

Canola herbicide systems, pre-emergent herbicides and variety hybridity: their effect on the control of annual ryegrass (*Lolium rigidum*) across three WA trials in 2017.



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Key messages

- *The highest gross margin and greatest level of weed control were both achieved by using a hybrid Roundup Ready® (RR) canola variety in an RR canola system.*
- *Triazine tolerant (TT) canola systems are highly reliant on the annual ryegrass (ARG) being susceptible to clethodim. In a site with confirmed clethodim resistant populations the level of weed control was commercially unacceptable in all TT treatments.*
- *The dual herbicide tolerant (RT) canola system treatments generated a higher gross margin compared to traditional TT systems when used in a situation with a high weed burden.*
- *The addition of propyzamide to a TT canola system was shown to be beneficial across all three trials, with improved weed control and higher gross margins compared to trifluralin.*

Background

In 2017, at the request of the Mingenew-Irwin and Liebe grower groups, three trials were conducted in the northern WA Wheatbelt by Bayer Crop Science and Nufarm Australia comparing the yield, profitability and level of weed control of three canola herbicide systems (TT, RR and RT) using a combination of pre-emergent herbicides and canola varieties. The benefit of hybrid canola varieties compared to open-pollinated (OP) varieties was also investigated.

A combination of pre-emergent and post-emergent herbicides with different modes of action and seed set weed control options should be used by growers to reduce reliance on any single herbicide mode of action. Trifluralin has traditionally been used alongside atrazine pre-sowing in canola, but recently alternatives such as propyzamide and Butisan® have become available.

Open-pollinated TT varieties are currently the most commonly grown canola varieties in Western Australia. Over the past decade there has been increasing interest in RR and RT hybrid canola varieties as a tool to control hard-to-kill weeds, and to maximise gross margins in favourable seasons. In these trials there were four varieties grown; 3000TR is a dual triazine-tolerant and Roundup Ready (RT) (Group M + C tolerant) hybrid variety and has been used as the basal variety to compare herbicide systems and their effectiveness on yield, ATR-Bonito is the most commonly grown open-pollinated TT (Group C tolerant) variety in WA, InVigor® T4510 is a hybrid TT variety and InVigor R3520 is a hybrid RR (Group M tolerant) variety.

A pre-harvest application of Weedmaster® DST was sprayed across all three sites at 20% canola seed colour change. This use pattern is beneficial for reducing weed seed numbers for the following season when weeds have survived in-crop control measures, as was seen in all three of these trials.

Trial Details

| Trial ID | WF06 | WE04 | WE02 |
|--|---|---|---|
| Location | Dodd's Property, West Buntine | Dempster's Property, Arrino | Symes' Property, Cunderdin |
| Plot size & replication | 20 m x 2 m x 3 replications | 20 m x 2 m x 3 replications | 20 m x 2 m x 3 replications |
| Soil type | Sandy loam over gravel | Grey sand | Sandy loam |
| Soil pH (CaCl₂) | 0-10 cm: 6.2 10-20 cm: 4.4 20-30 cm: 4.4 | 0-10 cm: 4.8 10-20 cm: 4.4 20-30 cm: 4.5 | TBC |
| EC (ds/m) | 0-10 cm: 0.058 10-20 cm : 0.021 20-30 cm: 0.025 | 0-10 cm: 0.041 10-20 cm : 0.018 20-30 cm: 0.021 | TBC |
| Paddock history: | 2016 wheat | 2016 wheat | 2016 wheat |
| Sowing date | 24/04/2017 | 03/05/2017 | 28/04/2017 |
| Sowing rate | 1.7 kg/ha 3000TR, 1.4 kg/ha InVigor T4510, 1.7 kg/ha InVigor 3520RR, or 1.9 kg/ha ATR-Bonito (target 35 plants per m ²); all treated with EverGol® Xtend 65 mL/100 kg + Poncho® Plus 500 mL/100 kg | | |
| Fertiliser | 24/04/17: 100 kg/ha Gusto Gold + 80 kg/ha urea 15/08/17: 50 L/ha UAN | 03/05/17: 120 kg/ha Gusto Gold + 50 kg/ha urea 15/08/17: 60 L/ha UAN | 28/04/17: 120 kg/ha Gusto Gold + 50 kg/ha urea 15/08/17: 80 L/ha UAN |
| Herbicides, insecticides & fungicides | 24/04/17: 100 mL/ha Talstar® + 1 L/ha Lorsban® + 2 L/ha Roundup® Ultra®MAX 20/07/17: 50 g/ha Transform® + 100 mL/ha Lontrel® Advanced 11/08/17: Application B as per treatment list | 03/05/17: 100 mL/ha Talstar + 1 L/ha Lorsban + 2 L/ha Roundup UltraMAX 15/06/17: Application B as per treatment list 05/07/17: Application C + 550 mL/ha Aviator Xpro as per treatment list | 28/04/17: 100 mL/ha Talstar + 1 L/ha Lorsban + 1.5 L/ha Roundup UltraMAX 02/06/17: Application B as per treatment list 23/06/17: Application C + 550 mL/ha Aviator Xpro as per treatment list |
| | 15/08/17: 50 g/ha Transform 25/08/17: Application C + 550 mL/ha Aviator® Xpro® as per treatment list 30/10/17: 4.1 L/ha Weedmaster DST | 15/08/17: 50 g/ha Transform 18/10/17: 4.1 L/ha Weedmaster DST | 15/08/17: 50 g/ha Transform 25/09/17: 150 mL/ha Success® Neo 12/10/17: 4.1 L/ha Weedmaster DST |
| Growing season rainfall | 112.5 mm | 255 mm | 264 mm |

Table 1: A list of treatments used in this trial. Treatments shaded in grey are treated as RR or RT systems. Note: Edge® (propyzamide 900 g/kg) was used at the Buntine site (550 g/ha).

| Trt. | Variety | Pre-emergent | Crop: 2 leaf | Crop: 4-6 leaf |
|------|------------------|--|---|---|
| 1 | 3000TR | Nil | Nil | Nil |
| 2 | 3000TR | Atrazine 1.1 kg/ha | Nil | Atrazine 1.1 kg/ha + Select® 500 mL/ha + 1% Hasten v/v |
| 3 | 3000TR | Atrazine 1.1 kg/ha + propyzamide 1 L/ha | Atrazine 1.1 kg/ha | Select 500 mL/ha + 1% Hasten® v/v |
| 4 | 3000TR | Atrazine 1.1 kg/ha + propyzamide 1 L/ha | Nil | Atrazine 1.1 kg/ha + Select 500 mL/ha + 1% Hasten v/v |
| 5 | Bonito | Atrazine 1.1 kg/ha + propyzamide 1 L/ha | Nil | Atrazine 1.1 kg/ha + Select 500 mL/ha + 1% Hasten v/v |
| 6 | InVigor T4510 | Atrazine 1.1 kg/ha + propyzamide 1 L/ha | Nil | Atrazine 1.1 kg/ha + Select 500 mL/ha + 1% Hasten v/v |
| 7 | 3000TR | Atrazine 1.1 kg/ha + Butisan 1.8 L/ha | Nil | Atrazine 1.1 kg/ha + Select 500 mL/ha + 1% Hasten v/v |
| 8 | 3000TR | Atrazine 1.1 kg/ha + trifluralin 2 L/ha | Nil | Atrazine 1.1 kg/ha + Select 500 mL/ha + 1% Hasten v/v |
| 9 | 3000TR | Atrazine 1.1 kg/ha + propyzamide 1 L/ha | Weedmaster DST 1.3 L/ha + atrazine 1.1 kg/ha | Weedmaster DST 1.3 L/ha |
| 10 | 3000TR | Atrazine 1.1 kg/ha + propyzamide 1 L/ha | Weedmaster DST 1.3 L/ha | Weedmaster DST 1.3 L/ha + atrazine 1.1 kg/ha |
| 11 | 3000TR | Propyzamide 1 L/ha | Weedmaster DST 1.3 L/ha | Weedmaster DST 1.3 L/ha |
| 12 | InVigor R3520 | Propyzamide 1 L/ha | Weedmaster DST 1.3 L/ha | Weedmaster DST 1.3 L/ha |

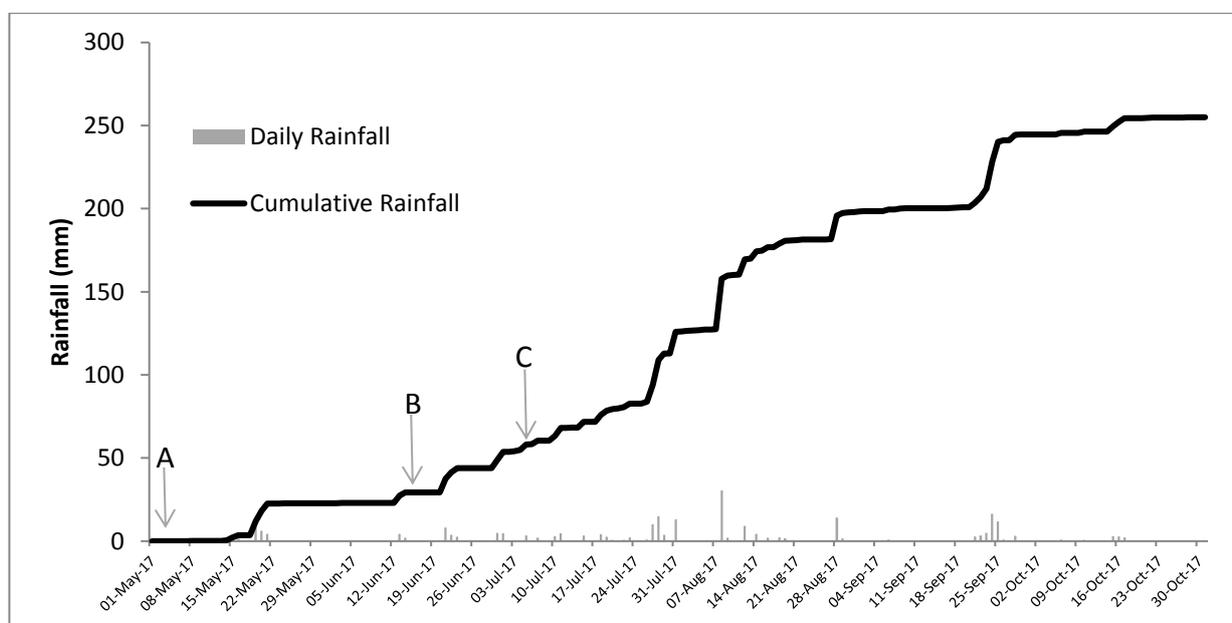


Figure 1: Cumulative rainfall at the Mingenew-Irwin Group 2017 trial site near Arrino. Application A represents the timing of the pre-emergent treatments. Application B represents the timing of the first post-emergent treatment. Application C represents the timing of the second post-emergent treatment.

The Arrino trial was sown on the 3rd of May into a dry soil profile. Rainfall of 22 mm over the following 10 days resulted in good crop germination, and an initial flush of annual ryegrass. Most ryegrass was found in the crop row due to the water harvesting effect of the furrows. No rainfall was received for the next three weeks (see figure 1) which limited early crop vigour. The first post-emergent application was applied on the 15th of June after a 6 mm rainfall event; the annual ryegrass was mostly at the 2-3 leaf growth stage. The second post-emergent application was applied on the 5th of July following 10 mm of rain; the annual ryegrass was 2-4 tiller growth stage.

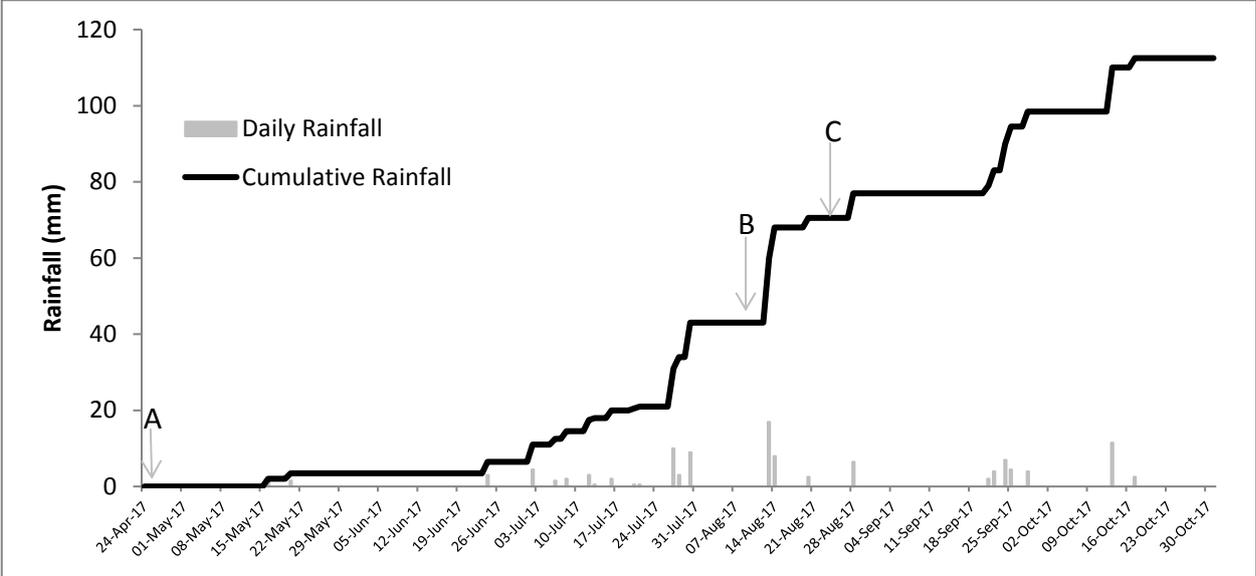


Figure 2: Cumulative rainfall at the Liebe Group 2017 trial site near West Buntine. Application A represents the timing of the pre-emergent treatments. Application B represents the timing of the first post-emergent treatment. Application C represents the timing of the second post-emergent treatment.

The Buntine trial was sown on the 24th of April into a very dry soil profile; the previous rainfall event was the 25th of March. No weed or crop emergence occurred until July. The first significant rain fell 71 days after sowing, on the 3rd of July (see figure 2); the crop emerged unevenly over the following week after 8 mm of rain. The crop plant density was less than half the target plant density (35 plants/m²). This was most likely due to furrow-fill following seeding, resulting in a deeper seed depth. The first substantial rains of the growing season were not received until the 28th of July, where 21 mm fell over four days: this was enough to germinate a large stand of annual ryegrass with some further crop emergence. The majority of the ryegrass could be found in the furrow most likely as a result of the water harvesting effect of the furrows. The 2 leaf early post-emergent treatments were applied on the 11th of August three days after a 17 mm rain event. The target weed (annual ryegrass) was mostly at the 2-3 leaf growth stage. The next day 23 mm of follow-up rain was received on the 12th of August. The 6 leaf treatments went out on the 25th of August. The target weed (annual ryegrass) was mostly at the early tillering growth stage.

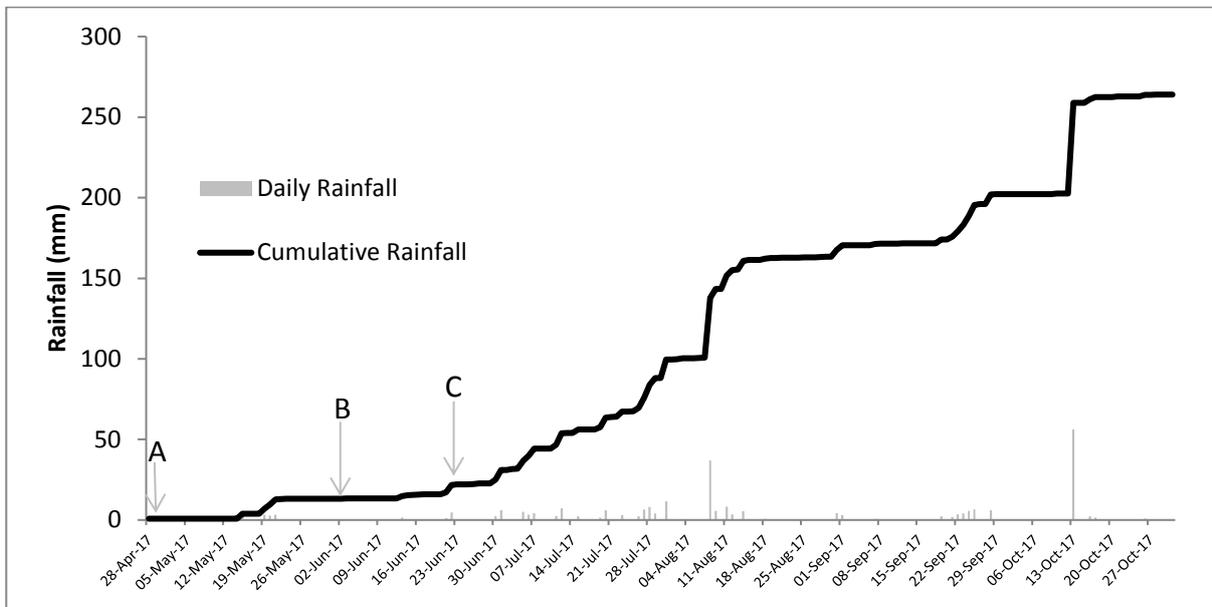


Figure 3: Cumulative rainfall at the WANTFA 2017 trial site near Cunderdin. Application A represents the timing of the pre-emergent treatments. Application B represents the timing of the first post-emergent treatment. Application C represents the timing of the second post-emergent treatment.

The Cunderdin trial was sown on the 28th of April into damp soil following 222 mm of rainfall between January and March. Both post-emergent applications were applied in June: with the first targeting 1-2 leaf growth stage annual ryegrass, and the second targeting early tillering annual ryegrass.

The annual ryegrass populations at the three sites were independently tested by Plant Science Consulting following the 2016 season, with no resistance detected to the herbicide modes of action used in the trials at Buntine or Cunderdin. However, the annual ryegrass population at the Arrino site was determined to be highly resistant to clethodim.



Table 2: Yield (t/ha) compared to ATR-Bonito treatment, gross margin (GM, \$/ha) compared to ATR-Bonito treatment and control of annual ryegrass panicles (% control) compared to untreated control in canola trials at West Buntine, Arrino and Cunderdin.

| Ttt | Treatment | Variety | Arrino (832 ARG panicles / m ²) | | | West Buntine (1068 ARG panicles / m ²) | | | Cunderdin (118 ARG panicles / m ²) | | | Mean | | |
|-------------------------------------|--|---------------|--|----------------------------|-------------------------|---|----------------------------|-------------------------|---|----------------------------|-------------------------|----------------------------------|----------------------------|-------------------------|
| | | | ARG panicle control to UTC % UTC | Yield % compared to Bonito | GM % compared to Bonito | ARG panicle control to UTC % UTC | Yield % compared to Bonito | GM % compared to Bonito | ARG panicle control to UTC % UTC | Yield % compared to Bonito | GM % compared to Bonito | ARG panicle control to UTC % UTC | Yield % compared to Bonito | GM % compared to Bonito |
| 1 | Nil | 3000TR | 0 | -34.08 | -\$208.05 | 0 | -46.34 | -\$92.76 | 0 | -0.88 | -\$42.41 | 0 | -27.10 | -\$114.41 |
| 2 | TT system, no propyzamide | 3000TR | 21 | -23.47 | -\$212.77 | 52 | -46.34 | -\$140.41 | 90 | -0.27 | -\$97.23 | 54.3 | -23.36 | -\$150.13 |
| 3 | TT system with propyzamide, split post-emergent atrazine/clethodim | 3000TR | 58 | +6.20 | -\$83.99 | 87 | +41.46 | +\$6.13 | 93 | +5.50 | -\$103.06 | 79.3 | +17.72 | -\$60.31 |
| 4 | TT system with propyzamide | 3000TR | 67 | +3.69 | -\$83.34 | 66 | +14.63 | -\$37.95 | 98 | +9.91 | -\$50.46 | 77.0 | +9.41 | -\$57.25 |
| 5 | TT system with propyzamide | ATR Bonito | 58 | 0.91 t/ha | \$71.51/ha | 68 | 0.41 t/ha | -\$213.15/ha | 91 | 1.47 t/ha | \$265.54/ha | 72.3 | 0.93 t/ha | \$41.30/ha |
| 6 | TT system with propyzamide | InVigor T4510 | 54 | +12.85 | -\$29.47 | 66 | +26.83 | -\$4.67 | 99 | +23.95 | +\$73.34 | 73.0 | +21.21 | +\$13.07 |
| 7 | TT system with Butisan 1.8 L/ha | 3000TR | 65 | +3.76 | -\$67.68 | 82 | +26.83 | -\$35.73 | 97 | +1.70 | -\$107.61 | 81.3 | +10.76 | -\$70.34 |
| 8 | TT system with trifluralin 2 L/ha | 3000TR | 38 | +0.92 | -\$142.13 | 48 | +17.07 | -\$92.50 | 78 | +4.61 | -\$104.86 | 54.7 | +7.53 | -\$113.16 |
| 9 | RT system with atrazine in 1st post-emergent spray | 3000TR | 95 | +40.28 | +\$78.40 | 100 | +58.54 | +\$26.20 | 97 | +1.09 | -\$124.88 | 97.3 | +33.30 | -\$6.76 |
| 10 | RT system with atrazine in 2nd post-emergent spray | 3000TR | 96 | +35.27 | +\$53.33 | 100 | +68.29 | +\$47.74 | 92 | +1.63 | -\$119.73 | 96.0 | +35.06 | -\$6.22 |
| 11 | RR system with propyzamide | 3000TR | 95 | +34.54 | +\$65.34 | 100 | +63.41 | +\$46.40 | 97 | +4.55 | -\$89.39 | 97.3 | +34.17 | +\$7.45 |
| 12 | RR system with propyzamide | InVigor R3520 | 96 | +52.67 | +\$169.43 | 100 | +97.56 | +\$138.95 | 97 | +42.74 | +\$243.00 | 97.7 | +64.32 | +\$183.79 |
| Pricing: CAG1 - \$527, CAN1 - \$567 | | | Delivered to CBH Mingenev | | | Delivered to CBH McLevie | | | Delivered to CBH Avon | | | | | |

Gross margin calculations take into account gross income less variable costs. Gross income is determined by calculating canola price, canola yield and oil bonuses. Variable costs are determined by calculating seed costs, technology fees, levies, pesticide costs, fertiliser costs, application costs, and freight.

Results

The trial run by the Mingenew-Irwin Group (MIG) at its Spring Field Day site near Arrino was different to the other two trials in that a high level of clethodim resistance was measured in the annual ryegrass population. This put pressure on the herbicide systems that were reliant on clethodim to control annual ryegrass. The best performer at this site was the RR system grown with InVigor R3520 (see figure 4), which yielded 35% higher than the ATR-Bonito treatment in a TT system (0.91 t/ha) and returned a gross margin of +\$169/ha more than the ATR-Bonito in a TT system (GM of \$71.51/ha). All other treatments using RT or RR systems at this site resulted in a 35 to 40% higher yield, with a gross margin \$53/ha to \$78/ha higher than the ATR-Bonito treatment. The RR and RT treatments achieved an ARG panicle reduction of 95-96%, whilst the best performing TT treatment only reduced panicle numbers by 67% (see table 2).

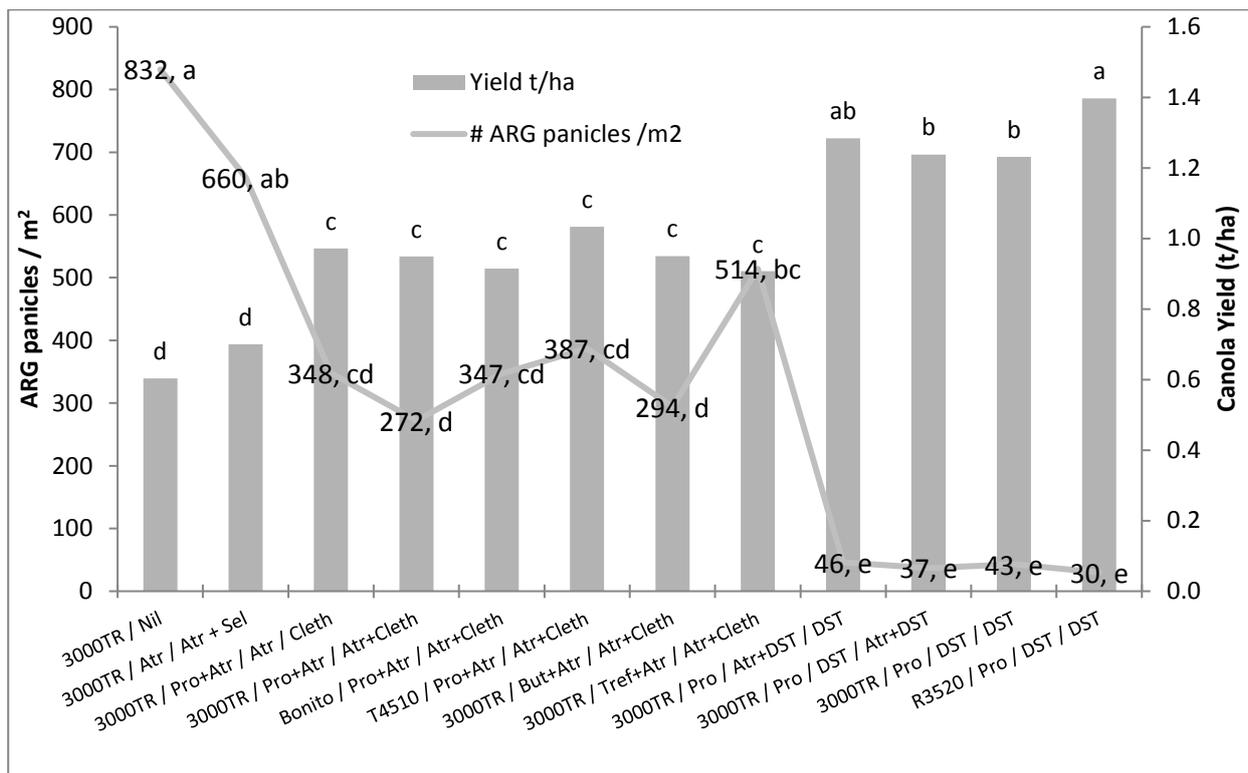


Figure 4: Annual ryegrass panicle control and crop yield results comparing different pre-emergent herbicide, variety and system treatments in canola at Arrino. Atr = atrazine, Sel = Select, Pro = propyzamide, But = Butisan, DST = Weedmaster DST. Data points followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

The trial run by the Liebe Group at its Spring Field Day site near Buntine was limited by an extremely dry start to the season, with no significant rainfall until 71 days after sowing. The hybrid RR variety (InVigor R3520) in an RR herbicide system recorded a 98% higher yield than ATR-Bonito in a TT herbicide system (see table 2). When comparing canola varieties in a standard TT system, the highest yielding variety was InVigor T4510, which recorded a 27% higher yield than ATR-Bonito. The treatment with the highest gross margin was the RR system treatment grown with InVigor R3520, which resulted in a benefit of +\$139/ha when compared to the ATR-Bonito treatment in a TT system. The other RR system treatment and both RT system treatments also resulted in a positive return, with returns of between +\$26/ha and +47/ha relative to the ATR-Bonito treatment. The highest level of weed control was achieved with the four treatments (treatments 9-12) that utilized RR and RT systems with 100% reduction of annual ryegrass panicles when compared to the untreated (see

figure 5). Of the different pre-emergent herbicides used alongside atrazine in the TT system Butisan recorded the highest level of ARG control (82%), followed by propyzamide (62%), and trifluralin (48%).

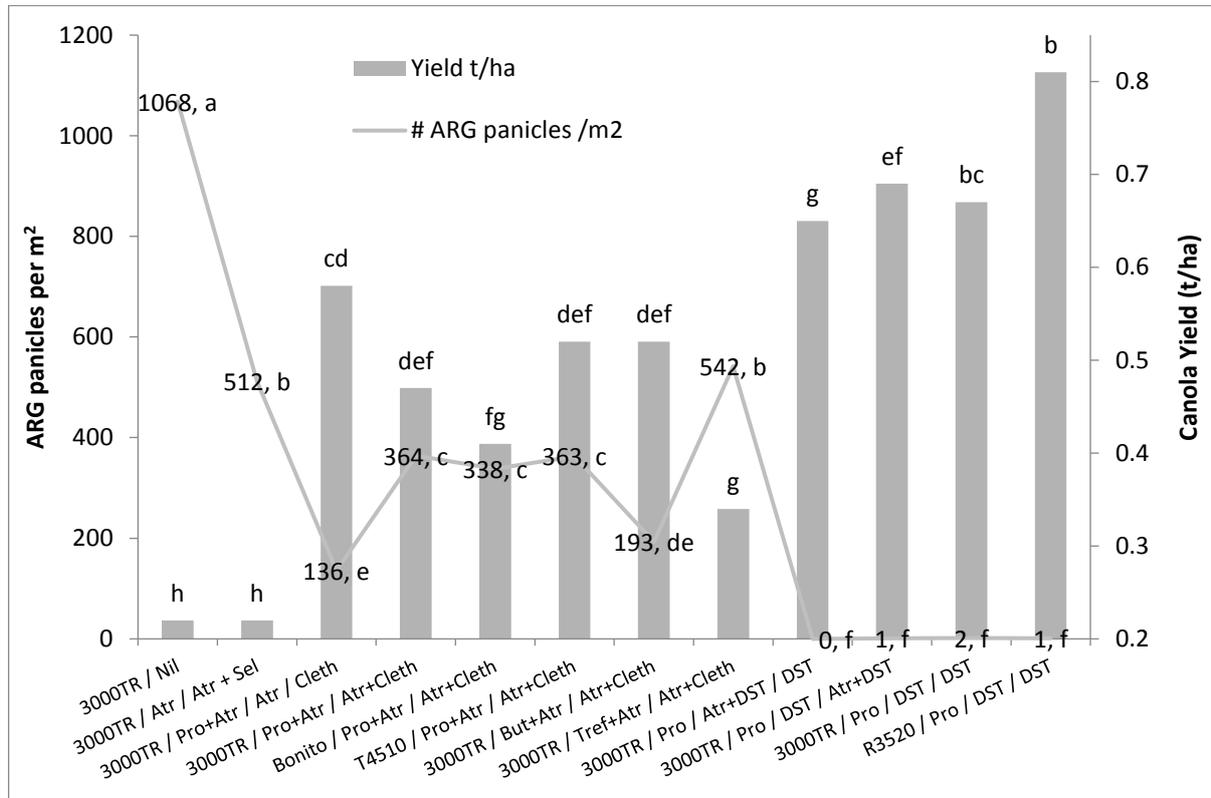


Figure 5: Annual ryegrass panicle control and crop yield results comparing different pre-emergent herbicide, variety and system treatments in canola at Buntine. Atr = atrazine, Sel = Select, Pro = propyzamide, But = Butisan, DST = Weedmaster DST. Data points followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

The trial at the Western Australian No-Tillage Farmers Association (WANTFA) trial site near Cunderdin was conducted in a paddock with a lower weed burden, and in a higher yielding environment with more favourable conditions for pre-emergent chemistry. The highest gross margin treatment was once again the RR system grown with InVigor R3520 (43% higher yield and +\$243/ha higher return when compared to ATR-Bonito in a TT system). Growing a hybrid TT variety (InVigor T4510) resulted in a 24% yield increase and a +\$73/ha gross margin advantage over growing the open-pollinated variety (ATR-Bonito). Due to some pod shattering and lost grain coupled with the lower weed burden not causing a limitation on yield, the advantages in using an RT system recorded in the other two trials was not observed in this trial. Most treatments at this site reduced ARG panicle numbers by $\geq 90\%$, with only the trifluralin with TT treatment (78%) and TT treatment with no pre-emergent grass herbicide (54%) recording lower control (see table 2).

Discussion

TT canola systems are highly reliant on the population of annual ryegrass being susceptible to clethodim. In the Arrino trial, where there was a confirmed populations of clethodim resistant annual ryegrass, the level of weed control was commercially unacceptable in all TT treatments (<67% control).

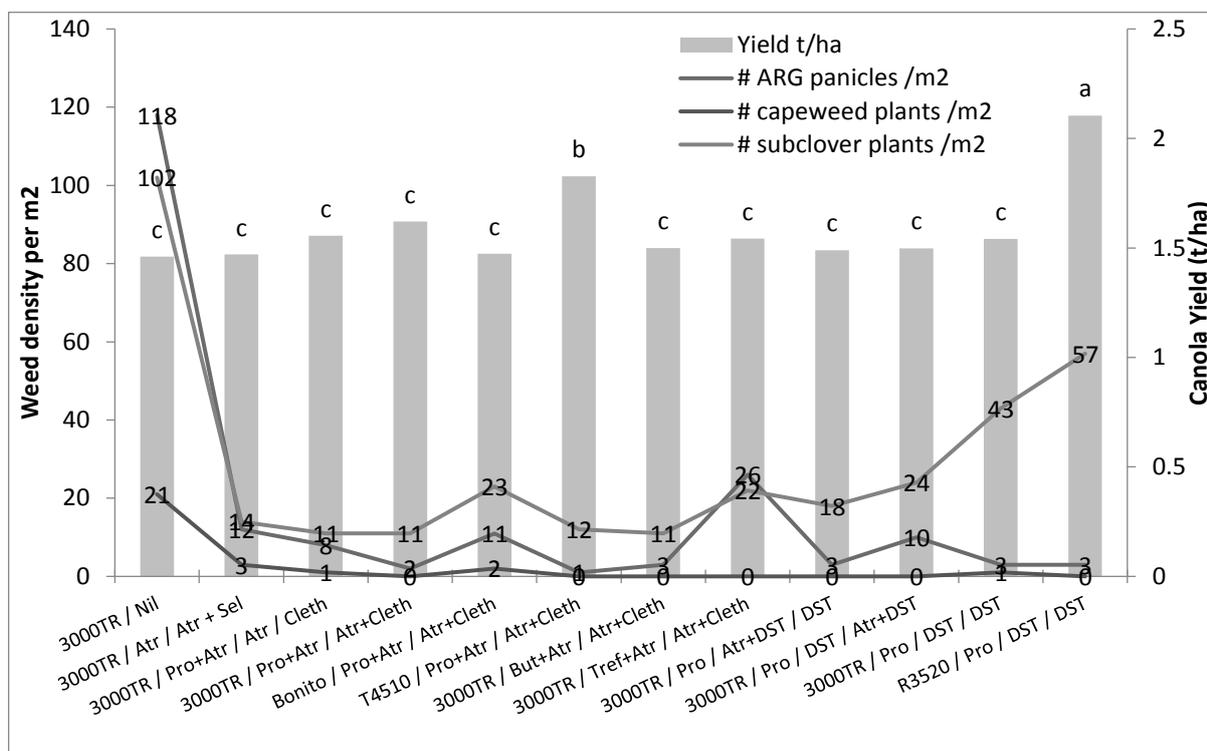


Figure 6: Weed control and crop yield results comparing different pre-emergent herbicide, variety and system treatments in canola at Cunderdin. Atr = atrazine, Sel = Select, Pro = propyzamide, But = Butisan, DST = Weedmaster DST. Data points followed by same letter do not significantly differ (Duncan's New Multiple Range at 5% significance level).

In all three sites the highest gross margin was achieved by InVigor R3520 using the RR canola system. This was due to a combination of superior weed control, superior hybrid vigour, and lower input costs when compared to the RT canola system.

The RT canola system treatments generated a higher gross margin compared to traditional TT systems when used in paddocks with a high weed burden; the level of weed control was consistently higher than a TT canola system. Using a combination of atrazine, propyzamide and glyphosate in an RT canola system also utilises three unique herbicide modes of action; when combined with harvest weed seed management practices this is a strategy to prevent the build-up of further herbicide resistant weed populations. An advantage of the RT system against the RR system was observed at the Cunderdin site, where a population of sub-clover was better controlled by treatments containing atrazine (see figure 6).

Pre-emergent chemistry is reliant on favourable early season growing conditions for effective weed control. In the Buntine trial, the dry start to the season meant that pre-emergent herbicides such as trifluralin and propyzamide recorded lower weed control. The use of a post-emergent glyphosate application was able to control the surviving weeds in the RR and RT canola systems (100% reduction in annual ryegrass panicles), whereas there were more variable results when using clethodim in a TT canola system (52-82% control).

The benefits of propyzamide were observed across all three trials, with the addition of propyzamide to the TT canola system resulting in an average increase in ARG control from 54% up to 77%, along with a 27% increase in yield and a +\$57/ha gain in gross margin. There was also a benefit over trifluralin when using propyzamide in the TT system: with improvements in ARG control (from 55% to 77%), a 9% increase in yield and a +\$56/ha improvement in gross margin. This is in addition to the benefit of giving trifluralin a “rest”

for a season (herbicide resistance management). The new pre-emergent herbicide Butisan recorded an increase in weed control compared to propyzamide (from 77% to 81%), and was a standout in the West Buntine site under tough conditions. However the high cost of the product resulted in an average \$10/ha lower gross margin.

The benefits of hybrid vigour was observed under the good early season growing conditions at the Cunderdin site, where the hybrid TT variety InVigor T4510 was much more profitable than the open-pollinated variety ATR-Bonito. Under more challenging conditions at Arrino and West Buntine InVigor T4510 was still able to out-yield the ATR-Bonito, but with a reduced gross margin.

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