



**WESTERN**  
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# **GRDC** **GROWNOTES™**



**GRDC**  
GRAINS RESEARCH  
& DEVELOPMENT  
CORPORATION

# CANOLA

## SECTION 2

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## PRE-PLANTING

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VARIETAL PERFORMANCE AND RATINGS YIELD | AGZONES | NATIONAL  
VARIETY TRIALS PROJECT YIELD AND OIL INFORMATION | COMMERCIAL AND  
AGRONOMIC INFORMATION | PLANTING SEED QUALITY

## SECTION 2

## Pre-planting

 More information

[NVT 2015 canola mudmaps](#)

[NVT variety brochures](#)

[Current canola variety guide for Western Australia](#)

[WA's hybrid canola demand growing](#)

## FAQ

## 2.1 Varietal performance and ratings yield

The main features to consider when selecting a variety are maturity, yield, oil content, herbicide tolerance and blackleg resistance. Early-maturing varieties are generally more suited to lower rainfall areas, and mid-season types are suited to medium and higher rainfall growing areas. <sup>1</sup>

## 2.1.1 Varieties for WA

The vast majority (87%) of the Western Australian (WA) canola crop is triazine-tolerant (TT). The area of Roundup Ready® (RR) canola increased from 8% to 13% in 2013–14 (Table 1). The most popular canola varieties grown in 2013–14 were Crusher TT, ATR-Stingray, ATR-Cobbler, Hyola® 404RR and ATR-Snapper. These five varieties made up >70% of the area sown to canola in the 2013–14 season (Table 2). <sup>2</sup>

The 2014 growing season was very kind to the mid-long maturity groups. Clearfield® (imidazolinone-tolerant) and RR varieties continue to demonstrate a yield advantage over the TT group.

Roundup Ready®-TT (RT) varieties were in the National Variety Trials (NVT) program for the second year and their performance was a very close second to benchmark hybrids from the TT group, which indicates that this chemistry group should be used only for its herbicide agronomic traits. TT hybrids have demonstrated some yield benefit over open pollinated lines, although this is not consistent.

The financial reward from the oil bonus has shown benefit with some varieties, but oil content remains the second selection criterion, with yield still the greatest influencing factor on profit. <sup>3</sup>

 More information

[Canola National Variety Trial Results 2014](#)

<sup>1</sup> L Serafin, J Holland, R Bambach, D McCaffery (2005) Canola: northern NSW planting guide. NSW Department of Primary Industries, <http://www.nvtonline.com.au/wp-content/uploads/2013/03/Crop-Guide-Canola-Northern-NSW-Planting-Guide.pdf>

<sup>2</sup> J Bucat (2014) 2015 Canola guide for WA. Department of Agriculture and Food Western Australia., Bulletin June 2014, <https://www.agric.wa.gov.au/sites/gateway/files/Canola%20variety%20guide%202015.pdf>

<sup>3</sup> M Davey (2015) Canola National Variety Trial results 2014. GRDC Update Papers, 20 April 2015, <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/04/Canola-National-Variety-Trial-Results-2014>

## More information

[Genetically modified canola: a resource guide](#)

[Canola talk](#)

[SEPWA 2014 all trials in the Esperance port zone](#)

Table 1: Canola herbicide systems in Western Australia: percentage of area planned to be sown under different herbicide systems

Data courtesy of CBH Group. Conventional canola has no specific herbicide tolerance

Herbicide system	2012-13	2013-14
Triazine-tolerant	87	83
Roundup Ready®	8	13
Clearfield	4	3
Conventional	1	1

Table 2: Canola varieties in WA: percentage of area sown

Data courtesy of CBH Group. TT, Triazine-tolerant; RR, Roundup Ready®; IT, imidazolinone-tolerant (Clearfield®); CC, conventional canola with no specific herbicide tolerance

Variety	Group	11/12	12/13	13/14
Crusher TT	TT	1.9	21.3	23.0
ATR-Stingray	TT	0.4	7.9	19.3
ATR-Cobbler	TT	41.3	29.6	14.6
Hyola® 404 (RR)404RR	RR	0.3	3.4	7.4
ATR-Snapper	TT	0.1	2.7	6.7
Telfer	TT	2.7	4.4	5.1
ATR-Gem	TT		0.4	3.8
Jackpot TT	TT		0.4	3.3
Pioneer® 43Y23(RR)	CLRR		0.4	1.9
Tanami	TT	8.2	5.0	1.4
Pioneer® 45Y86(CL)	IT			1.0
GT Cobra	RR		1.1	0.9
Nuseed® GT-50	RR			0.9
Thunder TT	TT	6.6	3.2	0.9
AV Garnet	CC	0.5	0.6	0.9
ATR-Stubby	TT	2.0	1.9	0.7
Pioneer® 44Y84(CL)	CLIT	1.3	0.9	0.6
GT Viper	RR		0.6	0.5
Tornado TT	TT	3.8	2.0	0.5
ATR Beacon	TT	1.7	1.3	0.5
Thumper TT	TT		0.0	0.5
Hyola® 559TT	TT			0.5
Tawriffic TT	TT	2.6	1.2	0.4
Other		26.6	11.7	4.7

## 2.2 Agzones

Agzones have been developed to group together environmental regions that give similar crop performance. The six Agzones are shown in Figure 1:

- Agzone 1 is the northern medium- and high-rainfall area including Mingenew and Northampton.
- Agzone 2 is the northern-central medium-rainfall area including Coorow, Northam and Wagin.

## **i** More information

[Growing western canola](#)

[Getting the good oil on the right canola for your region](#)

[Selecting canola varieties for Western Australia](#)

- Agzone 3 is the southern-central high- and medium-rainfall areas including Williams and Kojonup.
- Agzone 4 is the north-central low-rainfall area east of Mullewa and Merredin.
- Agzone 5 is the southern low- and medium-rainfall area including Newdegate, Scaddan and Salmon Gums.
- Agzone 6 is the south-coast high-rainfall area including Wellstead, Munglinup and Gibson.<sup>4</sup>

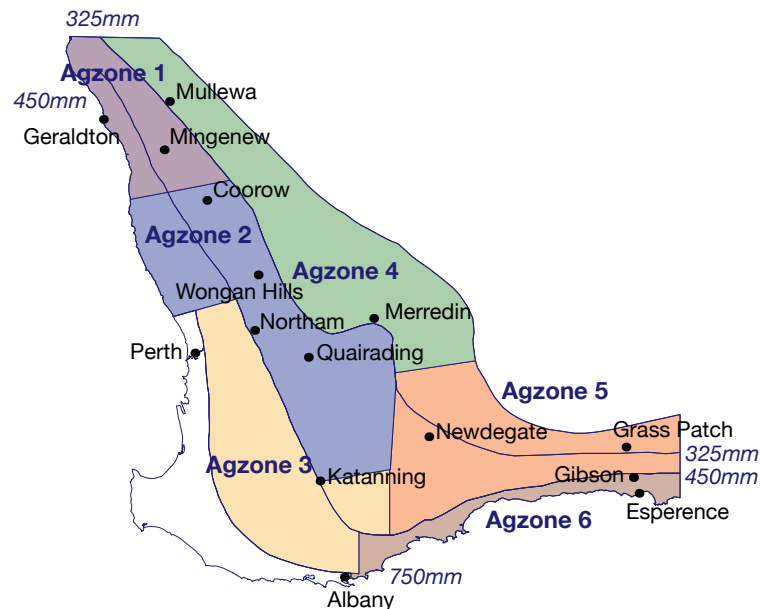


Figure 1: Agzones of Western Australia. (Source: DAFWA)

## 2.3 National Variety Trials Project yield and oil information

There are two series of NVT trials for canola: early-maturity series and mid-maturity series. Early-maturity trials are conducted where these varieties are needed—in northern areas and in the lower rainfall parts of central and southern areas (across Agzones 1–5). Mid-maturity trials are in the medium- and high-rainfall parts in central and southern areas (in Agzones 2, 3, 5 and 6).

Representatives from breeding companies nominate the series in which their varieties are tested. Many varieties are in both early- and mid-maturity trials.

Yield data are presented as predicted yield. Predicted yields are derived from long-term, multi-environment trials from 2009 to 2013. Results for TT and TT-RR canola are presented in Table 3 (early-maturity series) and Table 4 (mid-maturity series); likewise, RR canola results are in Tables 5 and 6, and Clearfield® canola in Tables 7 and 8. Predicted yield of each variety is presented relative to a 'standard' variety. For example, in Table 3, the TT variety ATR-Stingray has a predicted yield of 1.08 t/ha in the early maturity NVT trials in Agzone 1. The predicted yield of ATR-Bonito is 138%

<sup>4</sup> J Bucat (2014) 2015 Canola guide for WA, Department of Agriculture and Food Western Australia., Bulletin June 2014, <https://www.agric.wa.gov.au/sites/gateway/files/Canola%20variety%20guide%202015.pdf>

of ATR-Stingray's yield in the same zone; therefore, the predicted yield of ATR Bonito can be calculated as 1.49 t/ha.

Oil data presented are the average oil percentage for each variety. The number of trials for each variety is shown in each yield table. Note that data are less reliable where there are only a few trials.<sup>5</sup>

For further information about long-term yields or individual NVT trial results, refer to NVT online at [nvtonline.com.au](http://nvtonline.com.au).

Table 3: NVT trials (2009–13) early-maturity triazine-tolerant (TT) canola and TT-Roundup Ready® (RR) canola

GY, Predicted grain yields as a percentage of ATR-Stingray; oil is expressed as average percentage for that variety; n, number of trials

ATR-Stingray (t/ha):	Agzone 1			Agzone 2			Agzone 3			Agzone 4			Agzone 5		
	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n
ATR-Stingray	100	42.5	7	100	43.0	4	100		2	100	42.3	2	100	43.0	13
ATR-Bonito	138	40.8	3	92	44.4	3				112	43.8	2	98	46.0	7
ATR-Cobbler	124	42.7	8	81	40.4	3	90		3				87	40.0	12
ATR-Gem	133	40.2	3	92	45.6	3				99	43.2	2	91	45.3	7
ATR-Snapper	127	44.5	6	91	43.7	2	97		2				94	43.4	9
ATR Wahoo													87	46.7	2
Crusher TT	127	37.3	3	98	44.5	3							96	42.6	9
Hyola® 450TT													99	47.8	4
Hyola® 555TT	143	41.2	3	103	42.0	3							98	40.8	4
Hyola® 559TT	158	41.1	3	99	46.6	3							98	46.4	6
Jackpot TT	136	40.5	2										82	42.4	2
Sturt TT <sup>(1)</sup>	134	42.2	5	92	42.4	4	101		2	110	41.9	2	97	43.6	10
Tanami	109	40.8	4										83	36.8	6
Telfer	88	42.6	9	85	41.7	3	90		3	93	41.9	2	91	43.3	13
Thumper TT													83	42.8	5
TT + RR															
Hyola® 525RT				95	47.3	2							98	47.4	2

<sup>5</sup> J Bucat (2014) 2015 Canola guide for WA., Department of Agriculture and Food Western Australia., Bulletin June 2014, <https://www.agric.wa.gov.au/sites/gateway/files/Canola%20variety%20guide%202015.pdf>

Table 4: NVT trials (2009–13) mid-maturity triazine-tolerant (TT) canola and TT-Roundup Ready® (RR) canola

GY, Predicted grain yields as a percentage of Crusher TT; oil is expressed as average percentage for that variety; n, number of trials

Crusher TT (t/ha)	Agzone 2			Agzone 3			Agzone 6		
	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n
Crusher TT	100	42.4	15	100	43.0	13	100	43.5	9
ATR-Bonito	101	43.2	14	98	45.9	6	99	46.4	5
ATR-Cobbler	84	42.5	28	78	42.6	14	69	44.1	11
ATR-Gem	95	43.7	18	96	45.7	9	97	45.7	7
ATR-Snapper	93	45.4	18	87	46.1	9	79	46.6	8
ATR-Stingray	94	43.3	25	93	44.1	12	91	45.3	10
ATR-Wahoo	95	42.6	12	94	45.2	6	97	45.6	5
Hyola® 450TT	93	45.1	7	101	46.5	3	99	46.7	2
Hyola® 555TT	97	42.1	20	103	43.4	13	102	43.8	11
Hyola® 559TT	100	43.7	12	105	45.9	8	102	45.6	6
Hyola® 650TT	95	45.8	2	106	46.4	3	105	45.5	2
Hyola® 656TT	97	43.9	2	103	44.2	6	103	43.9	4
Jackpot TT	91	41.0	7	96	46.4	3	97	45.5	3
Sturt TT <sup>(b)</sup>	93	41.8	19						
Tanami	72	39.9	12	67	40.3	5	57		2
Telfer	80	42.9	28	73	43.9	4	58	44.9	4
Thumper TT	84	44.9	8	91	44.6	13	95	45.6	10
TT + RR									
Hyola® 525RT	92	45.3	5				94	46.4	2

Table 5: NVT trials (2009–13) early-maturity Roundup Ready® (RR) canola

GY, Predicted grain yields as a percentage of Hyola® 404RR; oil is expressed as average percentage for that variety; n, number of trials

Hyola® 404RR (t/ha)	Agzone 1			Agzone 2			Agzone 3			Agzone 4			Agzone 5		
	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n
Hyola® 404RR	100	44.8	5	100	45.7	4	100		2	100	44.6	2	100	45.5	4
GT Cobra	74	43.2	5	94	43.9	4	87		2	82	41.5	2	90	44.2	4
GT Viper	55	43.5	5	86	43.4	3	79		2	72	41.5	2	85	44.5	4
Hyola® 400RR				94	48.1	2									
Hyola® 500RR				99	47.0	2									
Hyola® 505RR	86	44.1	4	93	45.4	4							88	46.1	3
IH30 RR	89	40.7	3	95	45.2	3				89	43.1	2	93	45.8	2
IH50 RR				96	44.0	3	86		2				89	42.3	4
Nuseed GT-41	84	40.9	3	100	45.1	3				95	41.8	2	100	48.0	2
Nuseed GT-50	87		2	99	46.6	2									
Pioneer® 43Y23(RR)	104	42.4	5	98	43.3	4	97		2	97	41.9	2	96	43.9	4
Pioneer® 44Y24(RR)	88	40.0	3	100	44.9	3				91	41.6	2	97	45.3	2

Table 6: NVT trials (2009–13) mid-maturity Roundup Ready® (RR) canola

GY, Predicted grain yields as a percentage of Hyola® 404RR; oil is expressed as average percentage for that variety; n, number of trials

Hyola® 404RR (t/ha)	Agzone 2			Agzone 3			Agzone 6		
	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n
Hyola® 404RR	100	45.4	19	100	46.9	7	100	46.8	8
GT Cobra	91	43.4	16	89	45.5	6	91	45.2	7
GT Viper	85	43.7	15	79	45.0	4	76	45.8	5
Hyola® 400RR	97	46.3	4				103	46.8	2
Hyola® 500RR	101	45.0	3	104	47.2	2	107	47.0	2
Hyola® 505RR	90	45.9	13	98	47.9	7	99	46.4	8
IH30 RR	97	42.6	8						
IH50 RR	89	42.0	14	94	44.6	6	95	44.1	7
Nuseed GT-41	100	42.8	10	94	45.3	2	96	45.4	5
Nuseed GT-50	103	44.0	11	101	45.3	6	106	45.1	7
Pioneer® 43Y23(RR)	103	41.6	10	106	44.2	4	105	44.6	5
Pioneer® 44Y24(RR)	100	43.2	16	101	44.6	6	104	44.7	7
Pioneer® 45Y22(RR)	91	42.8	21	99	45.8	8	104	44.7	9

Table 7: NVT trials (2009–13) early-maturity Clearfield (CL) canola

GY, Predicted grain yield as a percentage of Pioneer® 44Y84(CL); oil is expressed as average percentage for that variety; n, number of trials

Pioneer® 44Y84(CL) (t/ha)	Agzone 1			Agzone 2			Agzone 5		
	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n
Pioneer® 44Y84 (CL)	100	40.5	3	100	45.8	2	100	43.9	4
Archer	99		2	97	45.7	2	92	44.5	2
Carbine	88	39.9	3	104	46.0	2	104	43.8	3
Hyola® 474CL	82	41.1	3	108	45.4	2	104	45.0	3
Hyola® 575CL	84	41.5	3	109	45.4	2			
Pioneer® 43C80(CL)	66	39.7	2				96	42.8	3
Pioneer® 43Y85(CL)	77	38.3	3	103	45.1	2	102	43.9	3
Pioneer® 44Y87(CL)	86		2	106	44.4	2	104	43.2	2

Table 8: NVT trials (2009–13) mid-maturity Clearfield (CL) canola

GY, Predicted grain yields as a percentage of Pioneer® 44Y84(CL); oil is expressed as average percentage for that variety; n, number of trials

Pioneer® 44Y84(CL) (t/ha)	Agzone 2			Agzone 3			Agzone 6		
	GY	Oil%	n	GY	Oil%	n	GY	Oil%	n
Pioneer® 44Y84 (CL)	100	45.4	12	100	44.8	11	100	44.9	8
Archer	95	41.7	3	105	45.1	9	108	44.1	4
Carbine	101	45.1	7	99	44.8	9	100	44.6	5
Hyola® 474CL	89	44.9	7	102	44.0	9	107	44.3	6
Hyola® 575CL	91	43.8	8	103	44.3	10	110	43.9	7
Hyola® 577CL	91	45.1	2	101	45.9	3	110	46.0	2
Pioneer® 43Y85(CL)	89		3						
Pioneer® 44Y87(CL)	101	40.9	2	102	40.6	3	104	42.2	2
Pioneer® 45Y86(CL)	101	45.5	9	106	45.1	10	109	44.8	7
Pioneer® 45Y88 (CL)	100	42.6	4	106	43.0	6	113	43.5	4

## 2.4 Commercial and agronomic information

### 2.4.1 Open-pollinated and hybrid canola

Open-pollinated canola has relatively uniform genetics within a population and is ~75% self-pollinating, so each generation mostly retains the characteristics of the population. Retained seed is suitable to use for seeding.

Hybrid seed is produced by controlled cross-pollination of two distinctly different parent lines, which produce hybrid seed (F1). Hybrids may show better performance than either parent because of hybrid vigour.

Retaining seed from hybrids leads to variability in the next crop (F2) and has negative effects on plant vigour, uniformity of plant height, uniformity of flowering, blackleg resistance, lodging resistance, oil levels and their combined effects on yield.<sup>6</sup>

#### Blackleg rating

Blackleg information is provided in Tables 9, 10 and 11. See the GRDC Fact Sheet *Blackleg Management Guide* for further information about the importance of blackleg ratings, resistance groups and management of blackleg.<sup>7</sup>

#### Genetically modified (GM) canola

All Roundup Ready® canola is genetically modified, including varieties that are also triazine-tolerant (RT).<sup>8</sup>

### More information

[What is Roundup Ready canola?](#)

<sup>6</sup> J. Bucat (2014) 2015 Canola guide for WA. Department of Agriculture and Food Western Australia, Bulletin June 2014, <https://www.agric.wa.gov.au/sites/gateway/files/Canola%20variety%20guide%202015.pdf>

<sup>7</sup> J. Bucat (2014) 2015 Canola guide for WA. Department of Agriculture and Food Western Australia, Bulletin June 2014, <https://www.agric.wa.gov.au/sites/gateway/files/Canola%20variety%20guide%202015.pdf>

<sup>8</sup> J. Bucat (2014) 2015 Canola guide for WA, Department of Agriculture and Food Western Australia, Bulletin June 2014, <https://www.agric.wa.gov.au/sites/gateway/files/Canola%20variety%20guide%202015.pdf>



Table 9: Triazine-tolerant (TT) canola and TT-Roundup Ready® (RR) canola commercial and agronomic information

OP, Open pollinated. Maturity information provided by licensees. Maturity key: V, very; E, early; M, mid; L, late (maturity range: VE, E, EM, ME, M, ML, LM, L, VL). Blackleg data provided from the GRDC 2014 Blackleg Management Guide. Blackleg rating key: R, resistant; MR, moderately resistant; MS, moderately susceptible; S, susceptible; VS, very susceptible. Jockey® seed dressing contains fluquinconazole. Blackleg resistance group refers to the different combinations of blackleg resistance genes carried by each variety

Variety	Licensee	Release year	Type	Maturity	2014 blackleg rating		Blackleg resistance group
					Bare seed	+ Jockey®	
<b>TT</b>							
ATR-Bonito	Nuseed	2013	OP	EM	MR	R-MR	
ATR-Cobbler	Nuseed	2007	OP	E			
ATR-Gem	Nuseed	2011	OP	EM	MR	R-MR	A
ATR-Snapper	Nuseed	2011	OP	EM			
ATR-Stingray	Nuseed	2011	OP	E	MR	R	C
ATR-Wahoo	Nuseed	2013	OP	ML	MR	R-MR	A
Crusher TT	Pacific Seeds	2010	OP	M	MR-MS		A
Hyola® 450TT	Pacific Seeds	2013	Hybrid	ME	R	R	ABD
Hyola® 555TT	Pacific Seeds	2010	Hybrid	ME	R		D
Hyola® 559TT	Pacific Seeds	2012	Hybrid	M	R	R	
Hyola® 650TT	Pacific Seeds	2014	Hybrid	ML	R	R	E
Hyola® 656TT	Pacific Seeds	2012	Hybrid	ML	R	R	ABD
Jackpot TT	Pacific Seeds	2011	OP	M			
Sturt TTA <sup>(1)</sup>	NPZA	2012	OP	E	MS		
Tanami	NPZA	2006	OP	VE			
Telfer	NPZA	2008	OP	VE			
Thumper TT	Pacific Seeds	2011	OP	ML	R		E
<b>TT-RR</b>							
Hyola® 525RT	Pacific Seeds	2014	Hybrid	M	R-MR	R	ABD

Table 10: Roundup Ready® (RR) canola commercial and agronomic information

OP, Open pollinated. Maturity information provided by licensees. Maturity key: E, early; M, mid. Blackleg data provided from the GRDC 2014 Blackleg Management Guide. Blackleg rating key: R, resistant; MR, moderately resistant. Jockey® seed dressing contains fluquinconazole. Blackleg resistance group refers to the different combinations of blackleg resistance genes carried by each variety

Variety	Licensee	Release year	Type	Maturity	2014 blackleg rating		Blackleg resistance group
					Bare seed	+ Jockey®	
GT Cobra	Nuseed	2011	OP	EM	R-MR		A
GT Viper	Nuseed	2011	OP	E	MR		
Hyola® 400RR	Pacific Seeds	2014	Hybrid	E	R		ABD
Hyola® 404RR	Pacific Seeds	2010	Hybrid	EM	R-MR		ABD
Hyola® 500RR	Pacific Seeds	2014	Hybrid	M	R		ABD
Hyola® 505RR	Pacific Seeds	2010	Hybrid	ME	R		
IH30RR	Bayer	2014	Hybrid	E	R-MR	R	AB
IH50RR	Bayer	2012	Hybrid	M	R-MR	R	A
Nuseed GT-41	Nuseed	2012	Hybrid	EM	R-MR	R	ABF
Nuseed GT-50	Nuseed	2012	Hybrid	M	R-MR		ABF
Pioneer® 43Y23(RR)	Pioneer®	2012	Hybrid	E	R-MR	R	
Pioneer® 44Y24(RR)	Pioneer®	2013	Hybrid	EM	R-MR	R	C
Pioneer® 45Y22(RR)	Pioneer®	2011	Hybrid	M	MR	R	C

Table 11: Clearfield (CL) canola commercial and agronomic information

OP, Open pollinated. Maturity information provided by licensees. Maturity key: E, early; M, mid. Blackleg data provided from the GRDC 2014 Blackleg Management Guide. Blackleg rating key: R, resistant; MR, moderately resistant; MS, moderately susceptible. Jockey® seed dressing contains fluquinconazole. Blackleg resistance group refers to the different combinations of blackleg resistance genes carried by each variety

Variety	Licensee	Release year	Type	Maturity	2014 Blackleg rating		Blackleg resistance group
					Bare seed	+ Jockey®	
Archer	Heritage Seeds	2012	Hybrid	M	MR-MS	R-MR	
Carbine	Heritage Seeds	2012	Hybrid	EM	MR-MS	R-MR	A
Hyola® 474CL	Pacific Seeds	2011	Hybrid	ME	R		BF
Hyola® 575CL	Pacific Seeds	2010	Hybrid	M	R		BF
Hyola® 577CL	Pacific Seeds	2013	Hybrid	M	R	R	
Pioneer® 43C80(CL)	Pioneer®	2008	OP	E			
Pioneer® 43Y85(CL)	Pioneer®	2012	Hybrid	E	MR	R-MR	A
Pioneer® 44Y84(CL)	Pioneer®	2010	Hybrid	EM	MS	MR	A
Pioneer® 44Y87(CL)	Pioneer®	2013	Hybrid	EM	MR	R-MR	A
Pioneer® 45Y86(CL)	Pioneer®	2012	Hybrid	M	MR-MS	R-MR	AB
Pioneer® 45Y88(CL)	Pioneer®	2013	Hybrid	M	R-MR	R-MR	A



[www.nvtonline.com.au](http://www.nvtonline.com.au)

[www.agric.wa.gov.au](http://www.agric.wa.gov.au)

## 2.4.2 Oil

Canola was developed from rapeseed to produce an oilseed crop with improved nutritional composition. The aim was to produce a crop that had low levels of glucosinolates in the meal and low levels of erucic acid in the oil.<sup>9</sup>

Oil is extracted by mechanically crushing the seed. The oil is then processed by using heat and/or chemicals. Approximately 73% of canola in Australia is processed by addition of solvents, 25% by expeller treatment and 2% by cold-pressing.

The seed typically has an oil content of 35–45%. Oil content is generally expressed as a percentage of the whole seed at 8% moisture content. The oil contains:

- 10–12% linolenic acid (omega-3)
- <0.1% erucic acid
- 59–62% oleic acid
- 12–22% linoleic acid

<sup>9</sup> R Mailer (2009) Grain quality. In Canola best practice management guide for eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, [http://www.grdc.com.au/uploads/documents/GRDC\\_Canola\\_Guide\\_All\\_1308091.pdf](http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf)

Canola oil is high in unsaturated fats (93%) and has no cholesterol or trans-fats. It has the lowest saturated fat content (7%) of any common edible oil. When canola is processed to form canola oil, all traces of protein are removed to the residue, which becomes the seed meal.<sup>10</sup>

### 2.4.3 Seed meal

The seed meal is what is left over after the oil is removed. It contains proteins, carbohydrates, minerals and fibre. The exact composition of seed meal depends on the oil extraction method. The protein content varies each season and increases as the oil content decreases. Typically, seed meal consists of 36–39% protein, 1.5–2.0% fat, 11–13% fibre and <10 µmol glucosinolate/g.

The minimum protein content of seed meal, as determined by the Australian Oilseeds Federation (AOF) is 36%, measured at 12% moisture.<sup>11</sup>

## 2.5 Planting seed quality

### 2.5.1 Seed size

Canola seeds are smaller than other grains such as wheat, barley or lupins. They weigh only 3 mg each. The 1000-seed weight of canola is typically 3–6 g. Seed size varies according to the growing conditions. There are also varietal differences. Generally, hybrid varieties have larger seeds however it is not always reflective with the seed that is supplied to growers from production crops.

Seed size plays an important role in crop establishment. Larger seeds produce seedlings that are more vigorous and give improved crop establishment. There is also an interaction with sowing depth (Table 12). Larger seeds establish more plants, particularly if sown at depth of  $\geq 3$  cm.<sup>12</sup>

Table 12: Effect of seed size and sowing depth on plant establishment (no. of plants/m<sup>2</sup>) of canola  
Source: Kathi Hertel, unpublished data, NSW DPI<sup>13</sup>

Seed size (mm)	Sowing depth (cm)			
	4.5	3.0	1.5	Mean
>1.7	41.7	64.2	77.0	61.0
1.4–1.7	26.6	43.2	73.3	47.7
<1.4	23.0	33.0	78.5	44.8
Mean	30.5	46.8	76.3	

<sup>10</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

<sup>11</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

<sup>12</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

<sup>13</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

Similar plant numbers established when seeds were sown at depth of 1.5 cm, regardless of seed size. Larger seeds (>1.4 mm) established more plants when sown at 3.0 and 4.5 cm deep.

## 2.5.2 Diagnosing poor-quality seed in canola

Poor-quality seed can affect germination rates and market quality (Figure 2). It can be due to small seed or damage by harvest, storage, long-term storage of seed coated with fungicide, weather or environment.<sup>14</sup>

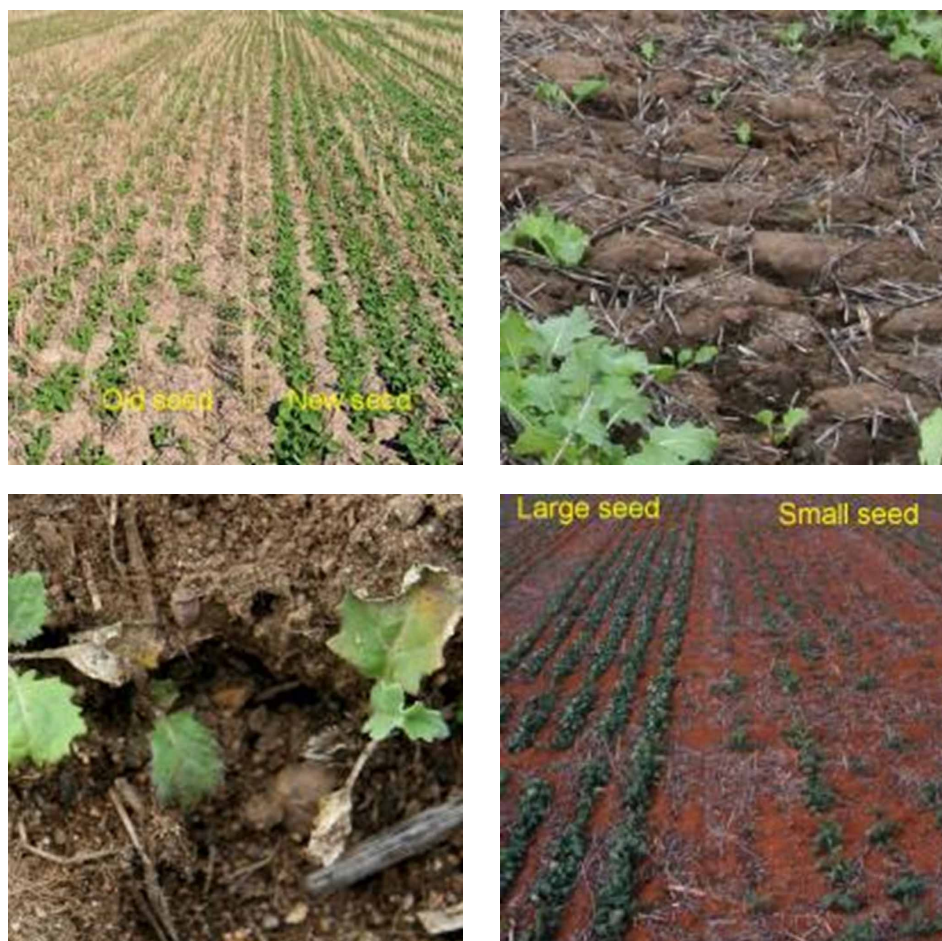


Figure 2: Effects of seed quality on canola establishment. (Photos: DAFWA)

### What to look for

In the paddock, look for reduced germination and/or weak seedlings that may be uniformly affected across a paddock, or more pronounced in rows or areas that are less favourable for germination and early growth.

Signs in individual plants:

- seeds that swell but fail to germinate
- seed that germinates but resulting seedlings are malformed or too weak to reach the surface

<sup>14</sup> DAFWA (2014) Diagnosing poor quality seed in canola. Department of Agriculture and Food Western Australia, <https://www.agric.wa.gov.au/mycrop/diagnosing-poor-quality-seed-canola>

- weak seedlings after emergence
- broadleaf seedlings with broken roots, cotyledons or growing points <sup>15</sup>

### *What else could it be?*

Deep seeding of canola can also cause reduced emergence and weak seedlings. It can be confirmed by measuring seeding depth. <sup>16</sup>

### *Where did it come from?*

Poor seed quality may arise from:

- small seed (<1.8 mg) being less resilient than large seed
- poor storage where seed is exposed to moist and hot conditions
- old seed (canola seed quality declines faster than for cereals)
- frost-affected grain
- green sappy grain that has been harvested too early
- insect-damaged grain <sup>17</sup>
- Seed collected from areas desiccated with glyphosate

### *Management strategies*

Poor seed quality can be managed by germination testing of 1000 seed weight and not using seed weighing <1.8 mg.

### *How can it be monitored?*

Grain that is being retained for seed should be germination tested. <sup>18</sup>

For expert help, consult [AGWEST Plant Laboratories](#) (+61 (0)8 9368 3721).

## **i** More information

[Diagnosing poor quality seed in canola](#)

[GIWA past events:](#)

[Blackleg in canola seed](#)

## 2.5.3 Retaining seed

A Department of Agriculture and Food Western Australia (DAFWA) trial investigated options for improving production from retained, hybrid and open-pollinated canola seed: grading harder, buying new seed, increasing the seed rate, mixing retained and new seed, or no action.

At Grass Patch, retaining seed of CB Telfer from a dry harvest in 2012 resulted in small seed. This seed was then graded by a commercial cleaner and further graded with 1.85-mm slotted sieve in an attempt to achieve a higher proportion of large seeds. If the crop was sown at 2 kg/ha, the highest yields of CB Telfer in 2013 were obtained by purchasing fresh seed from the seed company. However, if the seeding rate was increased to 4 kg/ha, then grower-retained seed produced similar grain yield

<sup>15</sup> DAFWA (2014) Diagnosing poor quality seed in canola. Department of Agriculture and Food Western Australia, <https://www.agric.wa.gov.au/mycrop/diagnosing-poor-quality-seed-canola>

<sup>16</sup> DAFWA (2015) Deep seeding in canola. Department of Agriculture and Food Western Australia, <https://www.agric.wa.gov.au/mycrop/deep-seeding-canola>

<sup>17</sup> DAFWA (2014) Diagnosing poor quality seed in canola. Department of Agriculture and Food Western Australia, <https://www.agric.wa.gov.au/mycrop/diagnosing-poor-quality-seed-canola>

<sup>18</sup> DAFWA (2014) Diagnosing poor quality seed in canola. Department of Agriculture and Food Western Australia, <https://www.agric.wa.gov.au/mycrop/diagnosing-poor-quality-seed-canola>

and equal gross margins to purchased seed. Thus, addressing issues with small seed in canola by increasing the seed rate appears feasible.

Hybrids are yet to prove superior in lower rainfall areas in Western Australia. At Grass Patch in 2013, the older TT hybrid variety was not as productive as the open-pollinated TT variety CB Telfer. However, the treatments in that experiment were designed using a scenario of a grower who had decided to grow hybrids and then retain seed from the F1 seed crop. (Growers buy first-generation hybrid seed (F1); F2 seed is the subsequent generation.) The results showed that if growers retained F2 hybrid seed and sowed it at the same rate of 2 kg/ha as F1 seed purchased from the seed company, they would lose yield and would be financially worse off than purchasing new F1 seed. However, if they increased the seed rate of the F2 hybrid to 4 kg/ha or made mixes of F1 and F2, then some of the loss in performance could be overcome. Farmers need to ensure that they have the legal right to retain and grow F2 seed prior to undertaking such operations.

Results summary:

- In dry years, open-pollinated canola can produce small seed in low-rainfall areas. Sowing the small seed at a low seeding rate of 2 kg/ha reduced yield, and farmers could benefit by increasing the seeding rate to 4 kg/ha in the following year or purchasing fresh seed.
- Grading small seed hard was not as reliable as increasing the seeding rate to 4 kg/ha.
- F2 hybrid seed produced lower yields than F1 seed unless seeding rates were increased to 4 kg/ha or mixes were made with F1 seed.
- Hybrid TT was less productive than open-pollinated TT canola.

Comparisons to retaining CB Telfer and sowing at 2 kg/ha:

- Grading seed over a 1.85-mm slotted sieve did not increase plant establishment; the only reliable way to improve plant numbers was to increase seed rate.
- Compared with using the grower-retained CB Telfer seed and sowing it at 2 kg/ha, only the strategies of purchasing new CB Telfer seed and sowing it at 2 or 4 kg/ha and purchasing the new hybrid variety (name not disclosed) and sowing it at 4 kg/ha increased grain yield.
- The extra expenses incurred resulted in no treatment producing higher returns than the farmer-retained CB Telfer seed sown at 4 kg/ha.

Comparisons to retaining hybrid TT seed and sowing at 4 kg/ha:

- F1 hybrid seed is relatively expensive at \$24 to \$35/kg for IT, RR and TT Hybrid seed, \$43/kg for RT Hybrid seed; therefore, seeding rates are usually relatively low, at ~2 kg/ha.
- If growers were to retain hybrid TT seed and sow the F2 at 2 kg/ha, they would lose yield and be financially worse off than buying fresh F1 seed.
- Because F2 hybrid seed cost is reduced to ~\$2/kg, growers are more likely to increase seeding rate to 4 kg/ha, in which case, yields and returns similar to F1 sown at 2 kg/ha could be achieved.

## **i** More information

[Estimating the size of retained canola seed](#)

[Retained canola seed options at Grass Patch, 2013](#)

[BCG trial details: retaining hybrid canola](#)

[Testing retained sowing seed of hybrid canola over a range of rainfall zones](#)

[Testing retained sowing seed of hybrid canola over a range of rainfall zones \(Adelaide\)](#)

[Growing hybrid canola Fact Sheet](#)

## **i** More information

[Canola establishment: does size matter?](#)

[Canola re-seeding: is it worth it?](#)

- A mix of 25% F1 and 75% F2 was not quite as productive as 100% F1 seed, but might be more productive than 100% F2 seed.<sup>19</sup>

### 2.5.4 Canola establishment

Check the seed size every year; it can vary depending on how well the seed crop finished in the previous spring.

For *Brassica napus* varieties, the range is 250,000–350,000 seeds/kg for open-pollinated varieties and 150,000–260,000 for hybrids. Table 13 shows the large difference in plant establishment rates for a given seeding rate between open-pollinated varieties and hybrids.<sup>20</sup>

Table 13: Number of plants established per m<sup>2</sup> from different sowing rates and establishment percentages of open-pollinated varieties based on 290,000 seeds/kg and hybrids based on 175,000 seeds/kg

Sowing rate (kg/ha)	Establishment percentage					
	40%	50%	60%	70%	80%	90%
<i>Open-pollinated</i>						
2.0	23	29	35	41	46	52
3.0	35	44	52	61	70	78
4.0	46	58	70	81	93	104
5.0	58	73	87	102	116	131
<i>Hybrid</i>						
2.0	14	18	21	25	28	32
3.0	21	26	32	37	42	47
4.0	28	35	42	49	56	63
5.0	35	44	53	61	70	79

#### *Canola re-seeding: Is it worth it?*

Trials conducted by DAFWA demonstrated that it was not worth re-seeding canola. April-sown plots at only 5 plants/m<sup>2</sup> produced yields equal to or greater than May-sown plots at 5–30 plants/m<sup>2</sup>. Over a number of years, DAFWA trials show canola producing 60–80% of maximum yield at ~5 plants/m<sup>2</sup>, and 80–90% at 10 plants/m<sup>2</sup>.

Low plant numbers sown early therefore appears to be an acceptable approach, although weed control may be compromised.

Canola is often the first crop sown each autumn. Because the small seed is best suited to shallow seeding, it is susceptible to drying soil conditions. If growers do not receive a good break or decent follow-up rains, they may need to consider reseeded 2–3 weeks later. The important question for growers is whether they should leave their low-density crop (<10 plants/m<sup>2</sup>) or reseed (Figure 3).

<sup>19</sup> DAFWA (2015) Retained canola seed options at GrassPatch, 2013. Department of Agriculture and Food Western Australia, <https://www.agric.wa.gov.au/canola/retained-canola-seed-options-grass-patch-2013-13ed19?page=0%2C2>

<sup>20</sup> L Jenkins (2009) Crop establishment. In Canola best practice management guide for eastern Australia. (Eds D McCaffrey, T Potter, S Marcoft, F Pritchard) GRDC, [http://www.grdc.com.au/uploads/documents/GRDC\\_Canola\\_Guide\\_All\\_1308091.pdf](http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf)





Figure 3: Low-density (<5 plants/m<sup>2</sup>) plot at Salmon Gums.

In 2014, DAFWA conducted a series of trials with plots sown before or at the break of season with plant densities of 5, 10, 15 and 30 plants/m<sup>2</sup> compared to plots sown 3 weeks later with densities ranging from 5 to 60 plants/m<sup>2</sup>. At this time, some plots were included that were sown over the top of earlier sown, low-density plots.

The most successful trial in this series was at the Northern Agri Group’s (NAG) main trial site at Ogilvie. The first sowing time of Pioneer® 43Y23RR was on 29 April with establishment ~90% of target. The second sowing time was 16 May, when conditions were actually drier and less favourable than at the April sowing; consequently, establishment was ~40% of target. At this site, the resown plots were in offset rows and seeds were ‘tickled in’ to reduce damage to the earlier sown plants, with only 13% of these plants establishing, and no extra yield produced (see Figure 4).

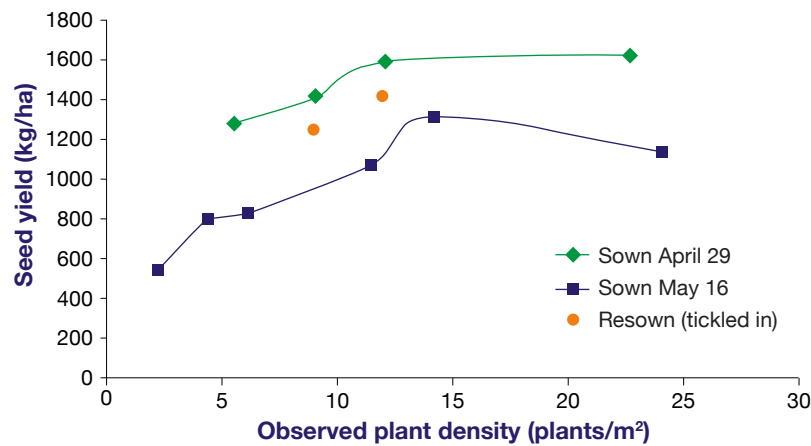


Figure 4: Time of sowing density and reseeding of canola at Ogilvie in 2014—GRDC-funded DAFWA trial at Northern Agri Group’s main trial site.

As expected, the April-sown plots outyielded plots sown in May at every comparable plant density. In addition, April-sown plots that had only 5–10 plants/m<sup>2</sup> produced yields equal to or greater than later plots sown at higher densities. Over several years, canola has produced 60–80% of maximum yield at ~5 plants/m<sup>2</sup> and 80–90% at 10 plants/m<sup>2</sup> in DAFWA trials.

From a yield perspective, low plant numbers sown early appears an acceptable approach as long as insects are under control. However, weed control may be

compromised at these low densities. For example, in a DAFWA plant-density trial at the Liebe site in 2013, more ryegrass panicles were observed in TT canola when the crop density was  $<20$  plants/m<sup>2</sup>, whereas in RR hybrid plots, no such effect of plant density was found. This indicates that with a competitive variety (e.g. RR hybrid) and effective herbicides such as glyphosate, low crop densities are less of an issue than when using less competitive crops (e.g. TT canola) combined with—in this instance at least—a less effective herbicide system (see Figure 5).<sup>21</sup>

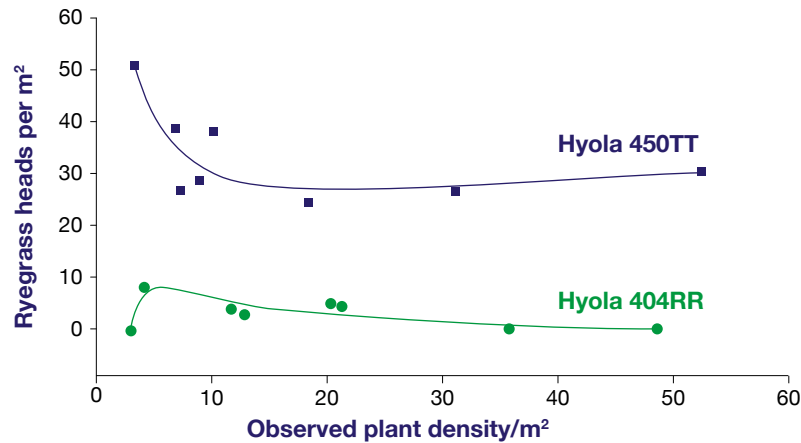


Figure 5: Ryegrass panicles (expressed as % of maximum) of TT and RR canola at North Miling (Liebe main trial site) in 2013—GRDC-funded DAFWA trial 13WH12.

### 2.5.5 Seed germination and vigour

Seed quality is important for good establishment. Canola seed should have a germination percentage  $>85\%$ . Planting high-quality seed is essential for rapid, even crop establishment.

Early seedling growth relies on stored energy reserves in the seed. Good seedling establishment is more likely if the seed is undamaged, stored correctly, and from a plant that has had adequate nutrition.

Seed moisture content, age of seed, seed size and germination percentage all contribute to seed quality. There can be substantial differences in the performance of commercial certified seed lots from different sources, and these differences can be as great as differences among varieties.

Several factors can greatly affect germination, including seed size, seed handling and harvest timing.<sup>22</sup>

The larger the seed, the larger the cotyledon and the lipid reserves. Although seed size does not affect germination, larger seeds have earlier and faster emergence than medium-sized and small seeds. This is because larger seeds germinate more rapidly

<sup>21</sup> DAFWA (2015) Canola re-seeding: is it worth it? Department of Agriculture and Food Western Australia, <https://www.agric.wa.gov.au/canola/canola-re-seeding-it-worth-it>

<sup>22</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

## **i** More information

[Improved canola establishment, yield and oil with large seed on sandplain soil in Western Australia](#)

and produce longer roots than smaller seeds. Under adequate moisture, medium-sized seeds will emerge in 5–6 days.

Seed size is usually measured by weighing 1000 grains; this is known as the 1000-seed weight. The 1000-seed weight differs among varieties and from season to season. As a result, sowing rates should be altered according to seed weight to achieve the desired plant population.<sup>23</sup>

### *Harvest timing*

The timing of swathing can also affect germination. If the crop is not swathed at the correct time, seed development can stop, resulting in unripe seeds with reduced germination ability.

### *Seed chlorophyll*

High levels of seed chlorophyll can reduce seedling vigour and increase seedling mortality. Chlorophyll levels <35 mg/kg are desirable. Canola seed harvested from plants suffering frost or severe moisture stress during seed-filling may have elevated chlorophyll levels.

### *Seed handling*

Germination can also be affected by seed-handling procedures. Care needs to be taken when harvesting canola seed to ensure that it is not cracked. Cracking can reduce germination.<sup>24</sup>

## 2.5.6 Seed storage

The aims of storage are to preserve the viability of the seed for future sowing and to maintain its quality for market. Canola is more difficult to store than cereals because of its oil content. The oil content makes canola more prone to deterioration in storage. For this reason, canola should not be stored on-farm for more than one summer.

The rate at which canola deteriorates in storage depends on:

- storage temperature
- seed moisture content
- seed oil content
- relative humidity
- storage time
- percentage of green or immature seeds in the sample
- amount of weathering after physiological maturity

<sup>23</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

<sup>24</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

Monitoring of seed moisture of canola is necessary during storage because a moisture content of 6.0–8.5% can be unsafe, depending on the seed oil content (Figure 6).

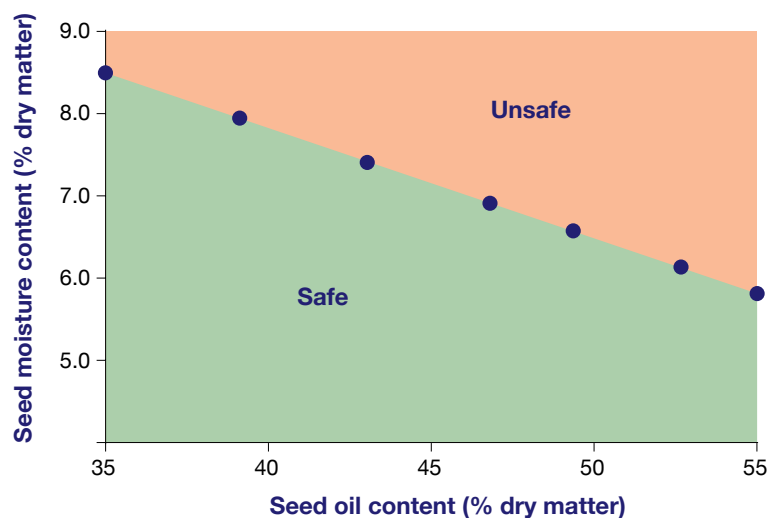


Figure 6: Potential unsafe storage limits for Australian canola varieties at 60% equilibrium relative humidity and 25°C. (Source: [http://www.australianoilseeds.com/\\_data/assets/pdf\\_file/0006/4110/Oilseeds\\_Flyer.pdf](http://www.australianoilseeds.com/_data/assets/pdf_file/0006/4110/Oilseeds_Flyer.pdf))

High temperatures or moisture levels can cause a number of reactions in the seed, resulting in:

- increased levels of free fatty acids, causing off-flavours in the oil
- oxidation and browning reactions, which taint the oil
- changes to the oil profile of the seed, due to reactions involving chlorophylls, carotenoid pigments, flavonoids and phenols

Canola should be stored at  $\leq 8\%$  moisture and at temperatures  $< 25^{\circ}\text{C}$  (and preferably  $< 20^{\circ}\text{C}$ ).

Safe storage limits are determined by the oil and moisture content of the seed. Canola falling into the potentially unsafe area above the line in Figure 6 should not be stored for any length of time unless appropriate action is taken, such as lowering the moisture content and seed temperature.<sup>25</sup>

### 2.5.7 Safe rates of fertiliser sown with the seed

Canola seedlings are particularly sensitive to damage from close proximity to fertiliser. Larger seeds are less prone to damage.<sup>26</sup>

Nitrogen and starter (N and phosphorus, P) fertilisers can affect germination and reduce establishment if sown in contact with canola seed. Seed can be affected in a number of ways:

<sup>25</sup> J Edwards, K Hertel (2011) Canola growth and development. PROCROP Series. NSW Department of Primary Industries, [http://www.dpi.nsw.gov.au/\\_data/assets/pdf\\_file/0004/516181/Procrop-canola-growth-and-development.pdf](http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/516181/Procrop-canola-growth-and-development.pdf)

<sup>26</sup> GRDC (2011), Fertiliser toxicity fact sheet. <http://www.grdc.com.au/GRDC-FS-FertiliserToxicity>

- toxic chemical effects from ammonium vapour, most likely from urea and ammonium phosphates (e.g. mono- and di-ammonium phosphate, MAP and DAP)
- osmotic or salt effects due to high concentrations of salts produced from soluble fertiliser dissolving in water (both N and P)
- seed desiccation from direct moisture absorption by fertiliser in very dry soil

Fertiliser applied at high rates is best separated from the seed at sowing, by banding. The risk of seed damage from fertiliser increases:

- with narrow sowing tines or discs, particularly at wider row spacing, where fertiliser becomes more concentrated close to the seed (Table 14)
- in more sandy soils
- in partially wet soils that are drying
- in dry soils

Table 14: Amounts of nitrogen (kg N/ha) that can be sown with canola seed, as determined by calculations of seedbed utilisation

Source: Jim Laycock, Incitec Pivot, adapted from 'Fertiliser management in direct seeding systems'. Better Crops 81(2), 1997

	25-mm seed spread (e.g. discs, knife-point)			50-mm seed spread		
	15 cm	22.5 cm	30 cm	15 cm	22.5 cm	30 cm
Row spacing:						
Seed bed utilisation:	17%	11%	8%	33%	22%	17%
Light (sandy loam)	10	5	0	20	15	10
Medium-heavy (loam-clay)	15	10	5	30	20	15

Figure 7 shows the approximate safe rates of P that can be sown with the seed using DAP fertiliser (18% N). Seedbed utilisation (Figure 7, x-axis) takes into account the width of the seed row and the row spacing. In dry soils, the amounts shown in the graph should be halved.<sup>27</sup>

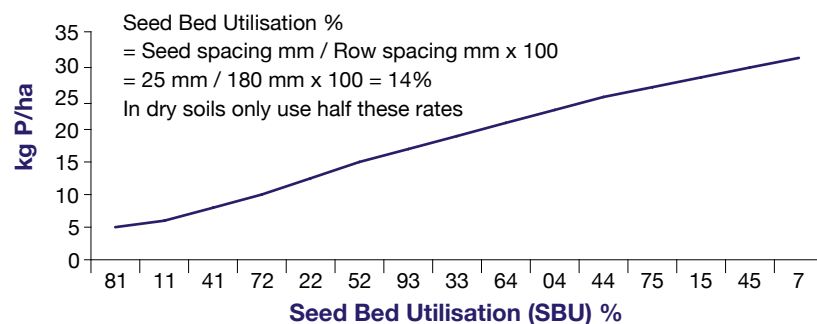


Figure 7: Approximate safe rates of phosphorus with seed when using di-ammonium phosphate under good soil-moisture conditions.

**i More information**

[Care with fertiliser and seed placement](#)

[Fertiliser toxicity](#)

**i More information**

[Canola best practice management guide for south-eastern Australia](#)

[Canola irrigated: GM—SQ](#)

<sup>27</sup> R Mailer (2009) Grain quality. In Canola best practice management guide for eastern Australia. (Eds D McCaffrey, T Potter, S Marcroft, F Pritchard) GRDC, [http://www.grdc.com.au/uploads/documents/GRDC\\_Canola\\_Guide\\_All\\_1308091.pdf](http://www.grdc.com.au/uploads/documents/GRDC_Canola_Guide_All_1308091.pdf)

Birchip Cropping Group (BCG) trials in 2012 at Sea Lake, Victoria, showed that applying urea with the seed, even deep-banded, could affect establishment and slow growth and development.

### More information

[BCG trial details: are canola and nitrogen good 'seed bed' fellows?](#)

Key points included:

- There was no advantage in applying nitrogen at sowing (deep-banded).
- The effects of seed burn on canola are much greater on sandier soils than clay. Dry soils are also more susceptible than wet soils; if applying up-front N, rates should not exceed 10 kg N/ha (22 kg/ha urea) on 30-cm spacing, and seed should be separated by at least 3–4 cm from the N fertiliser.<sup>28</sup>

<sup>28</sup> BCG. Are canola and nitrogen good 'seed bed' fellows? Trial Details, Birchip Cropping Group, [http://www.bcg.org.au/view\\_trial.php?trial\\_id=874&src=](http://www.bcg.org.au/view_trial.php?trial_id=874&src=)