Stabilizing chickpea yield in challenging environments: genetic options

Richard Trethowan, Peter Kaloki, Daniel Tan and Angela Pattison
I. Finding the germplasm

• Learning from the experience of industry
  – National Variety Trials/breeders

• Exploiting international germplasm & knowledge
  – CIMMYT Australia ICARDA Germplasm Evaluation (CAIGE) program
  – Focused Identification of Germplasm Strategy (FIGS)
II. Optimising genotypes and farming systems

- Using relevant hybridization, selection and screening strategies
- Exploiting genotype x management interactions
Learning from industry: the national variety trials
Sites sown to desi types in each state 2010 - 2014

NVT is a standardised national trial supported by the Grains Research & Development Corporation

64 sites/trials sown to NVT over 5-years
Learning from industry: the national variety trials
Classification of sites/years

Dry < 250mm of rainfall during the growing season
Wet > 250mm of rainfall during the growing season

Warm >22°C average maximum temperatures during the growing season.
Cool < 22°C average maximum temperatures during the growing season.
Learning from industry: the national variety trials
Site/trial classifications 2011 - 2014
Learning from industry: the national variety trials
Genotype responses under drought
Learning from industry: the national variety trials
Genotype responses to high-temperature
Learning from industry: the national variety trials
NVT dry environment comparisons with WUE at Narrabri (2-years)

Narrabri managed field trial data provided by P Kaloki
Exploiting international germplasm & knowledge
The CIMMYT Australia ICARDA Germplasm Exchange (CAIGE)

• Importation to Australia of internationally bred, publicly available adapted materials
• The CAIGE program coordinates the importation, quarantine, distribution and evaluation of materials
• Chickpea CAIGE under-way with the first extensive yield trials expected in 2017

(Wheat and barley CAIGE yield trial sites 2016)

(GRDC supported)
Exploiting international germplasm & knowledge
Focused identification of germplasm strategy (FIGS)

FIGS assumes that germplasm reflects the selection pressures of the environment of origin.

Wet sites = blue
Dry sites = green

Khazaei, Street, Bari, Mackay, Stoddard (2013). Traits Related to Drought Adaptation in Vicia faba Genetic Resources. PLOS one
Exploiting international germplasm & knowledge
Focused identification of germplasm strategy (FIGS)

Chickpea FIGS sets currently held by the Australian Grains Genebank

<table>
<thead>
<tr>
<th>Trait</th>
<th>Number of accessions</th>
<th>Number of countries represented</th>
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<tbody>
<tr>
<td>Acid soil</td>
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<tr>
<td>Ascochyta</td>
<td>66</td>
<td>12</td>
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<tr>
<td>Botrytis gray mould</td>
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<td>10</td>
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<tr>
<td>Cold</td>
<td>84</td>
<td>10</td>
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<tr>
<td>Fusarium</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>Heat</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
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<td>7</td>
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<tr>
<td>Viruses</td>
<td>69</td>
<td>14</td>
</tr>
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</table>

FIGs manager
K Street
(GrDC supported)
The chickpea germplasm collection at ICRISAT, India
## Optimising genotypes and farming systems

Effects of tillage and irrigation on chickpea yield at Narrabri

<table>
<thead>
<tr>
<th>Fixed term</th>
<th>Probability</th>
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<tbody>
<tr>
<td>Tillage</td>
<td>&lt;0.001</td>
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<tr>
<td>Moisture</td>
<td>&lt;0.001</td>
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<tr>
<td>Year</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Genotype</td>
<td>&lt;0.001</td>
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<tr>
<td>Moisture.Year.Genotype</td>
<td>0.338</td>
</tr>
</tbody>
</table>

- 8 experiments across 2-years
- 36 genotypes
- No significant tillage x genotype interaction
- No significant moisture x genotype interaction

Source: P Kaloki PhD research
Optimising genotypes and farming systems
SNP genotypes of materials screened at Narrabri in drought
Optimising genotypes and farming systems
Effects of tillage and irrigation on chickpea yield, Narrabri 2014 & 15
Based on these data, the available diversity and assuming resistance to diseases, chickpea adaptation to abiotic stress can be improved by:

Selecting for yield under irrigation (highest $h^2$) and sowing under zero-tillage
Acknowledgements

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