Mapping of QTL associated with seed phytic acid concentration in pea recombinant inbred lines

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Soils and Crops
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Outline

- Background
- Phytate in environment
- Low phytate pea lines
- Mapping phytic acid QTL
- Conclusion
Background

• Phytic acid
  - Storage form of P
  - Mixed cationic salt

• Binds $K^+$, $Mg^{++}$, $Ca^{++]$, $Mn^{++}$, $Zn^{++}$, $Fe^{+++}$
Phytate in environment

Storage of P as Phytate in mature seeds

Growth to maturity

Use of seeds for food

Harvest

Seed used to feed non-ruminants

Unable to digest phytate

Phytate decreases the bioavailability of iron and other minerals

Manure with undigested phytate is used to fertilize lands

Industrial P added to fertilizer

Pools of P in soil

80% of applied P in immobilized in soil & can’t be taken up by plants

P taken up from soil

Eutrophication

(Modified from Brinch-Pedersen et al., 2002)
• Consequences
  - Micro nutrient deficiency
  - Environmental phosphorus pollution

• Strategies to reduce Phytate
  - Fermentation
  - Soaking
  - Processing

Plant Breeding – Low Phytate Crops
Low Phytate Pea Lines

- Two low phytate (lpa) pea lines
  - Chemical mutagenesis of CDC Bronco

(Raboy.V., Plant Science 2009)
What do we know about these *lpa* pea lines?

  - approx 60% reduction
- **High in Inorganic Phosphorus**
- **Agronomic performance**
  - similar to CDC Bronco
  - slower flowering time and maturity
  - lower seed weight and yield
Mapping of QTL for Phytate-P concentration

• Hypothesis

QTL associated with seed phytic acid concentration can be identified from the recombinant inbred lines developed

• Objective

Mapping of QTL associated with seed phytic acid concentration in pea recombinant inbred lines
Materials and Methods

- PR-15
  - Recombinant Inbred lines
  - Sutherland 2011
  - Sutherland & Rosthern 2012, 2013

- Phenotyping
  - Phytate –P estimation

- Genotyping
  - GoldenGate assay
  - 1536 SNP markers

- Statistics
  - SAS 9.3 PROC MIXED
Results – Phytate-P concentration

Distribution of Phytate P in PR-15 lines at Sutherland 2011

Distribution of Phytate P in PR-15 lines at Sutherland & Rosthern 2012
Results – Phytate-P concentration

ANOVA for phytate-P concentration in 2012 & 2013

<table>
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<th>Den DF</th>
<th>F Value</th>
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<td>344</td>
<td>1.45</td>
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PR-15 Linkage Map with SNP markers
Results – QTL for Phytate P

GenoPlot display in GenomeStudio showing PR-15 lines with 2 distinct clusters for PsC14876p245 SNP marker

PsC14876p245 associated with phytate-P in PR-15
## Results – QTL for Phytate P

QTL associated with Phytate-P in PR-15 lines across 5 site years

<table>
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<tr>
<th>Year</th>
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<th>Linkage Group</th>
<th>LOD</th>
<th>Phenotypic variation (%)</th>
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Conclusion

• Phytate P QTL
  - consistent in all 5 site years
  - explains high phenotypic variation

• Validation of QTL
  - in PR-15 and other lines

What are the possible outcomes of this project?
• SNP marker - Marker assisted selection (MAS)
• Lpa pea varieties with improved mineral nutrition
• Reduced environmental pollution

We don’t eat nutrients….
We eat food that gives us nutrients….
Acknowledgement

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