Herbicide tolerance of canola varieties – a summary

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Key messages

Some canola varieties differ in their sensitivities to herbicides.

- ATR Bonito may be sensitive to propyzamide, ATR Snapper to s-metolachlor, ATR Mako to clopyralid + haloxyfop, Hyola® 404RR and Pioneer® 43Y23RR to clomazone + napropamide (Altiplano®) at label rate and timings.

- ATR Bonito registered narrow crop safety margin for s-metolachlor, ATR Mako for metazachlor (Butisan®), Pioneer Sturt for propyzamide, Hyola® 404RR and Pioneer® 45Y88 for butroxydim at the label rate and timings.

Triazine Tolerant and Roundup Ready® (RT) varieties (Hyola® 525RT® and Bayer 3000TR) tolerated a sequential application of glyphosate (621g/ha) followed by two-way tank mix of glyphosate with either atrazine or butroxydim or clethodim or clopyralid or haloxyfop or terbuthylazine quite well.

Pay careful attention to the label recommendations when growing canola where soil active and residual herbicides like isoxaben and terbuthylazine were used during cereal phase. Gallery® (isoxaben) used as pre-emergent in wheat and barley has a plant back period of 22 months with more than 300 mm rainfall (over two seasons) for canola. However, Nuseed GT-50RR showed sensitivity to terbuthylazine residues on a sandy loam even after satisfying the plant back period of 6 months with 175 mm rainfall.

Aims

To identify herbicide sensitivities of new canola varieties with the view to reduce their yield losses due to herbicide damage. This paper provides information on the following topics:

- Tolerance of new canola varieties to the herbicides those are common to all canola production systems ie conventional (CC), Triazine Tolerant (TT), Roundup Ready® (RR), Triazine Tolerant and Roundup Ready® (RT) and Clearfield® (CL).
- Tolerance of RT canola varieties to glyphosate mixes with other herbicides to reduce selection pressure on glyphosate.
- Residual effect of herbicides applied to wheat on a range of canola varieties grown in rotation.

Method

Eight trials were conducted under weed free conditions from 2014 to 2017 at Mullewa (1), Mingenew (3) and Katanning (4) using criss-cross design. The soil type at Mullewa was red loam (pH-$Cacl_2$ 5.8 and OC 0.75%), at Mingenew sandy (pH-$Cacl_2$ 4.9 and OC 0.9%) and yellow sandplain (pH-$Cacl_2$ 5.5 and OC 0.8%) and at Katanning sandy loam to loam (pH-$Cacl_2$ 4.9 - 5.1 and OC 1.1 - 1.25%). All the trials were sown using conseeder fitted with knife points and press-wheels to a depth of 2cm using around 3 kg seed rate/ha and it travelled at 4-5km/hr speed. The herbicide treatments were applied over the variety plots in three replications using spray rig fitted with air induction nozzles and shields on boom and it was calibrated to deliver 75-80L/ha water volume. The net plot length varied from 9.5 m to 20 m with plot centre to centre 1.8 m.

Table1: The results were summarised using following criteria:

– not tested or insufficient data
✓ no significant yield reductions at the label recommended rates in (Z) trials.

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N (w/z) narrow crop safety margin, significant yield reductions at higher than the label recommended rate, but not at the label recommended rate. Significant event occurring in w trials out of Z trials conducted. Eg (2/5) = tested in 5 trials, 2 trials returning with a significant yield reduction.
x% yield reduction (1/z), significant yield reduction at recommended rate in 1 trial only out of z trials conducted (warning).
x - y% yield reductions (w/z), significant yield reductions at recommended rate in w trials out of z trials conducted (warning), w = 2 or more trials.

Crop safety margins: Higher than label rates of some the herbicides were included in the trials to determine the crop safety margin of the herbicides at the maximum label rates. **Good crop safety margin** means that a herbicide at its maximum label rate and at the higher rate(s) was tolerated well by a crop variety. Whereas, **narrow crop safety margin** for a herbicide indicates that the variety tolerated the maximum label rate well, but at higher than the label rate(s) there was significant yield loss. A narrow crop safety margin implies that when spraying under less than optimal conditions, herbicide damage and yield loss may occur even at the label rate. For example, when overlapping herbicide; spraying under wet conditions (for soil active and residual herbicides) and /or there are stressed plants due to abiotic/biotic factors.

Results

Tolerance of canola varieties to herbicides common to all canola production systems (Table 2)

The canola grain yield varied substantially across trial locations predominantly due to season rainfall. The yield of the untreated control plots (mean of 6 varieties) ranged from 410 - 820kg/ha during 2014 at Mingenew, 310 - 660kg/ha during 2015 at Mingenew and 1370 - 1720kg/ha during 2017 at Katanning. During 2015 grain yield at Mingenew was the lowest among 3 years of testing and it was mainly due of dry conditions. Total rainfall from May to October at Mingenew during 2015 was 166mm which was 47% lower than 2014 rainfall (312 mm) during the same period.

Trifluralin, clethodim and clopyralid + clethodim at label rates and timing were tolerated well by all the varieties with no significant yield loss recorded

Clomazone + napropamide (Altiplano® at 3kg/ha) applied before seeding resulted in significant grain yield loss in Hyola® 404RR and Pioneer® 43Y23RR. ATR Bonito appeared to exhibit more intense bleaching symptoms caused by Altiplano® than the other varieties. Altiplano® is a new herbicide (Group Q and K) available for ryegrass and wireweed control in canola.

Metazachlor (Butisan®) at label rate applied before seeding was tolerated well by all the varieties. However, its crop safety margin was narrow for ATR Mako. Butisan® (Group K) is a new registration for control of ryegrass, wild oats and wire weed in canola.

S-metolachlor (eg Dual Gold®) applied before seeding at label rate reduced grain yield of ATR Snapper significantly whereas its crop safety margin was narrow for ATR Bonito. S-metolachlor (Group K) at label rate (240g/ha) provides control of Toad Rush (*Juncus bufonius* L.) in canola.

Propyzamide (eg Edge®/Rustler®) applied before seeding at label rate caused significant grain yield loss in ATR Bonito and its crop safety margin was narrow for Pioneer Sturt TT. Propyzamide (Group D) at label rate provides control of annual ryegrass and other grass weeds in canola.

Clopyralid + haloxyfop at 90g + 52g/ha applied at 2 leaf stage caused significant yield loss in ATR Mako, but all the other varieties tolerated this mixture quite well.

Butroxydim at 20g/ha applied at 4 leaf stage of canola was tolerated well by all the varieties but its crop safety margin was narrow for Hyola® 404RR and Pioneer 45Y88CL. According to the label, Factor® (butroxydim) is registered only for conventional, TT and CL canola production systems.

A spray drift of diflufenican at 100g/ha could be damaging to canola varieties. In 2014 diflufenican 100g/ha at 3-4 leaf stage of canola following diuron 270g/ha applied before seeding caused 22-78% grain yield loss across all the 6 varieties tested. RR canola varieties (Hyola® 404RR and Pioneer® 43Y23RR) appeared to tolerate this treatment better than the TT varieties, especially ATR Snapper and Sturt TT (data not shown).

Tolerance of TR canola varieties to glyphosate mixes with other herbicides (Table 3)

Grain yield in the untreated control plots of Hyola® 525RT® was 160kg/ha, 1050kg/ha and 1560kg/ha during 2015 at Mingenew, 2016 and 2017 at Katanning, respectively. Bayer 3000TR yielded 1500kg/ha grain in the untreated control plots during 2017 at Katanning.

Glyphosate 621g/ha applied mixed with other herbicides (atrazine or clethodim or clopyralid) at 3-4 leaf stage or sequential application of glyphosate at 621g/ha at 1-2 leaf stage followed by glyphosate at label rate alone or in two-way tank mixes with other herbicides (atrazine or butroxydim or clethodim or clopyralid or haloxyfop or terbuthylazine) applied at 4-5 leaf stage were tolerated well by Hyola® 525RT® and Bayer 3000TR.

Pre-emergent propyzamide or simazine at label rate followed by glyphosate at 621g/ha mixed either with atrazine or atrazine + terbuthylazine at 1-2 leaf stage and then followed by another application of glyphosate at 621g/ha at 4-5 leaf stage was also safe when applied to both Hyola® 525RT® and Bayer 3000TR.

Glyphosate at 621g/ha in two-way mix with non-registered or off label canola herbicides s-metolachlor at 960g or oxyfluorfen at 48g/ha applied at 3-5 leaf stage reduced grain yield of Hyola® 525RT® during 2015 (Dhammu *et.al*, 2016) or with dicamba at 100g/ha reduced grain yield of Bayer 3000TR during 2017 significantly (data not shown). S-metolachlor at 240g/ha is registered on canola for pre-emergent use only.

Residual effect of herbicides applied to wheat on canola varieties grown in rotation

Grain yield ranged from 922 – 1158kg/ha during 2015 at Mullewa and 843 – 1298kg/ha during 2016 at Katanning across 6 canola varieties at each site. ATR Bonito, Hyola® 404RR and Hyola® 525RT® were the common varieties at both the sites, whereas Hyola® 450TT, Hyola® 577CL and Yetna were tested at Mullewa and Hyola® 559TT, Nuseed GT-50RR and Pioneer® 43Y23RR were included in the trial at Katanning only.

Isoxaben (eg Gallery®) at higher than label rate (experimental rate) applied to wheat at 3-4 leaf stage on a red loam soil at Mullewa during 2014 season, almost completely inhibited emergence of all 6 canola varieties during 2015 season. The total rainfall within 10 months from isoxaben application in wheat during 2014 to seeding of canola during 2015 was 202mm. Pre-emergent isoxaben is registered on wheat, barley and triticale at 53-105g/ha for control of wild radish. Isoxaben is also one of the components in X-Pand® herbicide (100g/ha) that is registered as an early post-emergent on wheat, barley and triticale. According to the label, if you use pre-emergent isoxaben at 53-105g/ha in cereals, then the plant back period for canola is 22 months along with more than 300mm rainfall in total (first and second seasons).

Terbuthylazine (eg Terbyne® Xtreme®) at 1050g/ha and at the higher rate applied pre-emergent to wheat on a sandy loam soil at Katanning during 2015 reduced grain yield of Nuseed GT-50RR by 12-15% during 2016 season whilst the yield of the other five varieties was not affected significantly. The total rainfall at Katanning from application of terbuthylazine on wheat during 2015 to seeding of canola after 11.5 months during 2016 was 435mm. According to the label, plant back period for canola after terbuthylazine application is 6 months with 175mm rainfall.

A number of herbicides and herbicide mixes applied to 6 wheat varieties at the label rates at Mullewa during 2014 and Katanning during 2015 had no significant negative effect on grain yield of 6 canola varieties at Mullewa during 2015 and at Katanning during 2016 seasons, respectively. These included pyroxasulfone + trifluralin (Sakura® + Triflur® X 480), s-metolachlor + prosulfocarb (Boxer® Gold), sulfosulfuron + trifluralin (Monza® + Triflur® X 480), sulfosulfuron + s-metolachlor + prosulfocarb (Monza® + Boxer® Gold), trifluralin + s-metolachlor + prosulfocarb (Triflur® X 480 + Boxer® Gold) applied before seeding, metribuzin applied at 2-3 leaf stage, carfentrazone + metribuzin (Aptitude®) + MCPA, diflufenican + bromoxynil + MCPA (Triathlon®, Howitzer®, Soar®) applied at 3-4 leaf stage, diflufenican + bromoxynil (Jaguar®, Ruger®), bromoxynil+ pyrosulfotole (Velocity®) and bromoxynil + bicyclopyrone (Talinor®) applied at 5-6 leaf stage (data not shown).

Conclusion

Current canola varieties appear to have good tolerance to herbicides at label rates as only 5% of the total 112 variety x herbicides combinations tested over 3 years turned out to be statistically significant. No herbicide consistently caused significant yield loss in more than one trial/year across varieties.

Glyphosate two or three-way mixes with herbicides registered on canola were tolerated well by Hyola® 525RT® and Bayer 3000TR.

Isoxaben and terbuthylazine residues have potential to negatively affect canola establishment and/or grain yield.

Reference:

Dhammu Harmohinder, Moore John, and Bartlett Paul (2016) Tolerance of Hyola® 525RT® canola to glyphosate mixes. In Proceedings of GRDC Grains Research Updates 2016. Perth convention and exhibition centre, Perth on 29th February to 1st March 2016, WA, Australia. http://www.giwa.org.au/2016researchupdates

Note: Always follow label recommendations. The Department Primary Industries and Regional Development, does not endorse the use of herbicides above the registered rate or off-label use of herbicides or off-label tank mixes. Crop tolerance and yield responses to herbicides are strongly influenced by seasonal conditions.

Key words

Herbicides, glyphosate, herbicide residues, canola.

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Table 2: Canola varieties response (% grain yield loss in w out of z trials) to herbicides during 2014 and 2015 at Mingenew, and during 2017 at Katanning, WA.

Herbicides	Rate a.i./ha	Timing	ATR Bonito TT	ATR Mako TT	ATR Snapper TT	ATR Stingray TT	Hyola® 404 RR	Hyola® 450 TT	Hyola® 525 RT	Nuseed GT-53 RR	Pioneer 43Y23 RR	Pioneer 45Y88 CL	Pioneer Sturt TT	Yetna
> Year of varieties' testing			2015, 2017	2017	2014	2014	2014-15 2017	2014-15	2015	2017	2014-15, 2017	2017	2014	2015
Metazachlor (Butisan®)	900 g	Pre-seeding	√ (1)	N (1/1)	-	-	√ (1)	-	-	√ (1)	√ (1)	√ (1)	-	-
Napropamide + clomazone (Altiplano®)	1200 g + 105 g	Pre-seeding	√ (2)	√ (1)	-	-	**25 (1/2)**	√ (1)	√ (1)	√ (1)	**30 (1/2)**	√ (1)	-	√ (1)
Napropamide + clomazone + triallate + trifluralin	1200 g + 105g + 1000 g + 960 g	Pre-seeding	√ (1)	√ (1)	-	-	√ (1)	-	-	√ (1)	√ (1)	√ (1)	-	-
Propyzamide	500 g	Pre-seeding	**12 (1/2)**	√ (1)	√ (1)	√ (1)	√ (3)	√ (2)	√ (1)	√ (1)	√ (3)	√ (1)	N (1/1)	√ (1)
S-metolachlor	240 g	Pre-seeding	N (1/1)	-	**24 (1/1)**	√ (1)	√ (2)	√ (2)	√ (1)	-	√ (2)	-	√ (1)	√ (1)
Trifluralin	1440 g	Pre-seeding	√ (2)	√ (1)	√ (1)	√ (1)	√ (3)	√ (2)	√ (1)	√ (1)	√ (3)	√ (1)	√ (1)	√ (1)
Clethodim + oil adjuvant	120 g + 1%	2 leaves	-	-	√ (1)	√ (1)	√ (1)	√ (1)	-	-	√ (1)	-	√ (1)	-
Clopyralid + clethodim + oil adjuvant	90 g + 120 g + 1%	2 leaves	√ (1)	√ (1)	-	-	√ (1)	-	-	√ (1)	√ (1)	√ (1)	-	-
Clopyralid + haloxyfop + oil Adjuvant	90 g + 52 g + 0.5%	2 leaves	√ (2)	**12 (1/1)**	√ (1)	√ (1)	√ (3)	√ (2)	√ (1)	√ (1)	√ (3)	√ (1)	√ (1)	√ (1)
Butroxydim + Superchage	20 g + 1%	4 leaves	√ (1)	√ (1)	-	-	N (1/1)	-	-	√ (1)	√ (1)	N (1/1)	-	-
Clethodim + oil adjuvant	120 g + 1 %	8 leaves	-	-	√ (1)	√ (1)	√ (1)	√ (1)	-	-	√ (1)	-	√ (1)	-

See Table 1 for explanation of shading and marking. a.i = active ingredient. The products used in the trials were Altiplano® (napropamide + clomazone), Butisan® (metazachlor), Dual Gold® (s-metolachlor), Edge® 900/Rustler® 500 (propyzamide), Factor® (butroxydim), Lontrel® 750 (clopyralid), Select® 240 (clethodim), Triflur® X 480 (trifluralin), Verdict® 520 (haloxyfop). Clethodim was applied with Hasten™ and clopyralid + haloxyfop with Uptake™ oil. Clethodim treatments at 8 leaves+ were applied before flower bud became visiable (green).

Treatments were compared with untreated control within each variety.

Table 3: Canola varieties response to glyphosate mixes for seed yield during 2015 at Mingenew, and during 2016 and 2017 at Katanning, WA.

NO	Herbicides	Rate a.i./ha	Timing		Bayer 3000TR	Hyola® 525RT®
				Year of testing	2017	2015,16 and 17
1	Glyphosate (GLP)	621g	3-4/1-2 leaves	2015-16	-	√ (2)
2	GLP + atrazine + Hasten™	621g + 990g + 1%	3-4 leaves	2015	-	√ (1)
3	GLP + clethodim + Hasten™	621g + 120g + 1%	3-4 leaves	2015	-	√ (1)
4	GLP + clopyralid	621g + 90g	3-4 leaves	2015	-	√ (1)
5	GLP fb GLP	621g fb 621g	1-2 leaves fb 4-5 leaves	2016-17	√ (1)	√ (2)
6	GLP fb GLP + atrazine + Hasten™	621g fb 621g + 990g + 1%	1-2 leaves fb 4-5 leaves	2016-17	√ (1)	√ (2)
7	GLP fb GLP + butroxydim + Supercharge®	621g fb 621g + 20 g + 1%	1-2 leaves fb 4-5 leaves	2017	√ (1)	√ (1)
8	GLP fb GLP + clethodim + Hasten™	621g fb 621g + 120g + 1%	1-2 leaves fb 4-5 leaves	2016-17	√ (1)	√ (2)
9	GLP fb GLP + clopyralid	621g fb 621g + 90g	1-2 leaves fb 4-5 leaves	2016-17	√ (1)	√ (2)
10	GLP fb GLP + haloxyfop + Uptake™	621g fb 621g + 52g + 0.5%	1-2 leaves fb 4-5 leaves	2017	√ (1)	√ (1)
11	GLP fb GLP + terbuthylazine	621g fb 621g + 1050g	1-2 leaves fb 4-5 leaves	2017	√ (1)	√ (1)
12	Propyzamide fb GLP + atrazine fb GLP	500g fb 621g + 990g fb 621g	Pre-seeding fb 1-2 leaves fb 4-5 leaves	2016	-	√ (1)
13	Propyzamide fb GLP + terbuthylazine + atrazine fb GLP	500g fb 621g + 788g + 600g fb 621g	Pre-seeding fb 1-2 leaves fb 4-5 leaves	2016	-	√ (1)
14	Propyzamide fb GLP + terbuthylazine + atrazine fb GLP	500g fb 621g + 788g + 990g fb 621g	Pre-seeding fb 1-2 leaves fb 4-5 leaves	2017	√ (1)	√ (1)
15	Simazine 900 fb GLP + atrazine fb GLP	990g fb 621g + 990g fb 621g	PSPE fb 1-2 leaves fb 4-5 leaves	2017	√ (1)	√ (1)

See Table 1 for explanation of shading and marking. a.i = active ingredient, fb = followed by, and PSPE = Post seeding pre-emergent.
The products used in the trials were Atrazine 600/900 (atrazine), Butisan® (metazachlor), Rustler® 500 (propyzamide), Factor® (butroxydim), Lontrel® 750 (clopyralid), Select® 240 (clethodim), Simazine 900 (simazine), Terbyne® Xtreame® (terbuthylazine) and Verdict® 520 (haloxyfop).
For treatments 1-11,first application of glyphosate at 1-2 or 3-4 leaf stage was made with AMS 0.8% (Ammonium Sulfate, 980 g/kg). In treatment 5 both applications of glyphosate were made with AMS 0.8%.
Treatments 12 -15 were applied with Li700 0.1%, AMS 0.8% and Uptake™ 1% for both post-emergent applications.
Treatments were compared with untreated control within each variety.