Annual ryegrass viable seed reduced by desiccation and swathing of canola

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Key messages

The viability of annual ryegrass seed can be reduced substantially by desiccation, pre-harvest spraying or swathing of canola depending on the product and timing.

Pre-harvest spray with greater than 2.0 L/ha glyphosate weedmaster® DST® significantly ($p<0.05$) reduced ryegrass seed viability by an average of 96% in 2013 at Katanning.

Rates greater than 1300 g a.i./ha of glyphosate product X1 (unregistered) on a swather reduced viable ryegrass seed set by an average of 45% in 2010 and 33% in 2011 at Mt Barker.

All desiccation and pre-harvest treatments had no effect on canola yield or oil content in 2012 and 2013 at Katanning although there were some small but variable reductions in yield in 2010 and oil in 2011 at Mt Barker.

On average, desiccation with diquat reduced the viable ryegrass seed production by 65% in 2010 and 88% in 2013 but not in 2011 or 2012, which may be due to the spray timing being too late for the ryegrass.

Aims

To test the effect of desiccation, pre-harvest spraying, swathing and swather spraying on ryegrass seed viability at harvest of canola.

Method

Field studies were conducted at Mt Barker in 2010 and 2011 and Katanning in 2012 and 2013 to investigate techniques to reduce annual ryegrass viable seed set. The Mt Barker experiments included swathing with a commercially available sprayer kit attached and desiccation of the standing crop while at Katanning only desiccation was tested. The experiments were conducted in a randomised block design with 3 replications.

The ryegrass head density was measured after harvest in four 0.1m^2 quadrats/plot in 2010 and in four 0.2 by 0.2 m quadrats/plot in 2011. Also in both years 30 ryegrass heads/plot were collected from the ground after harvest and from the swaths for ryegrass seed viability determination. In 2012, ryegrass head number was determined from six 0.5 x 0.5 m quadrats/plot before harvest and in 2013 from two 0.32 x 0.32 m quadrats/plot before harvest. Ryegrass head samples from each plot were threshed and the ryegrass seed viability was tested by germinating 100 seeds in Petri dishes in a growth cabinet on a 12 hour cycle of 15/25°C (night/day). The remaining ungerminated seed were tested using tetrazolium chloride for viability and added to the germination count.

The viable ryegrass for the swathed treatments was calculated by the percentage seed viability in the swaths multiplied by the difference in head number between swathing and harvest (which was assumed to be in the swath) multiplied by the seeds per head. The on-ground viable ryegrass was the head number measured on the ground after harvest multiplied by the on-ground ryegrass seed viability percentage multiplied by the seeds per head. The total viable ryegrass was then the in-swath plus the on-ground ryegrass.

In the first three years, unregistered glyphosate formulations were used for experimental purposes. In this paper, they will be referred to as glyphosate product X1 (in 2010 and 2011) and glyphosate product X2 (in 2012).

2010 treatments at Mt Barker:

Treatments included untreated control, swathing, desiccation with diquat at around 75% seed colour change (as per label when 70% of the pods are yellow and the seeds are browny/bluish and pliable), swathing with two rates of diquat and three rates of glyphosate product X1 at 75% seed colour change and pre-harvest spray with six rates of glyphosate product X1 at 75% seed colour change.

Experiment details:

Swathing:	23 November: 2 rates of diquat (300 and 600 g a.i./ha + 0.16% BS1000® wetter) and three rates glyphosate product X1 (970, 1940, 3890 g a.i./ha)
Pre-harvest:	23 November: 3 rates glyphosate product X1 (970, 1940, 3890 g a.i./ha)
Desiccation:	23 November: 1 rate of diquat (600 g a.i./ha + 0.16% BS1000® wetter)
Equipment:	MacDon® 3020 PTO swather with 25’ (7.62m) cut with Brando Hill spray kit attached

All herbicides applied with Spraying Systems® Floodjet TK-.75 nozzles 50 cm apart working at 1.0 bar giving 75 L/ha water at 5.4 km/h.

Harvest: 21 December: KEW plot harvester with three Harvestaire® crop lifters for the swaths.

Treatment timing: The canola seed colour changed quickly as it was 30% colour change on the main stem (less on random average of the entire plant) the week before and 75% random average the day of swathing and so all desiccation was done on the same day.

2011 treatments at Mt Barker:

Treatments included untreated control, swathing, desiccation with diquat, swathing with two rates of diquat and swathing with three rates of glyphosate product X1 and pre-harvest with three rates of glyphosate product X1 with two timings.

Experiment details:

Swathing: 28 November: 3 rates of glyphosate product X1 (970, 1300 and 1940 g a.i./ha) at 80% seed colour change.

Pre-harvest: 23 November: 3 rates of glyphosate product X1 at 970, 1300 and 1940 g a.i./ha at 30% seed colour change.
25 November: 3rates of glyphosate product X1 at 970, 1300 and 1940 g a.i./ha at 60% seed colour change.

Desiccation: 28 November: 1 rate of diquat (600 g a.i./ha + 0.16% BS1000® wetter) at 80% seed colour change

Harvest: 23 December with a KEW plot harvester with two Harvestaire® crop lifters for the swaths.

Equipment: MacDon® 3020 PTO swather with 25' (7.62 m) cut with Brando Hill spray kit attached
Swathing and Pre-harvest herbicides applied with Spraying Systems® Floodjet TK-.75 nozzles 50 cm apart working at 1.0 bar giving 75 L/ha water at 5.4 km/h.
Desiccation herbicides applied with Lechler® IDK120-02 nozzles 50 cm apart, water rate 80 L/ha at 11 km/h

Treatment timing: On 23 November after a hot windy day, a random pod selection gave about 30% seed colour change, so the first pre-harvest treatment was done. On 25 November the canola appeared to be around 60% seed colour change so the second pre-harvest treatment was done. Swathing was done on 28 November at about 80% seed colour change, which perhaps was a little late for swathing but suitable for desiccation with diquat.

2012 treatments at Katanning:

The treatments included untreated control, desiccation with three rates of diquat and pre-harvest with four rates and two timings of glyphosate product X2, an unregistered product at the time of this work.

Experiment details:

Pre-harvest: 29 October: 4 rates of glyphosate product X2 (660, 1080, 1510 and 1940 g a.i./ha) at 20% seed colour change
2 November: 4 rates of glyphosate product X (same as 29 October) at 50% seed colour change

Desiccation: 7 November: 3 rates of diquat (300, 450 and 600 g a.i./ha) at 80% seed colour change

Harvest: 20 November with a KEW plot harvester.

Equipment: All herbicides sprayed with TT110015 nozzles, 2.4 bar, medium droplets with 50 L/ha at 12.8 km/h

2013 treatments at Katanning:

The treatments included untreated control, desiccation with two rates of diquat, pre-harvest with now registered glyphosate product weedmaster® DST® at three rates, two timings and three water rates.

Experiment details:

Pre-harvest: 18 October 2013: with 3 rates of weedmaster® DST® (940, 1410 and 1880 g a.i./ha) with 3 rates of water (40, 80 and 120 L/ha) and 20% colour change (actually 37%)
22 October 2013: same treatments as 18 October but at 50% colour change

Desiccation: 25 October 2013: 2 rates of diquat (400 and 600 g a.i./ha + 0.16% BS1000® wetter) and 100 L/ha water

Harvest date: 20 November 2013

Application: All treatments sprayed with green 110015 AIXR teejet nozzles at 2.3 bar

For the different water rates: Instead of changing nozzles to vary the water rates it was decided to keep the travel speed the same at 15.6 km/h using green 110015 AIXR teejet nozzles at 2.3 bar, spray quality = coarse, and used 1 pass = 40 L/ha, 2 passes = 80 L/ha, 3 passes = 120 L/ha.

Other site details: The trial was very weed free early on but the late rain produced very large numbers and growth of ryegrass with the average ryegrass head number of 607/m^2. On 17 October a random sample from all stages of plants showed the seed colour change was 11 in 30 pods = 37%.

Results

The results of the four years showed that a pre-harvest spray with glyphosate or spraying glyphosate on a swather can reduce the viable ryegrass substantially although in 2012 there appeared to be no effect. Diquat had no effect on viable ryegrass seed in 2011 and 2012 but did reduce viable ryegrass seed numbers in 2010 and 2013.

2010 Experiment

While the diquat at 600 g a.i./ha appeared to have the lowest viable ryegrass seed it did not differ to most glyphosate product X1 rates whether pre-harvest or when sprayed on the swather (Table 1).

There appeared to be no ryegrass heads in the swaths as the cutting height was relatively high and most of the ryegrass was bent over close to the ground. The ryegrass head density showed there were no significant differences between treatments (Table 1). The seeds per head varied between 40 and 55. The yield was low given the relatively late sowing and relatively low growing season rainfall. Even though the canola yield did not vary greatly, the desiccation with diquat at 600 g a.i./ha yielded slightly more than some swathing treatments (Table 1). The oil content showed no significant differences at the 5% level.

2011 Experiment

Swathing with above 1300 g a.i./ha of glyphosate product X1 or pre-harvest with above 1300 g a.i./ha of product X1 at either 30% or 60% seed colour change reduced ryegrass seed viability by an average of 74% compared to the average of the nil and swathing alone (Table 2). None of the treatments differed in viability of seed collected from the swaths, which averaged 76%. Desiccation with 600 g a.i./ha diquat did not reduce the viability of ryegrass.

There was no difference ($p<0.05$) in yield between treatments (Table 2). The oil content however was reduced with the desiccation with 600 g a.i./ha diquat treatments and also with the 1940 g a.i./ha product X1 rate at 60% colour change. The other glyphosate product X1 rates did not change the oil content.

There were lower ryegrass head numbers in the swathing treatments than the desiccation treatments (Table 2). This is most likely due to the ryegrass heads seen in the swath after being cut off.

Table 1. Yield, oil, ryegrass head density and viable ryegrass in the treatments in 2010 at Mt Barker.

Treatment	Yield* (t/ha)	Oil (%)	Ryegrass (heads/m^2)	Viable ryegrass* (seed/m^2)
1. Nil, no swath + no crop top	1.10 bcde	42.9	69	2600 a
2. Swathing + no spraying on swather	1.04 bcdef	41.9	50	1480 bcde
3. Desiccation 600 g a.i./ha diquat	1.21a	43.1	78	908 de
4. Swathing + 300 g a.i./ha diquat on swather	1.03 bcdef	42.4	70	2100 ab
5. Swathing + 600 g a.i/ha diquat on swather	1.01 def	42.6	64	1830 abcd
6. Swathing + 970 g a.i./ha product X1	1.11abcde	42.1	51	1340 bcde
7. Swathing + 1940 g a.i./ha product X1	0.97 ef	42.5	76	1800 abcd
8. Swathing + 3890 g a.i./ha product X1	1.13abcd	42.3	51	1040 de
9. Pre-harvest 490 g a.i./ha product X1	1.04 bcdef	42.5	76	1540 bcd
10. Pre-harvest 970 g a.i./ha product X1	1.12abcd	42.4	49	1370 bcde
11. Pre-harvest 1460 g a.i./ha product X1	1.17ab	42.6	79	2030 abc
12. Pre-harvest 1940 g a.i./ha product X1	1.02 cdef	42.8	59	1390 bcde
13. Pre-harvest 2920 g a.i./ha product X1	1.12abcd	42.0	66	1310 bcde
14. Pre-harvest 3890 g a.i./ha product X1	1.16abc	42.0	65	1150 cde
Lsd ($p<0.05$)	0.146	n.s.	n.s.	941
P-value	0.019	0.08	0.383	0.018
C of V (%)	8.1	1.2	26.7	37.6

* Means with similar letters in a column are not significantly different at the 5% level.

The ryegrass head density remaining in the plots after harvest on 23 December showed no differences between treatments (Table 2). This suggests the direct harvesting also captured the ryegrass heads so either swathing or direct harvesting removed around 60% of the ryegrass heads. If this material from the header was collected in a chaff cart, windrow burnt or processed through a Harrington Seed Destructor it would possibly remove 60% of this ryegrass seed.

2012 Experiment

The site was variable in that the yield increased along each replication. The average yields however did not differ across the treatments (Table 3) even at high rates of glyphosate product X2 and 20% seed colour change. Oil content also did not change with treatment.
The ryegrass head number was somewhat variable but there was no difference between treatments (Table 3). The viable ryegrass numbers also did not differ between treatments. All spray treatments averaged 60% viability so maybe the ryegrass seed development was already passed the point of treatments affecting seed viability.

Table 2. Yield, oil, ryegrass head density and viable ryegrass seed in the treatments in 2011 at Mt Barker.

Treatment	Yield (t/ha)	Oil content* (%)	Ryegrass 23 Dec (heads/m^2)	Viable ryegrass* (seeds/m^2)
1. Nil, no swath + no crop top	2.22	46.4 bc	75.0	2046 abcd
2. Swathing + no spraying on swather	1.76	46.0 bcd	64.6	3143 a
3. Desiccation 600 g a.i./ha diquat	1.99	44.5 f	83.3	2173 abc
4. Swathing + 300 g a.i./ha diquat on swather	1.97	45.0 def	75.0	2296 abc
5. Swathing + 600 g a.i./ha diquat on swather	1.92	45.3 def	64.6	2140 abc
6. Swathing + 970 g a.i./ha product X1	1.57	46.0 bcd	63.9	2676 ab
7. Swathing + 1300 g a.i./ha product X1	1.81	45.8 cde	52.1	1414 bcde
8. Swathing + 1940 g a.i./ha product X1	1.57	46.7 ab	56.3	1315 bcde
9. Pre-harvest 970 g a.i./ha product X1 30%	1.68	47.4 a	97.9	1902 abcd
10. Pre-harvest 1300 g a.i./ha product X1 30%	2.06	46.9 ab	60.4	652 de
11. Pre-harvest 1940 g a.i./ha product X1 30%	1.75	47.6 a	79.6	950 cde
12. Pre-harvest 970 g a.i./ha product X1 60%	2.12	46.7 ab	64.6	933 cde
13. Pre-harvest 1300 g a.i./ha product X1 60%	2.16	46.5 bc	56.3	657 de
14. Pre-harvest 1940 g a.i./ha product X1 60%	1.47	44.3 f	35.4	399 e
Lsd (p<0.05)	n.s.	0.98	n.s.	1459
P-value	0.453	<0.001	0.389	0.009
C of V (%)	21.7	1.3	38.0	56.1

* Means with similar letters in a column are not significantly different at the 5% level.

Table 3. Yield, oil, ryegrass head density and viable ryegrass with treatment at Katanning in 2012.

Treatment	Yield (t/ha)	Oil (%)	Ryegrass (heads/m^2)	Viable ryegrass (seed/m^2)
1. Nil, no crop top	1.27	48.8	5.8	83
2. Desiccation 300 g a.i./ha diquat	1.28	49.1	4.9	63
3. Desiccation 450 g a.i./ha diquat	1.16	49.0	3.8	64
4. Desiccation 600 g a.i./ha diquat	1.18	48.8	5.8	61
5. Pre-harvest 660 g a.i./ha product X2 20%	1.14	49.6	6.4	57
6. Pre-harvest 1080 g a.i./ha product X2 20%	1.28	49.2	8.2	59
7. Pre-harvest 1510 g a.i./ha product X2 20%	1.19	49.4	10.4	57
8. Pre-harvest 1940 g a.i./ha product X2 20%	1.28	48.8	4.4	58
9. Pre-harvest 660 g a.i./ha product X2 50%	1.15	48.8	7.6	66
10. Pre-harvest 1080 g a.i./ha product X2 50%	1.27	49.6	5.3	65
11. Pre-harvest 1510 g a.i./ha product X2 50%	1.17	49.7	5.1	60
12. Pre-harvest 1940 g a.i./ha product X2 50%	1.13	49.0	10.7	54
Average	1.21	49.1	6.5	62
Lsd (p<0.05)	n.s.	n.s.	n.s.	n.s.
P-value	0.104	0.429	0.537	0.122
C of V%	13.6	1.2	62.1	15.7

2013 Experiment

In 2013 there was no effect of treatment on yield or oil content but the canola seed size was smaller with the diquat treatment (Table 4). This might suggest the last pods to fill were stopped quickly but this did not reduce yield. The viable ryegrass was reduced with all desiccation and pre-harvest treatments but there were no significant differences between treatments. Perhaps the late germinating ryegrass, slightly earlier application time and higher water rate allowed the diquat to work more effectively than in other years.

Table 4. Canola yield, oil, seed weight, ryegrass head number and viable ryegrass density with treatment at Katanning in 2013.

Treatment	Yield (t/ha)	Oil content (%)	Canola seed wt* (g/1000)	Ryegrass heads per m^2	Viable ryegrass density* (seed/m^2)
1. Nil, no crop top	1.23	48.7	2.82 ab	798	14477 a
2. Desiccation 400 g a.i./ha diquat 100L/ha 80%	1.18	48.8	2.66 c	628	2194 bc
3. Desiccation 600 g a.i./ha diquat 100L/ha 80%	1.15	48.7	2.65 c	550	1373 bc
4. Pre-harvest 940 weedmaster® 40L/ha 20%	1.02	48.9	2.83 ab	745	240 c
5. Pre-harvest 940 weedmaster® 80L/ha 20%	1.14	49.2	2.84 ab	520	256 c
6. Pre-harvest 940 weedmaster® 120L/ha 20%	1.18	48.7	2.84 ab	713	487 c
7. Pre-harvest 1410 weedmaster® 40L/ha 20%	1.15	49.0	2.83 ab	575	159 c
8. Pre-harvest 1410 weedmaster® 80L/ha 20%	1.06	49.1	2.81 ab	635	282 c
9. Pre-harvest 1410 weedmaster® 120L/ha 20%	1.21	49.5	2.82 ab	613	111 c
10. Pre-harvest 1880 weedmaster® 40L/ha 20%	1.15	49.3	2.84 ab	602	0 c
11. Pre-harvest 1880 weedmaster® 80L/ha 20%	1.31	48.6	2.84 ab	580	572 c
12. Pre-harvest 1880 weedmaster® 120L/ha 20%	1.14	49.4	2.84 ab	542	801 bc
13. Pre-harvest 940 weedmaster® 40L/ha 50%	1.18	49.2	2.81 ab	505	570 c
14. Pre-harvest 940 weedmaster® 80L/ha 50%	1.12	48.9	2.82 ab	642	833 bc
15. Pre-harvest 940 weedmaster® 120L/ha 50%	1.11	49.2	2.83 ab	527	3424 b
16. Pre-harvest 1410 weedmaster® 40L/ha 50%	1.24	48.5	2.89 a	558	787 bc
17. Pre-harvest 1410 weedmaster® 80L/ha 50%	1.15	49.1	2.83 ab	512	729 bc
18. Pre-harvest 1410 weedmaster® 120L/ha 50%	1.05	48.8	2.81 ab	583	1105 bc
19. Pre-harvest 1880 weedmaster® 40L/ha 50%	1.09	48.7	2.79 b	670	477 c
20. Pre-harvest 1880 weedmaster® 80L/ha 50%	1.21	48.5	2.81 ab	545	190 c
21. Pre-harvest 1880 weedmaster® 120L/ha 50%	1.15	49.4	2.80 ab	708	537 c
Average	1.15	49.0	2.81	607	1410
Lsd (p<0.05)	n.s.	n.s.	0.0965	n.s.	2768
P-value	0.93	0.544	0.004	0.158	<0.001
C of V%	0	1.1	2.1	19.4	118.8
	14.0				

* Means with similar letters in a column are not significantly different at the 5% level.

Conclusion

The results from 2010 to 2013 showed that desiccation with diquat, a pre-harvest spray with glyphosate or spraying glyphosate on a swather can reduce the viable ryegrass substantially. The ability of glyphosate to reduce seed viability when applied pre-harvest however, may depend on the timing. In 2012 there was no effect on ryegrass viability and viability was not affected by rates of glyphosate product X2 at 20% or 50% seed colour change although the viable ryegrass numbers were relatively small in that year.

The reduction in ryegrass viability can sometimes be greater when the glyphosate is sprayed pre-harvest and not swathed (compared to swathing) but this varied with season. In 2011, pre-harvest with above 1300 g a.i./ha of glyphosate product X1 at either 30% or 60% seed colour change reduced ryegrass seed viability by an average of 74% compared to the average of the nil and swathing alone. In 2011, swathing with above 1300 g a.i./ha of product X1 also reduced ryegrass seed viability but by an average of 47% compared to nil and swathing alone. By comparison, in 2010, desiccation with 600 g a.i./ha diquat or the pre-harvest product X1 above 970 g a.i./ha reduced ryegrass seed viability by around 50%.

All desiccation and pre-harvest treatments had no effect on canola yield or oil content in 2012 and 2013 at Katanning although there were some small but variable reductions in yield in 2010 and oil in 2011 at Mt Barker.

Desiccation with diquat had no effect in 2011 and 2012 but in 2010 it reduced ryegrass seed viability to a similar extent as a pre-harvest spray with glyphosate or spraying glyphosate on a swather. The canola seed size was reduced with the diquat treatment in 2013.

Key words

Canola, direct harvesting, swathing, desiccation, pre-harvest, ryegrass, seed viability, diquat, glyphosate

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