Negative association between chickpea response to competition and crop yield: phenotypic and genetic analysis

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Australian chickpea

- Most important pulse in Australia (area and production)
- Important role in sustainable agriculture
- Limited breeding for adaptation (1978 Tyson)
- Yield may be considered low or unstable
- Strategies for improvement??
Competitive ability

Cereal plants with less competitive phenotypes are associated with higher yield in community
Our Aim: To investigate the relationship between intraspecific competitive ability and yield to determine if a greater competitive ability relates to a lower yield
Environments and lines

- Turretfield
  - Normal sowing: 8th June 2013 and 6th June 2014
  - Late sowing: 9th July 2013 and 15th July 2014
- Roseworthy
  - Normal sowing: 10th June 2014
  - Late sowing: 15th July 2014

<table>
<thead>
<tr>
<th>Variety</th>
<th>Desi</th>
<th>Name</th>
<th>Kabuli</th>
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<td>PBA Pistol</td>
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Method

Normal competition

Low competition

Low competition/Normal competition = Response to competition

Double wide plot spacing
Measurements

- Phenology
- Yield components
  - Pod number
  - Seed number
  - Seed per pod
  - Harvest index
  - Pod wall ratio
  - Seed size
  - Seed weight (Yield)
Environmental variation

\[ \text{PTQ} = \frac{\text{RAD}}{\text{T} \times \text{VPD}} \]

No stress, No growth

(a) Water supply/demand ratio vs. yield response to competition

(b) Photothermal quotient corrected for vapor pressure deficit

(c) Thermal time centered at flowering (°Cd)

(d) Yield response to competition vs. photothermal quotient corrected for vapor pressure deficit (MJ m\(^{-2}\) °C\(^{-1}\) kPa\(^{-1}\))
Results

Variables (axes F1 and F2: 64.88 %)

- Seed number (RC)
- Seed size (RC)
- Harvest Index (RC)
- Biomass (RC)
- Pods per pod (RC)
- Pod wall ratio (RC)
- Yield (RC)
- Yield (gm -1)

Variables (axes F1 and F2: 64.88 %)
Results

For higher yielding lines there is less of a difference between yield in low versus normal competition.

Seed number is the main component of variation in yield not seed size.
Genomic regions identified

Different regions under selection for yield in low and normal competition
Genomic regions identified

Peaks indicate regions that differ for trait
Acknowledgements

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Yield-Outer-1 Ch 6

A region under selection encodes Ca6:1267008, Ca6:1283051, Ca6:1282482 and bears similarity to AT2G02040 locus in Arabidopsis thaliana, which encodes PEPTIDE TRANSPORTER 2 (PTR2) gene of the NITRATE TRANSPORTER 1 (NRT1).

• Anti-sense expression of PTR2 causes impaired seed formation (seed number) in Arabidopsis.

• The OsPTR9 gene of Oryza sativa (LOC_06g49250) also closely related to PTR2 gene. Elevated expression of OsPTR9 enhances ammonium uptake, lateral root formation and grain yield, whereas the loss-of-function mutation causes the opposite effects.