Controlling environmental effects on seed quality: a molecular genetic perspective

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Wild and domesticated plants have different ideal properties

<table>
<thead>
<tr>
<th>Wild plants</th>
<th>Domesticated plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sensitive to environmental cues</td>
<td>• Limited sensitivity to some environmental cues</td>
</tr>
<tr>
<td>• Control timing of their growth and reproduction</td>
<td>• Timing controlled by breeders and sowing time.</td>
</tr>
<tr>
<td>• Adapt to local environment across many generations</td>
<td>• May be locally adapted, but ideally with an increased range of growth environments</td>
</tr>
</tbody>
</table>
Seed quality

Maternal genotype

environment

Zygotic genotype

Seed quality
Seed germinability has been shown to be affected by maternal effects

- Temperature
- Photoperiod
- Light quality (red / far red ratio)
- Water stress
- Position of seed in fruit
- Position of fruit on plant
- Age of mother plant (in perennials)
Ways to mitigate environmental effects on seed quality

• Always set seeds in the same controlled environment
• Use priming to improve seed performance
• Use coatings with germination vigour-enhancing compounds
• Use breeding to remove deleterious alleles.

Need to know whether the breed for the parental or filial characters.
Outline of talk

• Temperature during seed maturation: mechanism of affect on seeds
• Maternal environmental sensing and seed traits: how is the signal sensed and propagated to seeds.
• Finding alleles that give excellent vigour in all growth environments of the mother plant
Part I

- Temperature during seed maturation: mechanism of affect on seeds
In *Arabidopsis thaliana* lowering the maturation temperature reduces germination.
In Arabidopsis, mean maturation temperature is important for germination control.
Our understanding of how maturation environment affects seed behaviour is weak

Soppe et al., 2008
Transcriptomic analysis of mature ‘dry’ seeds set at either 20°C or 10°C.

<table>
<thead>
<tr>
<th>Gene Name</th>
<th>Locus</th>
<th>Average Expression at 20°C</th>
<th>Average Expression at 10°C</th>
<th>Fold change 10°C/20°C</th>
<th>CL Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG1</td>
<td>AT5g45830</td>
<td>506.6 ± 305.5</td>
<td>8809.8 ± 925.7</td>
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<td>GA2OX5</td>
<td>AT1g02400</td>
<td>167.4±24.9</td>
<td>816.5±277.1</td>
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<td>GA2OX2</td>
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<td>RGL3</td>
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<td>ABI2</td>
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<td>SPT</td>
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<td>GA3</td>
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<td>ABI3</td>
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<td>PHYB</td>
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<td>PHYE</td>
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<td>NIA2</td>
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</table>
Part II

- Maternal environmental sensing and seed traits: how is the signal sensed and propagated to seeds.
An assay which allows the assessment of maternal environmental affects on seeds: environmental switching upon flowering.

Maternal control of dormancy involves flowering time pathways

Flowering pathway mutants show increased accumulation of the plant hormone Jasmonic acid.
Testing whether FT controls dormancy in response to the maternal experience of the environment
FT controls seed behaviour in response to the vegetative environment.
Part 3:

isolating genetic loci that can make seed behaviour insensitive to the maternal environment
Maternal Dormancy Control mutants show a lack of dormancy no matter how they are grown.
MDC1 has a maternal affect on seed behaviour

![Bar graph showing germination frequency at 15°C for different genotypes: WT, mdc, WT x Mdc1 F1, mdc1 x WT F1.](image-url)
*mdc1* is not strongly affected in GA or ABA signalling.
Could MDC1 be useful in controlling dormancy in hybrid seed where sprouting is an issue?

MDC1 MDC1

X

F1 Germination vigour high

self

F2 Germination vigour low

mdc1 mdc1

PRODUCT

CROP
Summary

Low temperature
photoperiod

DOG1
ABA
Less GA
JA
Seed coat thickening

Low temperature
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