Selection of canola lines for low rainfall environment in south eastern Australia

Geoff Thomas[1] , Nigel Wilhelm[2] and Neil Fettell[3,4]
[1] Low Rainfall Collaboration Project, 48 Grevillea Way, Blackwood 5051, Australia
[2] South Australian Research & Development Institute, Hartley Grove, Urrbrae SA 5064, Australia
[3] Department of Agronomy & Soil Science, University of New England, Armidale NSW 2351, Australia
[4]NSW DPI, PO Box 300, Condobolin NSW 2877 Australia
Email: gtps@bigpond.net.au

ABSTRACT

The development of a profitable break crop in low rainfall cereal growing areas is essential for sustainable and profitable systems. Until now, canola, peas and lupins have been the most promising options, with canola having several valuable characteristics (eg herbicide tolerance, high value grain and well anchored stubble) for low rainfall rotations. In 2009 and 2010, well over one hundred lines were trialled at each of three locations (two locations in 2009). These included mustards and TT, IT, Round up Ready (except in SA because of the GM Moratorium) plus conventional lines of canola. The various lines were assessed for early vigour, height, standability, time to flowering, and yield. Other characteristics which may be of commercial significance (eg sensitivity to herbicides) were also noted. Grain analysis included commercial tests such as oil content and protein. Due to very mild temperatures in spring and prolonged moisture in the profile at many sites in the two years of study so far, it has only been possible to evaluate lines for their performance under drought and high temperature stress at one site in 2009. A number of entries were identified as promising for low rainfall environments at that site. However, the most desirable lines for low rainfall conditions will not only have to "tough it out" in drought years but also be able to do well in the better rainfall years. Mustard lines could not match the performance of their canola cousins under good growing conditions. Time to reach 50% flowering occurred over a 3-6 week window, depending on the site. Some lines flowered as much as one week earlier than the earliest commercial varieties. Lines were blocked according to their herbicide tolerance at each site. As a result, direct comparisons between these groups could not be made. However, RR lines appeared to reach similar yields to conventional and IT at the two sites at which they were tested, while the TT continued to carry some yield penalty. Despite the less than ideal seasons for testing low rainfall material, this project continues to show that there is real potential for some of the new material to do better than current commercial varieties in these locations, increasing the prospects of a more profitable and reliable break crop. The trials will continue in 2011.

Key Words: Canola – breeding – low rainfall – early generation

INTRODUCTION

The development of a profitable break crop in low rainfall cereal growing areas is essential for sustainable and productive rotations and hence, profitable systems. Until now canola, peas and lupins have been the most promising options, with canola having several valuable characteristics (e.g. herbicide tolerance and high value grain). It is relatively free of disease in low rainfall areas and is able to utilise the high nitrogen levels following medics or legume crops which makes it ideally suited to low rainfall rotations.

With the decision by Grains Research and Development Corporation (GRDC) to withdraw from mainstream canola breeding, selection and evaluation, this role has been assumed by the four major commercial companies, namely Nuseed, Pioneer, Pacific Seeds and Canola Breeders Western Australia Pty Ltd(CBWA).

There have been concerns that the commercial breeding companies may not select and evaluate new lines in low rainfall areas because of geography, cost, small size of the potential market, and risk of losing material in poor seasons. This was confirmed in discussion with the

breeders, although CBWA are committed to breeding for low rainfall areas. CBWA tests material in early phases of its breeding programme in lower rainfall regions in Western and eastern Australia, and has an end point royalty which supports low rainfall canola breeding.

Following discussion with the companies, a case was put to GRDC for greater support for canola selection for low rainfall areas and this was accepted subject to agreed protocols being developed. The agreement provided for trials at in the districts located around Minnipa (SA), Walpeup (Vic), and Condobolin (NSW).

The aim of this project is to identify early generation lines which perform well in low rainfall environments for use either in future breeding programs or for development by the company (or others under contract) to commercial release.

MATERIALS AND METHODS

Each trial tested up to 50 lines of early generation material from each of four companies, giving a maximum of 200 lines in total to be tested each year. Several commercial varieties were included in each trial to evaluate performance of breeding lines against current commercial varieties and allow "calibration" with the NVT programme. All experiments including GM material were conducted by practitioners trained in the Monsanto protocols for management of GM crops.

Site characterisation for each trial included soil fertility to depth, soil description, paddock history (including herbicide management) for previous 5 years, disease bioassay by RDTS, meteorological data from a nearby station, as well as pre seeding and post harvest soil moistures (except where rain falls between maturity and harvest).

Replicates were restricted to two due to limited seed supplies but all plots were approximately 12 metres long by 6- 8 rows wide. All experiments are seeded as soon as practical after 20 April each year following the first suitable rain at a seeding rate of 2.5 kg/ha.

Lines were blocked according to their herbicide tolerance (e.g. TT, RR, conventional) and herbicides managed according to the protocol for that particular type (although in some locations, absence of weeds meant these herbicides were not applied). Trials were managed according to best practice for each district and plots direct headed after dessication if necessary.

One replicate of all lines in each experiment were observed for early vigour, height, standability, the actual days to 50% flowering (i.e. 50% of plants have at least one open flower), days to end of flowering, and days to physiological maturity. Any other characteristics which may be of commercial significance (e.g. sensitivity to herbicides) were also noted.

All grain was analysed by standard commercial NIR tests for oil content, protein, glucosinolates, and sinapines.

RESULTS

2009

In 2009, about 120 lines were trialled at Minnipa and Condobolin. These included triazine tolerant (TT), Roundup Ready (RR, except in SA because of the GM Moratorium), Clearfield (IT) and conventional lines.

There were no Nuseed entries at Minnipa because of the company's concentration on Round Up Ready and the retention of the GM Moratorium in SA.

Pioneer did not provide entries to any site due to a shortage of seed and the shifts in their program from open pollinated to hybrid lines.

There was no trial in the Victorian Mallee because of uncertainties and policy changes with regards the preferred site.

Under what were very tough conditions at Condobolin, there were some spectacular successes and some abject failures. It appeared that each herbicide tolerant block was affected to a different degree by the tough conditions due to variation across the paddock so comparisons between herbicide tolerant material were difficult.

Establishment conditions were less than ideal, with little rain received in May after sowing (Table 1). There were considerable differences among the lines, a result of variations in seed size and quality. In general, the IT lines appeared to establish particularly well while the TT lines

struggled. CBWALR2, T2261 and T2413 were individual TT lines which established well despite the conditions.

Water stress was exacerbated by the lack of stored moisture, following the relatively dry summer and autumn. There was no available water stored below 50 cm in 2009, which is unusual for this environment and a feature which crops rely on for good productivity on these heavy deep soils.

There was a large spread in flowering time among the entries and many were much slower to flower and begin seed filling than Tarcoola, our current commercial benchmark for low rainfall areas, These later-developing lines suffered greatly and yielded poorly under the dry spring conditions and appear not suited to low-rainfall regions. The IT lines as a group flowered later. The two mustard lines flowered very early.

Grain yields also differed among the entries, with individual plots yielding less than 1 t/ha. The two conventional mustard lines (Q6501 and Q6503) were the stand out performers for yield. They averaged more than 0.9 t/ha while the rest of the conventional block averaged only 0.5 t/ha. However, there were several canola lines in this block which yielded between 0.6 and 0.8 t/ha (H6059, H6531, H6693, H6698, H6756).

The TT block averaged only 0.4 t/ha but four lines yielded better than 0.6 t/ha (CBWALR11, CBWALR15, CBWALR20, CBWALR8). A quarter of the TT lines out yielded Tarcoola (0.56 t/ha). The four IT lines yielded between 0.16 and 0.45 t/ha.

There was a wide variation in yield within the RR lines although variable drought stress across the block makes firm conclusions difficult. The average yield for the block was 0.4 t/ha but five lines yielded better than 0.55 t/ha (NGO479, NGO469, NGO465, NGO464 and NGO457). NGO457 yielded nearly 0.9 t/ha.

Oil contents were low which reflects the very harsh finishing conditions at this site last year and similar across all herbicide tolerance groups (an average of 36% for the whole trial). TT lines struggled to match the high oil content of Tarcoola. There was a large range of glucosinolate levels in RR lines, some to values undesirable for commercial material. Sinapine levels were very similar across all lines at the site.

Table 1. Monthly rainfall for 2009 and 2010 at the sites where canola was screened for low rainfall production (mm).

Site	Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Condobolin	2009	4	61	29	45	14	53	23	11	17	34	17	91
	2010	17	159	55	33	38	26	49	26	36	77	81	51
	Median	28	32	26	17	27	27	35	31	24	37	32	26
Walpeup	2010	14	17	29	40	32	16	17	66	38	60	75	142
	Median	13	14	10	12	26	25	30	35	27	28	25	15
Minnipa	2009	0	2	62	25	33	74	83	21	44	7	18	3
	2010	5	15	12	2	60	34	7	53	44	69	4	21
	Median	7	6	9	16	34	40	43	43	30	23	19	14

The results from 2009 at Minnipa were, in many respects, quite spectacular even if not particularly helpful for screening material for low rainfall environments.

In one of the best seasons ever, 330 mm rainfall fell in the growing season and early rains allowed the trial to be seeded under ideal conditions on 1 May (table 1). The site had very few broad-leaved weeds and only a grass selective herbicide was applied after crop emergence. The TT block or IT plots did not receive their herbicides of tolerance.

All lines established well under the excellent conditions and grew vigorously all season. Yields ranged from 1.73 to 2.87 t/ha, with an average of nearly 2.5 t/ha for the whole trial.

Many of the new lines yielded better than those currently available commercially while others were disappointing, even under the good seasonal conditions. The worst performers also tended to be the very earliest flowering lines which may mean they will do much better under harsher conditions. This group includes the two mustard lines. Tarcoola performed very well under these ideal conditions and yielded to within 15% of all but one of the highest yielding lines. It was the highest yielding of five commercial varieties in this trial.

The TT lines struggled to outperform the commercial varieties at these very high yield levels (all commercial varieties yielded between 2 and 2.5 t/ha). The TT gene appeared to cause a 10% yield reduction under the conditions of this trial.

Oil contents were high (over 40% for all lines) but the conventionals generally had higher levels than the TT lines (an average of 44% vs. 41%).

All glucosinolate levels were low across all lines, which is partly due to the mild finishing conditions at this site.

2010

All three trials were seeded promptly after the break in each location but were not especially early on the calendar by local standards (29 April at Condobolin, 3 May at Walpeup and 26 May at Minnipa). However the wet and prolonged season in all three districts meant that there was little penalty for the later dates on the calendar.

Due to the very mild temperatures in spring and prolonged moisture in the profile at all sites (table 1), it was not possible to evaluate lines in 2010 for their performance under drought and high temperature stress. However, the most desirable lines for low rainfall conditions will not only have to "tough it out" in drought years but also be able to do well in the better rainfall years. The 2010 season allowed us to assess them on that basis.

In 2009, a number of entries were identified as promising for low rainfall environments. Mustards performed well compared to canola under the drought conditions at Condobolin. H6693, H6698, H6756, CBWALR07, CBWALR08 CBWALR11, CBWALR15 and CBWALR20 were lines which topped yields at Condobolin and also performed well at Minnipa. They also had no major grain quality weaknesses.

Just as occurred in 2009 at Minnipa (a high yielding site) the mustard lines in 2010 could not match the performance of their canola cousins under good growing conditions. The mustard lines included current commercial releases. The yield gap between mustards and canola in high yielding situations has been substantial, eg over 1 t/ha difference at Condobolin. So far, this seems to be a feature of current mustard material – strong performers under tough conditions but really struggle to exploit good seasons.

More often than not, the early generation material being tested in this project struggled to outperform current commercial varieties. This is not surprising given that the early generation material was specifically selected for very low rainfall situations whereas the commercial varieties must have more general adaptability.

Of the lines which performed well at both sites in 2009 (H6693, H6698, H6756, CBWALR07, CBWALR08 CBWALR11, CBWALR15 and CBWALR20), only H6693 was carried forward into 2010 trials and it was only just into the top half of the conventional block.

Time to reach 50% flowering occurred over a 3-6 week window depending on the site and some lines were as much as one week earlier than the earliest commercial varieties.

Lines were blocked according to their herbicide tolerance at each site so direct comparisons between these groups could not be made. However, RR lines appeared to reach similar yields to conventional and IT at the two sites where they were tested while the TT continued to carry some yield penalty.

CONCLUSIONS

Despite the less than ideal seasons for testing low rainfall material, this project continues to show that there is real potential for some of the new material to do better in these locations than current commercial varieties, increasing the prospects of a more profitable and reliable break crop.

H6693, H6698, H6756, CBWALR07, CBWALR08 CBWALR11, CBWALR15 and CBWALR20 were lines which topped yields at Condobolin and also performed well at Minnipa. They also had no major grain quality weaknesses.

The ability of some lines to establish well under very difficult conditions may well be an important asset for low rainfall material; those lines which did so in these trials have been noted for continuing evaluation in future years.

The trials will continue in 2011 with the breeding companies submitting material for the three sites of Minnipa, Walpeup and Condobolin.

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