The release of canola quality *Brassica juncea* for Australia

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Abstract

Profitable alternative crops to provide a rotational break for control of root diseases and weeds in cereals in the low rainfall cropping environments have been a high priority in Australian agriculture in recent years. After over twenty-five years of cultivar development, The Victorian Department of Primary Industries in conjunction with the Saskatchewan Wheat Pool will commercially release canola quality *B. juncea* to Australian growers in 2007. The good yields, shattering tolerance, excellent early vigour and disease resistance characteristics of *B. juncea* will encourage growers to use this alternative species in low rainfall crop rotations. The development has required several significant changes to the quality of traditional condiment mustard, namely low total glucosinolates, low allyl glucosinolate, low erucic acid and increased oleic acid. Large scale seed production of two lines with acceptable quality and good yield potential in comparison to currently grown early and early- mid maturing *B. napus* cultivars is being undertaken in the Australian 2006 winter. Future challenges include further improvements to yield and oil content, plus the incorporation of herbicide tolerance, a hybrid system and other disease resistant traits.

Introduction

Brassica juncea has a number of advantages over B. napus in low rainfall environments, including more vigorous seedling growth, quicker ground covering ability, greater tolerance to heat and drought and enhanced resistance to the blackleg fungus, Leptosphaeria maculans (Woods et al. 1991, Burton et al. 1999, 2003). *B. juncea* seed pods shatter less readily and seeds potentially contain a higher percentage of oil plus protein because the yellow seed coat is thinner. These advantages made *B. juncea* the preferred species for production of canola quality oil for low rainfall areas in Canada and Australia and for late sowing in higher rainfall Australian environments.

Brassica juncea has been grown traditionally as a condiment mustard crop in Canada and Australia. The development of canola quality *B. juncea* has taken considerable time (Rakow and Raney, 1995; Oram et al., 1999; Potts et al., 1999). Sources of low erucic acid (Kirk and Oram, 1981), low glucosinolates (Love et al., 1990) and 60% oleic acid (Potts et al.1999) provided the necessary building blocks for breeding of canola quality *B. juncea*. In Canada, *B. juncea* canola cultivars can only be registered if they meet certain quality and agronomic performance standards as specified by the Western Canada Canola/Rapeseed Recommending Committee (WCC/RRC 2002). The quality requirements are less than 12 µmoles of total glucosinolates per gram of seed at 8.5% moisture (equivalent to approximately 20 µmoles of total glucosinolate in seed meal), including less then 1 µmole of allyl glucosinolates, oil with less then 2% erucic acid (C22:1) and more than 55% oleic acid (C18:1) and total oil and protein content not significantly less than current canola (B. napus) cultivars. The stringent quality requirements for *B. juncea* have focused breeding efforts on development of germplasm to meet these requirements. The first cultivars, 'Arid' and 'Amulet', were released by the Saskatchewan Wheat Pool in Canada in 2002.

For breeding purposes, two distinct *B. juncea* germplasm groups have been identified by Oram et al. (1999). The China-Eastern Europe-Canada geographic *B. juncea* is characterised by brown or yellow seeds containing predominantly allyl glucosinolate. These plants require long days for flowering and are resistant to leaf blight caused by Pseudomonas syringae. In contrast to this, the India-Pakistan geographic group has brown seeds containing a combination of butenyl and allyl glucosinolates, shorter stature, earlier flowering and susceptibility to leaf blight. Adaptation to Australian conditions required combining the shortness and earliness of the Indian germplasm with the quality and disease resistance European/Canadian germplasm. This paper reports on the development of canola quality *B. juncea* (juncea canola) for Australia.

Australian Progress

Results for near-canola quality *B. juncea* lines from multi-location trials from 2001 to 2003 (e.g. Burton et al. 2003) showed that at lower yielding sites where the B. napus controls yielded less than 1.5 t/ha, the juncea canola lines were generally equal to or higher than B. napus.

The first lines that met all the quality requirements for juncea canola were in multi-site trials in 2004 (Tables 1 and 2). Again, these lines were competitive with B. napus in low rainfall environments.

Trials of new generation breeding lines in 2004 revealed the continued improvement in quality of the germplasm with respect to both glucosinolates and fatty acid composition (Table 3).

Table 1 Yield and quality data of advanced breeding lines from multi-location breeding trials (6 sites) in 2004.

Line	Yield (t/ha)	Oil Content(%)	Meal Protein Content (%)
JR055	1.33	37.48	40.52
JT004	1.37	35.95	40.90
JT005	1.08	37.44	40.46
JT007	1.22	37.00	41.70
AG-Outback[1]	1.33	36.11	39.1

[1] *B. napus* control

Table 2. Allyl and total glucosinolate contents and fatty acid composition of advanced breeding lines sown at Horsham in 2004.

Line	Allyl Glucosinolates (µmoles/g)	Total Glucosinolates (µmoles/g)	C18:1[1]	C18:2	C18:3	C22:1
JR055	0.13	16.88	56.48	18.40	16.44	0.00
JT004	0.13	17.12	58.10	21.33	11.56	0.00
JT005	0.10	12.89	61.00	18.18	12.99	0.00
JT007	0.21	22.91	56.42	19.60	16.32	0.00
AG-Outback		13.16	56.03			

[1]Oleic acid levels were lower in both species due to seasonal conditions

Table 3. Allyl and total glucosinolate contents and oleic acid content of new generation breeding lines sown at Horsham in 2004.

Line	Allyl Glucosinolates (µmoles/g)	Total Glucosinolates (µmoles/g)	Oleic Acid (%)
JC05002	0.37	18.59	63.05
JC05005	0.27	19.17	62.39
JC05006	0.16	14.39	64.36
JC05007	0.15	14.49	64.66
JC05008	0.75	17.75	60.72
JC05009	0.12	15.61	60.03

Advanced breeding lines were evaluated in multi-location trials in 2005 (Table 4) and 2006. Very few trials were successfully completed in 2006, due to a widespread drought in all major growing regions. One additional 2005 site, at Culgoa in Victoria, was not included in the results due to a high coefficient of variation. However, the results in this severely stressed trial, with both B. napus controls yielding ⩽0.05t/ha, compared with 0.3-0.5t/ha for the juncea canola lines, reflect the increased stress tolerance of the latter species. As a result of trials over several years, JR 055 has been selected as the initial juncea canola release in Australia.

Table 4. Yield data (t/ha and % AG-Outback) from multi-location breeding trials in 2005

Line	South Australia		Victoria		Mean Yield (t/ha)	Mean Yield (% AG-Outback)
	Lameroo	Minnipa	Walpeup	Beulah		
JR055	0.88	0.87	0.87	1.18	0.95	100
JT004	1.08	1.01	0.81	1.19	1.02	108
JT005	0.81	0.93	0.78	1.24	0.94	99
JC05002	0.82	0.75	0.85	1.03	0.86	91
JC05005	1.05	0.72	0.94	0.95	0.92	97
JC05006	0.79	0.82	0.80	0.99	0.85	90
AG-Outback	0.99	1.13	0.83	0.84	0.95	100
AG-Spectrum	1.07	1.13	0.60	0.59	0.85	90
CV%	13.4	8.8	8.0	19.8		
LSD	0.22	0.10	0.09	0.24		

The Way Ahead

JR055 has been selected as the first juncea canola to be released in Australia. It is due for release in early 2007, subject to all appropriate regulatory and industry approvals being in place.

The major focus of the breeding program to date has been on quality, with the required conversion of the oil and meal from condiment to canola quality. Further quality improvements, including lower total glucosinolates, reduced linolenic acid and increased oil content, will continue to be a significant focus, along with increased selection pressure on yield and other agronomic traits.

Around 70% of the Australian canola crop is produced from herbicide tolerant cultivars, using both triazine tolerant and Clearfield (imidazolinone tolerant) types. Without herbicide tolerance, the initial impact of the first juncea canola cultivars will be restricted. Herbicide tolerant juncea canola (Clearfield and triazine tolerance) is in an earlier stage of development, with cultivars expected around 2010. This will significantly increase the prospects for market penetration of juncea canola. Future challenges include development of a workable hybrid system and other disease resistant traits. Juncea canola is expected to

significantly increase the production of canola oil in Australia, becoming the preferred option for production in low rainfall areas and for late sowing in higher rainfall Australian environments.

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