Understanding Australian Oilseed Brassica Germplasm : Conservation, Breeding and Research

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Introduction

Growing oilseed Brassicas as a crop started in Australia in 1969. Plant breeding started in 1970 with the program of the Victorian Department of Agriculture at Werribee. This coincided with the time of the decision by most rapeseed breeders to develop 'double low' varieties – later to be called canola.

Germplasm accessions

As part of this first breeding program, varieties and germplasm from around the world were introduced and evaluated for their adaptation to Australia. The first varieties introduced were mainly from Canada,Europe and Japan, mostly *B.napus* and fewer *B. rapa*. In subsequent years, large numbers of lines were introduced from India (*B.rapa* and *B.juncea*) and China *(B.napus).* As new breeding programs started in other states (NSW, WA and ACT) more germplasm was introduced. Each breeding program had a collection of lines, many of the lines being common. As the canola industry developed, more research was devoted to looking at the variation available in the Brassica gene pool: this led to the introduction of related species, *B.oleacea, B. carinata, B.nigra* as well as the development of a collection of lines from other closely related genera.

In 1989 the Federal government set up a number of national stations to manage the germplasm collections for species important to Australian agriculture. The Australian Temperate Field Crops Collection (ATFCC) at Horsham, Victoria has responsibility for oilseeds. This centre brought together the various collections from the breeding programs and other research institutions and centralized them at one location.

The ATFCC now has a very large collection of lines of Brassicas and lines from related genera. It has excellent long term storage facilities as well as facilities for working material. The ATFCC works with other international organizations for the collection and maintenance of germplasm. On request, it distributes free, seed of lines held in the collection. The centre grows out the lines and collects data to add to the data base on each line.

The ATFCC collection now has the following number of germplasm lines:

Brassica napus	830
B.rapa	1119
B. juncea	1210
B.nigra	237
B.oleracea	38
Brassicaceae wild	972

Initial Breeding

The first oilseed *Brassica* breeding program started in Australia at Werribee, Victorian Department of Agriculture with Greg Buzza as the breeder. From the start the objective was to breed 'double low' varieties of *B.napus* adapted to Australia. The first canola quality material was developed by crossing Zephyr (Canada) with Bronowski (Poland). Early evaluation of introduced germplasm had shown that the Japanese varieties were the best adapted lines for the Australian wheat belt. They had good winter growth and had early flowering in the winter/spring, but many of the lines had a slight vernalizationrequirement which delayed or prevented flowering when grown in summer. By crossing the canola quality material (Zephyr x Bronowski) to Japanese varieties such as Chikuzen, Haya, Norin 16, Chisaya and others it was possible to combine the good agronomic characteristics of the Japanese germplasm with canola quality. This material became the basis of the early Australian canola varieties developed in the seventies and eighties.

Other breeding programs began in the 1970's: Western Australian Department of Agriculture, Perth, (Narendra Roy), New South Wales Department of Agriculture, Wagga Wagga,(Neil Wratten) andCanberra, CSIRO (Rex Oram). The WA program also used Japanese varieties widely and also included winter *B.napus* and *B. juncea* in crosses as sources of blackleg resistance. The NSW program initially worked mostly developing 'double low' *B. rapa* varieties but discontinued this after a few years when it became apparent that napus was better adapted to Australia. CSIRO first worked on developing canola*B. napus* lines using winter lines as one parent but then switched to developing low erucic acid *B. juncea* – which led to the first *B. juncea* lines with this trait (ZEM lines).

Breeding in the eighties and nineties.

By the start of the eighties the Australian crop had switched to only growing canola quality B. napus. The three government breeding programs, NSW (Wratten), WA (Roy) and Victoria (Phil Salisbury) concentrated on developing OP varieties with good blackleg resistance. Blackleg was seen as the main impediment to developing a larger area sown to canola. Pacific Seeds started the first private breeding program (Greg Buzza) with the objective of developing F1 hybrids. This led to the release of the world's first canola hybrid (Hyola 40) in 1988. In the late eighties the release of varieties with improved blackleg resistance led to an increase in the crop area. The germplasm used for blackleg resistance was mainly from selecting within the "Australian material" ie. Japanese background – particularly from the Japanese forage variety Mutsu. Resistance also came from backcrossing European winter genes into spring canola lines. The use of resistance from *B. juncea* was of limited value as it seemed that the resistance genes were in the "B" genome and could not be incorporated into *B. napus*.

An ACIAR project (Australian Centre for International Agricultural Research) led to the introduction of more germplasm from China into the Australian germplasm pool. This project (1986-1991) focused on crossing canola quality Australian lines with 'double high' Chinese lines to develop a range of germplasm which could be selected in both China and Australia for quality and adaptation.

Triazine tolerance introduced from Canadian germplasm with a mutation in the chloroplast was transferred into Australian germplasm in the nineties. Although this cytoplasm caused the varieties to have lowervigour (and yield) and reduced oil content it enabled farmers to better control weeds. The release of TT varieties led to a large expansion of the canola growing area particularly in Western Australia. By the time of the 10th International Rapeseed Congress held in Canberra in 1999 the area sown to canola was up to 1.5 million hectares.

Recent breeding changes.

In the past decade there has been a move from public to private breeding so that now the public institutions are no longer involved in breeding commercial varieties and hybrids. Private companies breeding canola include Pacific Seeds (Andrew Easton and Kate Light), Bayer (David Pike), CBWA (Wallace Cowling), Nuseed (Gururaj Kadkol), CBI (Jutta Detering), and Pioneer (Rob Wilson). Specialty canola varieties and hybrids (modified fatty acid profiles) have been developed by Nuseed (Nelson Gororo) and CSCO (Deng Ximing). Viterra have a breeding program to develop canola quality *Brassica juncea*(Daryl Mayles with Wayne Burton).

Germplasm used by private companies is confidential but it is clear that breeders are building on the germplasm developed by the public breeding programs over the previous thirty eight years. As there are now varieties and germplasm well adapted to Australia the focus is on introducing new traits. Recently this has included GM traits by Bayer (Liberty Link with a pollination control system) and Monsanto's Roundup Ready (glyphosate tolerance). At present these two GM traits are released in Victoria and NSW but are under a moratorium in WA and South Australia.

Germplasm research

The public institutions now concentrate on "pre-breeding" or other related research. Pre-breeding is funded by the GRDC (Grains Research and Development Corporation) and is focused on the development of 'traits' that are of national interest for the improvement of canola. The breeding experience in the NSW and Victorian governments is being redirected into trait development. Traits indentified as high priority by industry include drought tolerance, frost tolerance, shattering resistance and 'new' sources of blackleg resistance. A recent ACIAR project involving public institutions in Australia, India and Chinashould lead to further evaluation of the value of germplasm from these three countries and help widen the gene pool.

However, for several of these high priority traits, there is limited variation within *B. napus* and traditional breeding approaches may not be successful. Other approaches, including incorporation of GM traits, are likely to be required.

Projects involving the development of molecular markers, genome and gene sequencing ,and microarray development for Brassicas are ongoing at the Department of Primary Industries, Bundoora, Victoria (led by German Spangenberg).

The NSW Department of Agriculture at Wagga Wagga has also projects developing molecular markers for Brassica (led by Harsh Raman).

With the development of the canola industry over the last forty years to become a major industry in Australia, there has been a corresponding growth in related research. This supports the breeding work and gives a better understanding of the germplasm available. Continued research and germplasm development is considered crucial to the long term sustainability of the Australian industry.