FINAL REPORT

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

DAW00101

Evaluation and selection of high quality Brassica breeding lines for short season environments of Western Australia

PROJECT DETAILS

PROJECT CODE:	DAW00101
PROJECT TITLE:	EVALUATION AND SELECTION OF HIGH QUALITY BRASSICA BREEDING LINES FOR SHORT SEASON ENVIRONMENTS OF WESTERN AUSTRALIA
START DATE:	01.07.2004
END DATE:	30.06.2007
SUPERVISOR:	GRAHAM WALTON
ORGANISATION:	DEPARTMENT OF AGRICULTURE WESTERN AUSTRALIA
CONTACT NAME:	GRAHAM WALTON

Summary

The Western Australian (WA) oilseed industry can increase by 100,000ha in the low rainfall areas by having improved early maturity varieties of either canola or mustard. The improved varieties also have higher oil and protein concentrations, which strengthens their demand in the marketplace.

This project aimed to produce a canola variety through the selection of plants in the targeted environment. Plants were selected from germplasm sourced out of the Victorian (VIC) and New South Wales (NSW) Department of Primary Industry (DPI) breeding programs, which had increased yield, oil plus protein and blackleg tolerance. The best selections proceeded into yield testing.

Eight new varieties were released after being tested in the Stage 2 trials in WA.

Report Disclaimer

Level 4, East Building | 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | t. +61 6166 4500 | f. +61 2 6166 4599 | grdc@grdc.com.au | grdc.com.au

Old or Archival Reports (Projects that concluded in 2007 or earlier)

The information contained in these older reports is now several years old, and may have been wholly or partially superseded or built upon in subsequent work funded by GRDC or others. Readers should be aware that more recent research may be more useful for their needs. Findings related to agricultural chemical use are also potentially out of date and are not to be taken as a recommendation for their use.

Conclusions

Of the 4,467 single plant selections that were made between 2004 and 2006, five triazine# tolerant (TT) canola lines, one Clearfield® line and three conventional lines appeared to be outstanding in yield, oil and protein concentrations, field performance and blackleg tolerance in comparison with the respective control varieties. The TT selections were TP005-1M8, TP003-01M2, TR002-03M09, TR006-03W08 and TR004-03M04. TR004-03M04 ranked highest in yield in the Stage 3 trials across Australia. The Clearfield® selection of BLN 2865CL-03W01 ranked second highest for yield in the Stage 3 trials across Australia. The conventional canola selections were RR009-03M04, BLN2852-03W02 (ranked fifth for yield in Stage 3 trials across Australia) and RT008-04M03 which ranked highest in yield in the Stage 2 trials across Australia. The VIC DPI chose four early selections made in 2003 and nine selections from 2006 for further germplasm selection work.

The Stage 2 interstate variety evaluation trials have proven to be a good vehicle for gathering field performance data about the best advanced selections across a wide range of climatic and soil environments in Australia. The data provide the plant breeder and seed marketing organisations with the tools to use to make decisions about the commercial release of new varieties. During the three years of this project (2004 to 2006) 19 new canola varieties were released, of which eight were evaluated through the Stage 2 trials in WA. The other new varieties were first evaluated in the Stage 3 variety trials and in the National Variety Trial (NVT) programs.

The interstate *Brassica juncea* evaluation trials were invaluable to the evolution and development that resulted in the release of the first juncea canola variety Dune(ℓ). The juncea material exhibited the trait of osmotic adjustment under very dry conditions, which enabled it to restrict the yield loss under dry conditions. The information obtained in WA from the mustard evaluation trials has been of great value to the oilseed industry, especially with the growing demand from growers for an alternative break crop in the low rainfall regions.

Recommendations

The project demonstrated that selection of material in the targeted environment can provide rapid improvement in germplasm. Widespread testing of advanced material in a wide range of environments across Australia provides information to plant breeders and their associated seed marketing companies and reliable data on which to base the choice for varietal release and guidelines for growing.

Outcomes

Economic Benefits

WA's annual canola production covers approx. 450,000ha and average yield is 1.2t/ha. There is potential for another 100,000ha to be planted in the low rainfall regions (<350mm). The stimulus to an expansion of the canola industry will come from new varieties adapted to the short season environment, giving greater consistency in yield and benefits in weed and disease control arising from having an oilseed break crop in the farm rotation. The canola industry has the potential to expand into the medium and low rainfall zones by another 90,000ha, bringing the total canola area up to 540,000ha annually.

Five new canola varieties (ATR-Banjo(Þ), Boomer(Þ), Tanami(Þ), Rottnest TTC(Þ) and ATR-Cobbler(Þ)) with early maturity and higher seed yields were released commercially after being tested in variety trials during the past three years of the project. These will encourage growers in the low rainfall area who are seeking a suitable break crop to return to canola. A modest 8% yield advantage, on top of the current eastern wheatbelt average yield of 0.8t/ha, would give an extra return of $19.38/ha (based on a cash price of $323/tonne). If this stimulated an increase in canola area of 90,000ha, the extra value would be worth $25 million to WA agriculture.

The inclusion of canola quality *B. juncea* into the cropping system in the low rainfall zone provides growers with an alternative break crop. The rapidly expanding interest in a crop for biodiesel production, mustard production and either of canola quality or fuel quality will predominate in the low rainfall zone, where it should have an agronomic advantage over canola. In the short term, the export markets for canola quality mustard seed will be India, Bangladesh and Pakistan. These markets have traditional knowledge of using mustard oil and will accept the different seed colour, size and quality differences more readily than the canola markets of Japan, Mexico, etc. The value to WA of the additional mustard seed will be on top of the value coming from the increase in area arising from improved canola varieties.

Environmental Benefits

The value of having canola or mustard in the crop rotation corresponds to a 20% yield advantage in the wheat crop following canola, compared to wheat following wheat (1. Norton, 2003). The increase in wheat yield is a response to better control of grass weeds, control of cereal root diseases and greater numbers of *Pseudomonas* bacteria in the wheat rhizosphere (2. Harris et al. 2002; 3. Smith et al. 2004). A 20% wheat yield increase over a 1.7t/ha average wheat yield in the low rainfall zone equates to an additional $55.40/ha return (based on a wheat price of $163/t). Over an increase in area of 90,000ha, this gives an extra $4.98 million in value to WA agriculture.

Achievements/Benefits

The significant contribution that the early maturity trait has on achieving high seed yields in WA's medium to low rainfall regions was reported by Walton et al. (2001). In 2004, three lines with WA selections as a parent were tested in the interstate Stage 2 trials. These lines were early flowering, with increased oil concentrations and suitable yields. Although they did not proceed further, one line (BLN 3224) underwent further re-selection and in the 2006 Australia-wide Stage 2 trials it ranked eighth in yield, ahead of the control varieties Av-Opal(Þ) and Ag-Outback(Þ). Selections made in 2001 performed well in comparison to the control variety ATR-Stubby(Þ) in the interstate Stage 2 evaluations across Australia. The selections TP005-01M8 and TP003-01M2 were early flowering, with higher oil and protein and had a higher blackleg tolerance rating than ATR-Stubby. The selection TP005-01M8 had continued evaluation in the following year (2005), where it again performed well in comparison to ATR-Stubby. The breeding organisation did not proceed with any development of this line. Another TT selection (TQ001-02W12) was very early flowering, outyielded ATR-Stubby and had higher oil and protein. The Clearfield® selection BLN2695CL-02W9 was early flowering, with higher oil and protein than the superior control variety 44C73.

Selections made in 2003 that progressed into the Stage 2 evaluations had enhanced blackleg tolerance ratings and showed significant yield superiority over the control varieties. A selection of particular interest is the conventional canola, RR009-03M04, which was chosen to continue in 2007. RR009-03M04 is early flowering and had 15% higher yield than the control variety. It had 3% higher oil and slightly higher protein than the control. Several of these selections performed well enough to be tested again in the Stage 3 evaluations in WA the following year (2006). The TT selections were mid-maturity (flowering three to 12 days after ATR-Stubby), had up to 20% higher yields and 1-2% higher oil. The Clearfield® selection and the

Level 4, East Building | 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | t. +61 6166 4500 | f. +61 2 6166 4599 | grdc@grdc.com.au | grdc.com.au

conventional selection were both early flowering, with 2% and 4% more oil concentration than the control varieties. Blackleg tolerance ratings of these selections were also superior to the controls.

These WA selections were included in the 2006 interstate Stage 3 evaluations located in NSW, VIC and South Australia (SA). The selection TR004-03M04 outyielded all other entries, including the best control variety Bravo TT$^{\Phi}$. The Clearfield® selection BLN2865CL-03W01 ranked second for yield after the early variety 44C73.

Of the 2004 selections tested in the Stage 2 trials in WA in 2006, the conventional canola selection, RT008-04M03, was 63% higher yielding than the control variety AG-Outback and had 5% higher oil concentration. This selection topped the yield ranking in all of the Stage 2 trials conducted throughout Australia and was one of the selections chosen for continued evaluation in 2007. These results endorse the selection progress made in WA during this project. The breeding organisations have the opportunity to continue to develop these lines. The VIC DPI has chosen several WA selections for further development beyond the completion of this project. These include RR002-03M05 - which flowered three days earlier than RR009-03M04; RR009-03M04 - which gave high yields and oil concentration in 2005; RT008-04M03 – which was the highest ranked entry in the interstate Stage 2 trials in 2006; and RT096-05W10 - which had 4% higher oil and 3% higher protein concentration than the control varieties AG-Outback and Rivette$^{\Phi}$ in the preliminary yield trials conducted in 2006.

The selections made in 2006 had up to 5% higher oil and up to 4% higher protein concentrations than the control varieties. The VIC DPI has chosen the nine highest ranked selections from its germplasm for further evaluation after the completion of the project. These lines are CC05032-06W1, CC05032-06W4, CC05032-06W5, CC05051-06W6, CC05016-06W6, CC05016-06W3, CC05032-06M3, CC05031-06M6 and CC05055-06M5.

Selections made in WA have provided the South Australian Research and Development Institute (SARDI) colleague in the National Brassica Improvement Program (NBIP), Trent Potter, with additional germplasm to select from. Five of the SA re-selections made at Minnipa progressed through to the Stage 2 interstate evaluations in 2006. The early maturity WA TT selection TP003-01M2 provided two lines - SARDI 612TT and SARDI 613TT. The selection TP005-01M5 provided two lines - SARDI 613TT and SARDI 614TT. The mid-maturity selection TO005-01M8 gave one line - SARDI 621TT. The re-selection SARDI 613TT ranked second for yield in the Australia-wide Stage 2 interstate evaluations in 2006.

The Stage 2 interstate variety evaluation trials provided the plant breeders and the seed marketing companies with field performance results across a wide range of Australian environments. From these results, a decision about whether a new crossbred line has given sufficient improved performance to warrant commercial release can be made. The range of environments provided by the interstate trials also allows the seed marketing companies to provide guidelines about the environments in which the new varieties are best suited. During the three years of this project, 19 canola varieties were commercially released. They are, ATR-Summitt, Boomer$^{\Phi}$, AGC-Muster, Rocket CL, Thunder TT, 45Y77, Tanami$^{\Phi}$, 44Y06, Hyola 50$^{\Phi}$, Hyola 75$^{\Phi}$, Tarcoola$^{\Phi}$, ATR-Barra$^{\Phi}$, ATR-Signal, ATR-Cobbler, Banjo TT$^{\Phi}$, Ag-Muster, ATR-Marlin$^{\Phi}$, Flinders TTC$^{\Phi}$ and Rottnest TTC. Of the 19 varieties, eight were entered in the Stage 2 evaluations conducted in WA. The results of the eight new varieties in the Stage 2 trials show them to be mid-maturity (except for Boomer), having a yield increase over the control variety in most cases and slightly increased oil concentrations. The field performance of those new varieties not included in the Stage 2 trials was seen in the NVT trials and Stage 3 trials.

The interstate *B. juncea* (mustard) evaluation trials were a vehicle for the development and commercial release of canola quality juncea by VIC DPI. The mustard evaluation trials also provided invaluable experience in determining the performance of mustards in WA. In the low rainfall area at Mullewa in 2004 (and in all WA sites in 2006), these gave very low yields (from nil to 0.4t/ha) and, in that environment, the best mustard lines outyielded the canola varieties by up to 60%. This demonstrates the reputation that *B. juncea* has for 'drought tolerance'. Under very low rainfall, the *B. juncea* has the capacity for osmotic adjustment to limit its yield decline, whereas the canola has less osmotic adjustment, giving a greater yield decline than juncea. However, under more normal rainfall, the best performing juncea lines yielded on average 85% of the canola yield. This indicates that the development of canola quality mustard has a considerable way to go. In 2007, the juncea canola variety Dune$^{\Phi}$ was released. This variety, in the interstate variety evaluation in WA in 2005, gave relative seed yields of between 70% and 124% of the canola variety AG-Outback.

Other research

1. Tolerance of *B. juncea* to clopyralid$^{\#}$ (Lontrel®$^{\#}$ herbicide).

In preparation for the release of a canola juncea variety, a trial was conducted at Wongan Hills in 2006 to provide data in support of an application for the registration of the use of clopyralid in the crop. Previous trials in VIC and SA were inconclusive about the extent of mustard's tolerance to clopyralid. The trial results showed a significant 2.5-fold yield increase in the variety Dune to the application of the label rate (300mL/ha) of Lontrel®. The large yield response was due to the complete kill of capeweed in the trial. At 1.5 times the label rate, there was no significant seed yield decline, but at twice the rate yield fell by 18%. A permit for the use of Lontrel® in mustard crops was issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA).

2. Herbicide tolerance of *B. juncea* to selected pre and post-emergent herbicides (collaboration with M. Campbell, Centre for Legumes in Mediterranean Agriculture (CLIMA)).

Trials to determine the crop tolerance of oilseed crops, including mustards, to pre and post-emergent herbicides were conducted in 2004, 2005 and 2006. The trials in 2004 and 2005 indicated that clopyralid was the only post-emergent herbicide tested that had no effect on mustard crop establishment and seed yield. Cyanazine# (Bladex®# herbicide) at 2L/ha gave the next best result, with 22% yield decline. The trials in 2004 identified trifluralin# and haloxyfop# (Verdict®#) as the only other pre-emergent herbicides, along with clopyralid, to be tolerated by mustard. However, in the 2006 trial under dry conditions, trifluralin gave a 20% yield reduction in the mustard.

3. Response in mustard and canola to nitrogen (N) x phosphorus (P) fertiliser rates.

Trials were conducted in 2004 and 2005 to determine if there were differences between mustard and canola crops in their response to different rates of N and P fertilisers. Both years had low rainfall and yields were below average (about 0.5t/ha). The rates of nil, 25, 50 and 150kgN/ha were applied as urea. The rates of nil, 10, 20 and 40kgP/ha were applied as Double Phos. In 2004, there was a significant yield response to an N-P interaction for mustard only at Merredin with the highest yield at 20kgP/ha and 50kgN/ha. Canola had no significant yield interaction at Merredin, with the yield responses up to 150kgN/ha. The Newdegate trial gave no significant interaction for either crop. In 2005, there was a significant N-P interaction for both crops at Merredin - with yield responses up to 150kgN/ha and 40kgP/ha. At Newdegate, there were no significant N-P interactions. Both canola and mustard responded similarly to the highest fertiliser rates.

The results suggest that both mustard and canola crops tend to give similar responses to N and P fertilisers.

Intellectual property summary

In 2005, agreement was reached for a Royalty Sharing Model for any variety that utilised SA and WA 'selection' expertise and resources. The agreed split was germplasm (40%), breeding (35%), selection (15%), evaluation (5%) and seed quality assurance (5%). Separate agreements were endorsed between Victoria DPI and SARDI and DAFWA and between NSW DPI and SARDI and DAFWA.

Additional information

1. Walton, G., Trent, T., Fels, P. and Robinson, D. (2001). Selecting canola varieties for Western Australia - Final GRDC Project Report. Proceedings 12th Australian Research Assembly on Brassicas (Ed. S.J. Marcroft), 2-5 October, Geelong, Victoria; pp23-28.

2. Norton R. (2003). Conservation farming systems and canola. University of Melbourne Publication (in association with Avcare).

3. Harris, R.H., Scammell, G.J., Muller W.J. and Angus J.F. (2002). Crop productivity in relation to species of previous crops and management of previous pasture. Aust. J. Agric. Res., 53(11): 1271-1283.

4. Smith, B.J., Kirkegaard, J.A. and Howe, G.N. (2003). Impacts of *Brassica* break-crops on soil biology and yield of following wheat crops. Aust. J. Agric. Res., 55: 1-11.

Level 4, East Building | 4 National Circuit, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | t. +61 6166 4500 | f. +61 2 6166 4599 | grdc@grdc.com.au | grdc.com.au