Clethodim tolerance in canola

Michael Zerner and Rob Wheeler, SARDI

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Key findings

- Grain yield losses of up to 40% can be caused by clethodim at particular rates and timings.
- Early application timings appear the best to avoid crop damage.
- Variation does exist between varieties across all herbicide tolerant crop types (Conventional, Clearfield and Triazine Tolerant) in their level of sensitivity to clethodim.
- Flower distortion was the major clethodim damage symptom observed, which led to poor pod development resulting in yield reductions.

Why do the trial?

Clethodim is a very important herbicide in the control of annual ryegrass in southern Australia. In recent times, label rate changes have occurred to enable higher rates of up to 500 mL/ha to be used for increased levels of weed control. This rate increase applies to canola, pulse crops and pasture legumes. Since the use of this higher rate of clethodim, a number of crop effects have been reported, particularly in canola. Observed symptoms include, delayed flowering, distorted flower buds and possible grain yield suppression. Symptoms appear to be more severe from later application timings. Other factors that may influence crop effects include herbicide rate, crop stress at herbicide application and possible varietal differences in tolerance.

Given the widespread importance of the use of clethodim in the farming rotation and increased application rates to combat herbicide resistant annual ryegrass, a field trial at Hart was established to identify the level of crop tolerance to these rates in canola. The level of actual yield losses that may occur from the use of high clethodim rates is relatively unknown.

How it was done?

Plot size:	1.4 m x 10 m	**Fertiliser:**	DAP (18:20) 2% Zn @ 60 kg/ha
Seeding date:	18th May 2013		UAN (42:0) @ 75 L/ha, 11th July 2013

The trial was established as a split-plot design with three replicates. Three canola varieties were used; AV Garnet (conventional), ATR Gem (triazine tolerant) and Hyola 474 CL (Clearfield) to investigate the influence of clethodim rate and timing. Nine clethodim treatments were applied to each variety as listed below in Table 1. This trial was solely aimed at investigating the impact of clethodim on crop safety rather than weed control.

Spray treatments for each growth stage were applied on the same day for each variety. As a result the exact growth stage at the time of application for each variety may have differed slightly, despite all varieties used in this trial being of very similar maturity. Following each spray application NDVI readings using a Greenseeker and visual damage scores were recorded.

Table 1. Clethodim treatments applied at Hart during 2013.

Clethodim Treatments
1. Untreated control
2. 0.5 L/ha applied at 4-leaf growth stage
3. 1.0 L/ha applied at 4-leaf growth stage
4. 0.5 L/ha applied at 8-leaf growth stage
5. 1.0 L/ha applied at 8-leaf growth stage
6. 0.25 L/ha applied at 4-leaf and 8-leaf growth stages (0.5 L/ha in total)
7. 0.5 L/ha applied at 4-leaf and 8-leaf growth stages (1 L/ha in total)
8. 0.5 L/ha applied at bud initiation (ie. first visible green buds)
9. 1.0 L/ha applied at bud initiation

Application of clethodim at 1 L/ha is not a registered rate and was undertaken for experimental purposes.

Results

The trial results reflected the sensitivity of canola to high rates of clethodim. Of the varieties tested the conventional type variety Garnet appeared to show a greater level of tolerance to clethodim than the other varieties. Both Gem (TT) and Hyola 474 CL were very similar in their response to clethodim, both incurring almost 40% yield losses in the most damaging clethodim treatment.

Table 2. Effect of clethodim applied at different timings and rates on canola flower damage assessed as a visual score (0%= no damage, 100% = killed flowers) at Hart during 2013.

Application timing	Clethodim rate	ATR Gem	AV Garnet	Hyola 474 CL
		% flower damage		
	Untreated	0	0	0
4 leaf	0.5 L/ha	0	0	0
	1.0 L/ha	0	0	5
8 leaf	0.5 L/ha	0	0	0
	1.0 L/ha	5	5	5
4 leaf and 8 leaf split	0.25 L/ha + 0.25 L/ha	0	0	0
	0.5 L/ha + 0.5 L/ha	5	0	5
Bud initiation	0.5 L/ha	10	0	15
	1.0 L/ha	40	5	55

Of the various clethodim timings, the latest application time caused the most visual crop damage (Table 2) resulting in the largest grain yield losses (Table 3). Applications within current label recommendations of up until flower buds become visible appear relatively safe in this trial. As all treatments sprayed with a single label rate application of 0.5 L/ha up to the 8-leaf growth stage were not significantly different from the unsprayed control for any variety.

Early sprays (4-leaf growth stage) at rates up to 1.0 L/ha had no significant implications on grain yield for any variety (Table 3). The next timing at 8-leaf was safe when applied at 0.5 L/ha, but when rates exceeded this, significant yield losses occurred,up to 13% in TT Gem and Hyola 474 CL. The more tolerant variety Garnet was unaffected at the higher rate at the same growth stage. The split application appeared to improve the safety of the 1.0 L/ha treatment when it is applied over two applications rather than in one application at the later 8-leaf timing. Yield losses were reduced to 9% in Hyola 474 CL and TT Gem was not significantly affected for the split application.

The latest timing treatment used in this study at bud initiation which is outside current label recommendations was found to be highly damaging causing significant yield reductions in all varieties (Table 3). TT Gem and Hyola 474 CL were both significantly affected at both rates with yield losses ranging from 13% (0.5 L/ha) up to 39% (1.0 L/ha). Garnet again showed increased tolerance at this timing where it was unaffected at 0.5 L/ha and only a 10% yield reduction at the higher rate.

These findings in grain yields closely matched visual scoring of damage symptoms during the season (Table 2). A range of symptoms were observed, the first of which was a slight change in the colour of the crop canopy. The more damaged or sensitive plots become paler green in colour as compared to the untreated control plots. There were no visual changes in overall crop biomass or any significant change in NDVI between treatments in this particular trial. As the crop further develops to reach flowering the damage symptoms become more pronounced. The flower buds become distorted and fail to open up fully leading to poor pod development (Figure 1), which in turn resulted in reduced grain yields. The grain yield losses were strongly correlated to the severity of the observed visual symptoms.

Table 3. Effect of clethodim applied at different timings and rates on the grain yield of canola at Hart during 2013. Highlighted values indicate significantly less than untreated (P≤0.05).

Application timing	**Clethodim rate**	**ATR Gem**	**AV Garnet**	**Hyola 474 CL**
Untreated		1.11 t/ha	1.37 t/ha	1.69 t/ha
		grain yield % of control		
4 leaf	0.5 L/ha	98	99	100
	1.0 L/ha	94	106	96
8 leaf	0.5 L/ha	99	104	96
	1.0 L/ha	87	106	87
4 leaf and 8 leaf split	0.25 L/ha + 0.25 L/ha	91	102	92
	0.5 L/ha + 0.5 L/ha	95	103	91
Bud initiation	0.5 L/ha	80	97	87
	1.0 L/ha	61	90	61

Figure 1. Hyola 474 CL at flowering showing no crop damage in untreated plot (left) and high degree of flower distortion in 1 L/ha clethodim applied at 8-leaf stage (right).

Implications

Increased application rates of clethodim have created concern due to crop damage in canola, which is the most sensitive crop of those registered for clethodim use. This trial at Hart has shown that late timings (bud initiation) of clethodim can result in severe yield losses, therefore care should be taken to apply at correct growth stages and application rates. Applications exceeding 0.5 L/ha are at high risk of causing yield reductions in most canola varieties. From the trial results it is evident that the early application at 4-leaf growth stage of canola was the safest on the crop but this may not be always the best time of application for targeting weed control. For example, a large proportion of the weed population may germinate later, requiring additional follow up sprays or delaying initial spray applications. Or higher use rates might be required to achieve acceptable control of weed populations developing resistance. This may require a compromise in rates and timings to best control weeds while minimising the risk of crop damage. There appears to be differences in clethodim tolerance between varieties. Such that varietal selection may be a contributing factor in minimising clethodim damage in canola. Further research is still required to establish ratings for varieties based on their level of clethodim tolerance.