The potential of canola quality *Brassica juncea* as an oilseed crop for Australia

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Abstract

The search for profitable alternatives to cereals in the low rainfall cropping environments has been a high priority in Australian agriculture in recent years. No oilseed crop is well adapted to the 225–350 mm rainfall environments, which occupy over three million hectares of arable land across Australia. Development of a suitable oilseed crop for this region would provide a rotational break to control root diseases and weeds that are difficult to manage in a cereal/pasture rotation. The near canola quality *B. juncea* Australian lines have showed good yield potential in comparison to currently grown early and early-mid maturing *B. napus* cultivars AG-Outback and Rainbow. Compared to *B. napus*, the superior yield, shattering tolerance, better early vigour and disease resistance characteristics of *B. juncea* will encourage growers to use this species in crop rotations where currently oilseeds are not grown once released in two to three years. Future challenges include the further development of high yielding and high oil cultivars and fully exploiting the existing variability and incorporation of herbicide tolerance and other disease resistant traits.

Key words: yield, oil, rainfall, disease, shatter tolerance

Introduction

There is a wide variation in climate across the Australian continent, with the annual rainfall ranging from 325 mm to 700 mm in current canola growing regions. In the southern Australian wheatbelt, the lower rainfall regions occupy three million hectares and receive 225–350 mm of rain per annum, mainly in the cooler half of the year. The risk of drought in low rainfall areas is ever present (Potter *et al.* 1999). *Brassica juncea* (Indian mustard) has several potential advantages over *B. napus* (canola) as an oilseed in semi-arid regions of Australia. Currently, no oilseed crop is well adapted to these regions, but one is needed for inclusion in cereal/pasture rotations to control the weeds and root diseases which become prevalent during the cereal phase. Research programs have been conducted for the past 25 years in Australia with the objective of creating *B. juncea* genotypes for low rainfall environments which produces canola seed quality equivalent to and interchangeable with *B. napus* canola in the market place. The advantages of *B. juncea* over *B. napus* include 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). *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. The oil of both species is low in saturated fats. The potential benefits of developing canola quality *B. juncea* are recognised by a number of northern hemisphere countries, particularly Canada, where there are major breeding programs focussed on its development. This paper summarises the potential of canola quality *B. juncea* as an oilseed crop for Australia.

The Australian canola quality *B. juncea* breeding program is aiming to select canola quality (double low) *B. juncea* lines which are high yielding, early flowering and large seeded with good early vigour and agronomic acceptability. A major objective is to select genotypes which reach the end of flowering equivalent to or earlier than the new early maturing *B. napus* cultivars and have comparable or enhanced yields. An additional aim is to raise oleic acid levels to 60–65% (Burton *et al.* 1999) to match those in canola and select lines, which have less than 1 μmol/g allyl glucosinolate in breeders seed. This will ensure the lines will consistently fall below the 3 μmol/g limit for commercial crops as per the Canadian requirements (Potts *et al.* 1999).

Materials and methods

B. juncea lines nearing canola quality have been evaluated across Australia in multi-location interstate canola quality *B. juncea* trials in recent years. Yield, agronomic and quality data was collected from 17 trial sites in 2001 but only three trial sites in 2002 due to loss of trial sites affected by a wide spread drought. Lines designated with the prefix JN, JO, JP and JQ represent the last four years (respectively) of breeding lines promoted into the multi-location trials. AG-Outback and Rainbow are early and early-mid *B. napus* controls and CPI81792 is an Indian line.

In all cases, trials were managed using standard agronomic practice for canola production in each region. Plots were 0.9–1.2 metres wide and 7–20 metres long. There was a range of environments particularly selected in low rainfall areas in which the different genotypes were sown in order to select lines with wide adaptation and also collect results on species potential in these areas.

Results

Yield results (2001, 2002) and oil quality results (2001) are presented for a sub-set of the highest yielding lines, plus controls are presented in Table 38. Yield data has been analysed using multiplicative models described by Smith *et al.* 2001. For 2001 yield data the overall mean (BLUP – best linear combined prediction of yield) across all sites, plus the mean of sites where the *B. napus* canola control cultivars AG-Outback and Rainbow yielded less than 1.5 t/ha (10 sites) are presented.

Across all seventeen sites in 2001, the best near canola quality lines (low glucosinolate, low erucic and mid-high oleic acid) yielded slightly less than *B. napus* canola. The Indian line CPI.81792 (high glucosinolate, high erucic and low oleic) yielded equivalently to the *B. napus* cultivars AG-Outback and Rainbow. At the ten low yielding (<1.5 t/ha) sites, the near canola quality lines where equal to or higher yielding than the *B. napus* control cultivars. Results presented for oil and glucosinolate contents are mean contents analysed from 14 sites in 2001. Oil content of the best canola quality lines is equal to or slightly less than the current *B. napus* cultivars. Glucosinolate contents are still significantly higher than the *B. napus* controls, however new breeding lines like JP003 and JP006 have lower contents than older lines (Table 38). *B. juncea* does have equal to or higher meal protein (results not presented) and, due to yellow seededness, meal quality will be better than current *B. napus* cultivars.

Table 38: Across site yield summaries for 2001 and 2002, oil and glucosinolate content for 2001 canola quality *Brassica juncea* Australian Interstate (stage two) trials.

Line	Yield (t/ha) 2001	Yield (t/ha) 2001 (< 1.5 t/ha sites)	Oil content 2001	Glucosinolate content 2001	Yield (t/ha) 2002	Canola quality[1]	Oleic content[2]
AG-Outback	1.20	0.76	39.6	10.8	0.40	00	H
Rainbow	1.10	0.67	38.6	8.5	0.26	00	H
887.1.6.1	1.22	0.93	38.4	48.6	NE[3]	++	L
JN004	0.98	0.74	39.5	21.4	0.37	00	M
JN028	1.10	0.95	37.3	70.5	0.41	+0	M
JO006	1.07	0.81	37.8	22.5	0.40	00	M
JP003	1.15	0.89	37.5	8.3	NE[3]	00	M–H
JP006	0.98	0.70	38.1	17.0	NE[3]	00	H
JP008	0.98	0.67	39.0	20.6	NE[3]	00	H
JP009	0.98	0.71	37.8	24.2	0.35	00	H
JQ001	NE[3]	NE[3]	NE[3]	NE[3]	0.38	00	H
JQ010	NE[3]	NE[3]	NE[3]	NE[3]	0.38	00	H
Site number	17	10	14	14	3		

[1] = 00 = erucic acid free, low in glucosinolates; 0+ = erucic acid free, high in glucosinolates; ++ = contains erucic acid, high in glucosinolates

[2] = H = >55%; M = <55 and >45% and L = <45%

[3] NE = Not evaluated

Discussion

The near canola quality *B. juncea* Australian lines showed good yield potential in comparison to currently grown early and early- mid-maturing *B. napus* cultivars especially in low yielding sites. Oil content of the best breeding lines was equivalent or slightly less than the current early and early-mid maturing *B. napus* cultivars. The advantages of shatter tolerance better early vigour and disease resistance will assist in the adoption of this new species. Shattering tolerance will provide a cost savings of $25/ha in Australia by avoiding the need to windrow. The information presented on breeding lines (with the prefix JN, JO, JP and JQ) are unlikely to be the first releases due to quality deficiencies. Lines in 2003 multi-location breeding trials are expected to be released in two to three years.

Future challenges include the further development of high yielding and high oil cultivars and to fully exploit the existing variability in this area. The last twenty years of breeding in Australia has focused mainly on improving quality and maintaining yield. Other priorities for breeding include disease resistance (white-rust, blackleg, and *Pseudonomas* leaf blight). Higher disease levels are expected once the industry is established. Other quality characteristics will also become important with changes in markets. The incorporation of herbicide resistances, especially those with no inherent yield penalty, into new Australian cultivars will be also important in ensuring success in low rainfall environments of Australia.

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