Canola improvement in WA:
Past, current and future

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Canola improvement in Australia

• 1970s: Public programmes based in Victoria, NSW and WA; responded to “disastrous” 1970-73 blackleg disease on rapeseed
  – Victoria DPI:
    • Greg Buzza, Phil Salisbury, Wayne Burton
  – NSW DPI:
    • Neil Wratten
  – WADA:
    • Dr N N Roy (breeder); Martin Barbetti (pathologist)
Canola improvement 1970s

• Breeding emphasis
  – Blackleg resistance:
    • moderate resistance in Japanese rapeseed
    • recurrent selection for polygenic resistance
    • Roy: wide crosses to *B. juncea*; not stable R
  – “Double low” quality from Canada/Europe:
    • low glucosinolates, low erucic acid
    • very susceptible to blackleg
  – Eliminate photoperiod requirement:
    • Canadian types respond to long days; too late
VIC DPI - Buzza, Salisbury 1970-on
Japanese blackleg MR, Canadian, European

Breeding institutions:

Note: varieties are not listed if their pedigrees are uncertain (eg, Rivette, Ripper, Farler, Lantern, AV-Sapphire, AG-Emblem, AG-Cornet). Hybrid and Clearfield (imidazolinone-tolerant) varieties are not listed.
WADA (Roy) 1973-88
Chinese, *B. juncea* parents; different sources of canola quality

Breeding institutions:
- **Canola Breeding, Inc.**
- **GreenEyes Oilseeds Limited**
- **Canadian Canola Group**

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Intercrossing east-west 1983-1993; Roy’s breeding stops at WADA in 1988
TT introduced from Tower-TT in mid 1980s; first variety Siren in 1993 (50% Canadian)
Australian canola year 2000
Cowling, Field Crops Research (2007)

- Australian canola “closed” population:
  - 5 cycles of selection, av. 6 years
  - 4 varieties make up 50% of the ancestry
  - 11 parents in pedigrees
  - inbreeding coefficient of the population 0.21
  - 21% loss of alleles (random genetic drift)
  - Karoo grown in the WA wheatbelt 1999
    (fails due to drought intolerance, late flowering, blackleg susceptibility, low prices)
Australian canola year 2000

- Western Australian selection program:
  - National Brassica Improvement Programme and Department of Agriculture WA
  - lines crossed in east in, selected $F_2$, $F_3$, $F_4$
  - selections then made in WA in $F_4$, $F_5$, $F_6$
  - no primary selection in WA wheatbelt
  - no “new blood” until Surpass 400 and Surpass 501TT appear
  - canola production in WA retreats to higher rainfall areas
WA canola improvement 2000-on

• New genetic diversity
  – Major private breeding programmes in eastern Australia:
    • Pacific Seeds (Surpass 501TT, sylvestris R)
    • Pioneer (46C01, ex Canadian lines)
    • AgSeed Research (ATR-Cobbler, early)
  – CBWA starts in Western Australia 2001:
    • Use genetic diversity from Australia, Europe....
    • Primary selection in WA wheatbelt
    • Rapid cycles of recurrent selection
The WA wheatbelt – a unique environment

CBWA 2002 trials – primary test of doubled haploid lines
The WA wheatbelt – a unique environment

CBWA 2003 trials – primary test of doubled haploid lines
CBWA experience in WA

• Primary selection on fixed lines in target environments
  – Select immediately for adaptation:
    • WA wheatbelt (several sites)
    • Esperance (behaves like eastern Australia)
    • Eastern Australia (range of sites)

• Increase genetic diversity
  – Early maturity from many different sources

• Composite varieties (e.g. CB™ Tanami)
WA canola improvement - future

• Genetic diversity in international canola
  (Chen et al. Genome 2008)

- but, how to use it???
WA canola improvement - future

- Genetic diversity from wide crossing
  (Schelfhout et al. AJAR 2008)

- but, how to use it???
WA canola improvement - future

• Association mapping
  – exploiting linkage disequilibrium in breeding populations with marker assisted selection
  – combine “real” field data with molecular markers (association mapping) and pedigrees to improve estimates of breeding values and selection of parents for crossing
  – ideally applied to fixed lines grown across a broad spectrum of target environments relatively early in the breeding programme
WA canola improvement - future

• Using genetic diversity in commercial crop breeding programmes:
  Cowling et al. AJAR (submitted 2008)
  – two phases of introgression
  – Phase 1: fix new alleles in BC$_2$-derived lines
  – Phase 2: cross selections into elite parents
  – avoid loss of alleles through genetic drift
  – large effective elite population size (>20)
  – moderate selection pressure
  – beneficial new alleles at frequencies >0.1
WA canola improvement - future

• Hybrids
  • adoption? (higher priced seed, annual cost)
  • higher cost and risk for breeding companies

• Genetically modified canola
  • adoption? (technology use agreement, no farmer saved seed)
  • new genes – nitrogen use efficiency, drought tolerance, salinity tolerance, new food and health properties??
  • herbicide technology – longevity??
WA canola improvement - future

• Politics and business
  • canola breeding dominated by multinational corporations with GM products
  • WA market considered a “lost cause” for new products
  • WA growers last to access new technologies
  • risks to canola growers in not having competitive breeding for region (=own part of a breeding company)
  • risks to breeders relying on WA market (=must breed nationally)
WA canola improvement - future

• “Tough WA Canola” in 2020:
  • high yielding hybrids (direct harvested) with better nitrogen efficiency, rapid maturity, and rapid translocation of nutrients under drought stress conditions
  • not just a break crop – valuable food crop
  • new oil properties for health and longevity
  • clean green image WA canola will continue even after GM introduced
  • N from legumes for canola and cereals will increase value of legumes in system