Developing a Genome Informed Breeding Program for Field Pennycress (*Thlaspi arvense* L.)

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Introduction

- Pennycress is a winter annual oilseed species native to Eurasia.
    - Has been naturalized throughout the US.
- As part of the Forever Green Initiative at the University of Minnesota, breeders and geneticists are domesticating pennycress for use as a cash cover crop.
    - Dual approach to domestication: induced mutations in a single line as well as evaluation and traditional breeding of wild collections.
    - Closely related to Arabidopsis, therefore useful genes in Arabidopsis can be identified in pennycress.
- Pennycress provides
    - Ecosystem services such as soil cover, nutrient removal, and water protection over the fall, winter, and early spring.
    - Early spring harvest, so pennycress can be used in relay crop or double crop systems.

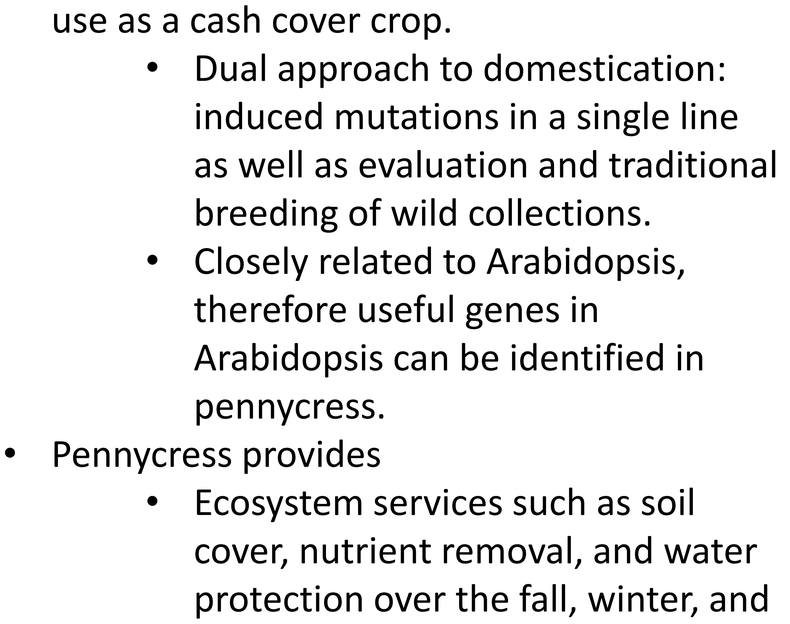

Figure 1. Life cycle of pennycress in a soybean relay crop system. Pennycress is planted in the fall after silage corn or other crops, overwinters in rosette form, flowers in early spring and is harvested in June. Soybean can be planted in the pennycress stand shortly after flowering. Once the pennycress is harvested, the soybeans can grow as normal.

Identifying Domestication Traits

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Figure 2. Useful domestication traits identified in mutant pennycress populations developed through chemical (EMS) and radiation (gamma and FN) mutation. In each pair, the left picture is wild type line MN 106. A) Improved germination B) Early flowering on April 15, 2016 C) Reduced seed shatter on June 30, 2016 D) Semi dwarf line for reduced lodging E) Increased seed size in mutant line (top) compared to MN106 (bottom)

Identifying Natural Variation

This project is funded by Minnesota Department of Agriculture Project 77358 and the Forever Green Initiative.

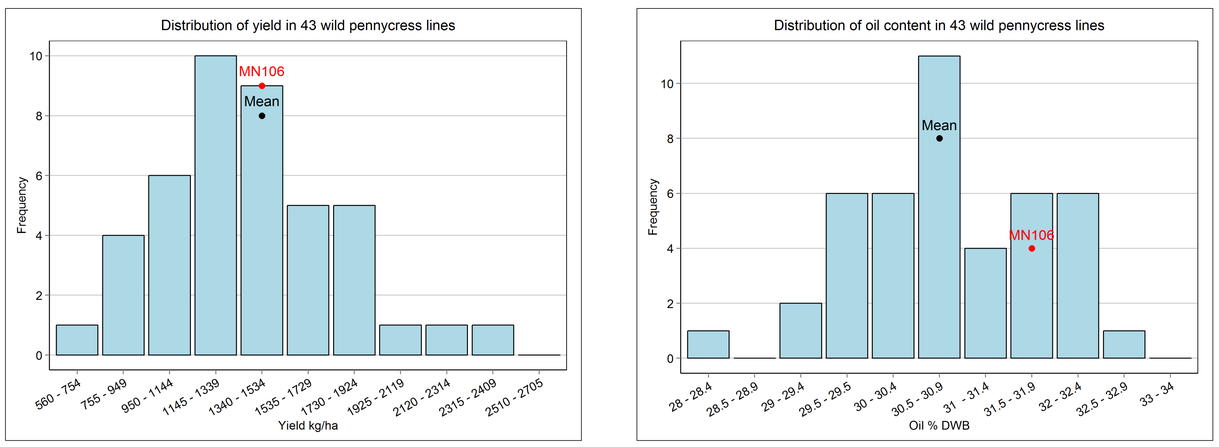

Figure 3. Phenotypic variation for total seed yield and total oil content in 43 wild pennycress lines evaluated over two years and five environments. Variation among lines was statistically significant for both yield ($P<0.05$) and oil content ($P<0.001$). Analysis of genetic variation of the 43 lines is underway.

Breeding Pipeline

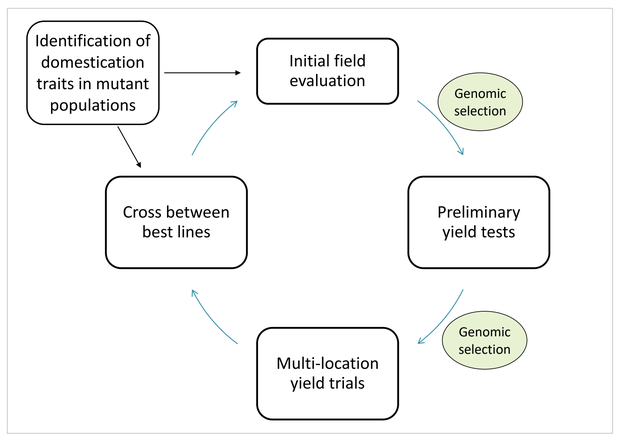

Figure 4. Proposed breeding pennycress cycle. Initial crosses between wild collected lines were made in 2013. F_3 progeny from these crosses were evaluated in the field in 2016, and 200 lines were visually selected for uniform germination and early flowering. Selected lines were planted in preliminary yield trials in two locations in Sept. 2017 and will become an initial training population for genomic selection models for yield and oil quality traits. Mutants shown in Figure 2 were identified in 2015 and were evaluated in the field in 2016. Valuable traits are being stacked into a single pennycress lines, as well as being introgressed into top performing wild lines.