control (73%, fair control), followed equally by, 40°[fwd &back] and Vertical[med] (34 – 45 %, very poor). Despite difference in control between these last three spray patterns, there was no significant difference in yield (0.4-0.5 t/ha). This result was not expected as medium droplets are generally more effective in targeting narrow grass weeds. It is possible that Vertical[v coarse] performed the best due to interference by the rain. Vertical[med], 40°[fwd &back] and 40°[fwd] treatments were in the medium droplet range, and may have been more readily diluted by the rain than the very coarse droplets sprayed in the Vertical[v coarse] plots.

At the 4 leaf time of application, there was no significant difference in ARG reduction percentages between Vertical[med], 40°[fwd &back] and 40°[fwd] (figure 2). They all reduced ARG numbers by 92-98%. However when visually assessed, 40°[fwd & back] and 40°[fwd] exhibited excellent control, whereas good-acceptable control was observed in Vertical[med] plots (figure 3). Despite the visual difference in ARG control, there was no significant difference in yield between these three spray patterns (0.7 – 0.8 t/ha) (figure 4). The least control was observed in plots sprayed with Vertical[v coarse] (61%, poor control) (figures 2 & 3). This treatment also produced the lowest yield at this timing (0.5 t/ha) (figure 4).

At mid-tiller and late-tiller timing of application there was no significant difference between the nozzles, reducing ARG numbers by 92 – 99% (figure 1). At mid-tiller, all four treatments exhibited excellent to very good control (figure 3). At late-tiller, control of excellent to good-acceptable was observed. Canola yields did not significantly differ at mid-tiller and late tiller timings, producing 0.6 – 0.7 and 0.5 – 0.6 t/ha respectively (figure 4).

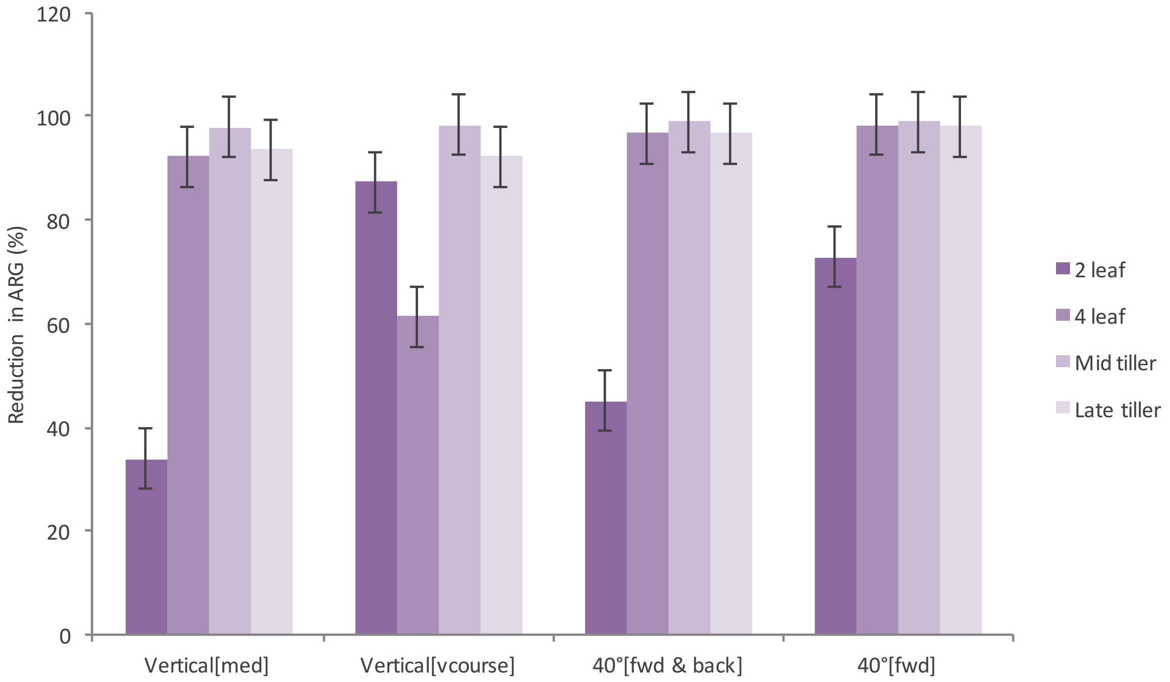

Figure 2. Reduction in ARG weeds after spraying with clethodim. LSD (p=0.05) = 11.59%, CV = 9.6%.
Error bars represent the standard error of the mean.

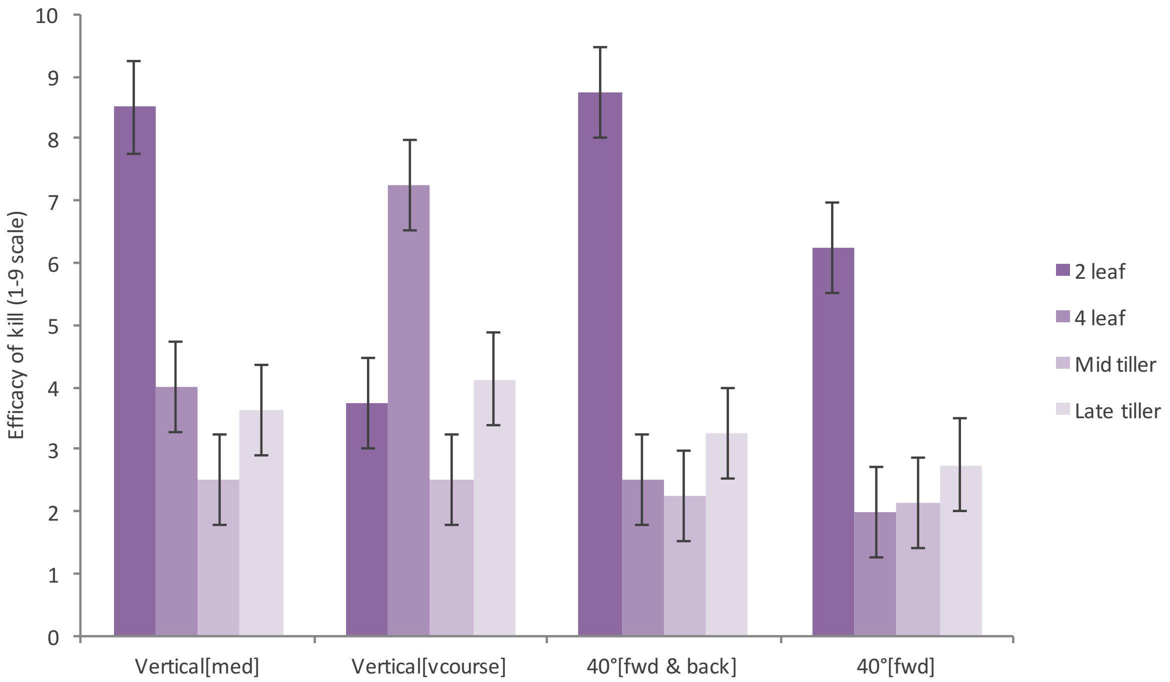

Figure 3. Efficacy of clethodim in controlling ARG as visually assessed on a scale of 1 to 9 (1= complete kill, 9= no control). LSD (p=0.05) = 1.5, CV = 25.9%.
Error bars represent the standard error of the mean.

Table 3. Canola yields according to nozzle type and timing of application. Means followed by the same letter do not significantly differ. LSD (p=0.05) = 0.09 t/ha, CV = 21.5%.

	Yield (t/ha)
Factor 1 – Nozzle type	
Vertical [med]	0.62 a
Vertical [v coarse]	0.57 a
40° [fwd and back]	0.59 a
40° [fwd]	0.58 a
Factor 2 – Timing of application	
2 leaf	0.52 a
4 leaf	0.68 b
Mid-tiller	0.65 b
Late-tiller	0.51 a

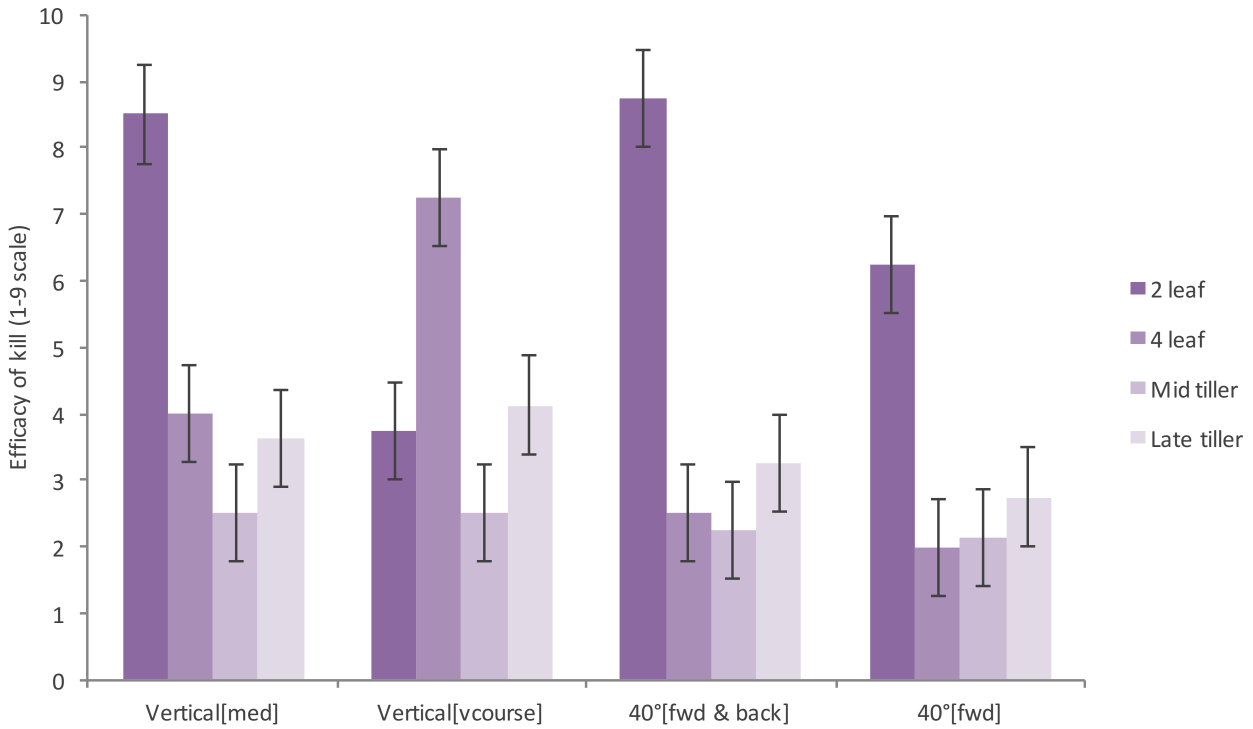

Figure 4. Canola yields and the interaction between nozzle type and timing of application. LSD (p=0.05) = 0.2 t/ha, CV = 21.5%.

Error bars represent the standard error of the mean.

DISCUSSION

When comparing the nozzles at 4 leaf, mid-tiller and late-tiller, there does not appear to be a clear advantage of spraying clethodim at 40° as opposed to vertically. At 4 leaf, there was no difference in both of the 40° angled treatments and Vertical[med] in ARG%. The 40° angled treatments did score slightly better when judged visually, however this did not translate to a better yield. The standout observation at 4 leaf, was that the medium droplet size, as was used in Vertical[med] and both 40° angled treatments, provided better control than very coarse droplets. Using a medium droplet resulted in both better ARG control and better canola yields than Vertical[v coarse]. This is not surprising as it is generally recommended that grass weeds should be sprayed with a medium droplet to encourage better coverage. At mid-tiller and late-tiller treatments, there was no advantage of using a 40° angled nozzle. There was also no difference in using a medium or very coarse droplet size. This was most likely because the ARG was a large target at this stage and easily intercepted the clethodim.

The results at mid-tiller and late-tiller timings demonstrates that clethodim does actually work effectively on large ARG. However given that overall canola yields were lower at late-tiller timings, this could indicate that delaying spraying until this stage could compromise yields when the weed burden is as great as approximately 300 plant/m2.

As previously indicated, the results at 2 leaf timing should be interpreted with caution due to interference by rain. It should also be noted that a commercial variety of ARG was used in this trial, and therefore issues with clethodim resistance would be unlikely.

This trial has emphasised the importance of using a medium droplet size in achieving good coverage and control if spraying ARG when it is small and narrow, as shown by the results at 4 leaf timing of application. Spraying at this droplet size does require careful consideration of spraying conditions (e.g. wind speed, air temperature and humidity), given that a smaller spray particles are more prone to drift.

ACKNOWLEDGEMENTS

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