Advancing Field Pennycress as a New Oilseed Biodiesel Feedstock-Focus on New Mutants

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Introduction

*Thlaspi arvense* (field pennycress; pennycress herein) is being targeted as a new oilseed biofuels crop [1]. Pennycress can be grown in the interval between the corn/soybean rotation in the Midwestern United States, where it can be seeded into standing corn, allowed to overwinter and then harvested in the spring, allowing for a summer crop of short-season soybeans. Thus, it has potential to provide a new source of biofuel without requiring new land or greatly changing current farming practices. Additionally, it provides a winter cover on land that is traditionally left barren, which will reduce nutrient leaching, soil erosion, and limit spring weed growth.

Genomic Resources

- Published transcriptome and draft genome [2,3].

Arabidopsis and Pennycress

- Both are members of the *Brassicaceae*
- Both are self-pollinators.
- Both show the same low level of whole genome duplication.
- Gene function in pennycress can be predicted by the ability to easily identify candidate orthologs in pennycress to genes with known function in Arabidopsis.
- Pennycress mutants that phenocopy Arabidopsis mutants are readily found in mutagenized pennycress populations.

Examples of Arabidopsis mutants with agronomically desirable phenotypes that would resolve weedingness in pennycress

- *dog1* – reduced seed dormancy
- *ga20ox1* – lodging resistant high yield semi dwarf
- *shatterproof 1 and 2* – reduce seed shatter
- *phyB* – flowers and matures early
- *dar1* – larger seeds
- *fatty acid elongase 1* – reduction in FAs longer than 18 C

Pennycress is considered a weed

- Seeds don’t evenly germinate – results in undesirable seed bank.
- Lodging can be an issue.
- Pods shatter before harvest, resulting in yield loss.
- Does not routinely mature at the appropriate time.
- Seeds are small (~1.2 mg) – results in loss during harvest.
- Oil quality is not optimized.

Goals – Identify pennycress mutants similar to those found in Arabidopsis with agronomically desirable phenotypes

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Images of select mutants

Wild type vs pennycress *ttg1* seeds

Wild type vs shatterless mutant

Early flowering *phyB* mutant

Wild type vs large seed mutant

Progress to Date:

2013 M1 Seeds were mutagenized with EMS, Fast neutron, and gamma rays.

2014 1000 rows of pooled M2s (10 per pool) were sowed (from ~10,000 M1).

2015 M3 seeds were collected from individual M2s with desirable phenotypes and sowed into small plots – shown: picture of field taken in March 2016

Individual M2 mutants with traits of interest planted into small plots

- 59 early flower
- 38 early maturing
- 27 semi dwarf - green revolution type yield increase
- 8 enlarged stems – lodging resistance
- 4 enlarged stems, tillerless and early flower
- 6 reduced pod shatter
- 3 smaller pods – less shading during relay cropping with soybean
- 3 larger flowers and more nectar
- 10 larger seeds
- 9 yellow seeds – easier chemical processing; better seed meal; reduced dormancy
- 8 early germination
- 4 waxy bright green - altered wax composition may impart unexpected greater resistance to biotic or abiotic stresses.
- Confirmed mutants in pennycress: *ttg1, phyB, pi, ify, ag, as1, flc*

References


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