

Advancing Field Pennycress as a New Oilseed Biofuels Feedstock that does not Require New Land Commitments

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<http://www.wiu.edu/pennycress/> <http://cbs.umn.edu/marks-lab/home>
<https://about.illinoisstate.edu/jcsedbr/Pages/Research.aspx>

Project Goals: This project aims to genetically improve the agronomic traits of Field Pennycress (*Thlaspi arvense* L.; pennycress) for its use as a profitable oilseed winter cover crop grown throughout the U.S. Midwest. We have identified a large number of EMS-induced pennycress mutant lines exhibiting a variety of improved agronomic traits. We have also developed and demonstrated the utility of pennycress *Agrobacterium*-mediated plant transformation and CRISPR-Cas9 genome editing, generating pennycress lines with undetectable levels of erucic acid in seed oil, reduced seed coat fiber, reduced pod shatter, and reduced seed dormancy. We are working to identify, characterize, and introgress into breeding lines these and additional trait-improving mutations so as to generate elite pennycress varieties having the following traits allowing for commercialization: 1) Harvestable seed yields of at least 1,500 lbs/acre; 2) Reduced sinigrin (glucosinolate) to below the regulatory limit; 3) Reduced seed coat fiber so as to improve the seed meal nutritional value 4) Shortened time to maturity to consistently allow pennycress harvest in time to plant full-season soybeans.

Pennycress (*Thlaspi arvense*; Field pennycress) is an oilseed plant of the Brassicaceae family closely related to Arabidopsis, camelina, and rapeseed canola. Pennycress is native to Eurasia and naturalized to North America, growing widespread throughout temperate regions of the world. Pennycress can be grown as a winter annual oilseed-producing cover crop, for example, planted in the fall in standing corn and harvested in the spring in time to plant full-season soybeans throughout the 80 million-acre U.S. Midwest Corn Belt. Once commercialized, elite pennycress varieties will provide additional income to farmers and agribusinesses thereby strengthening rural communities. Pennycress will also provide ecosystem services as a cover crop, reducing soil erosion and nutrients runoff and providing habitat and pollinator support on otherwise vacant farmland.

Field trials with current isolates have demonstrated that pennycress can be seeded in upper Midwest cornfields in the late summer and fall, at which time the plants begin to grow then overwinter, producing mature seed in the spring that can be harvested without disrupting soybean planting or yields. As an energy crop adopted throughout the U.S. Midwest, pennycress varieties could annually produce 1.3 billion gallons of liquid transportation fuels and 15 million tons of high-protein seed meal, once modest breeding improvements are made (facilitated by resources and germplasm from this project). Many other products could also be produced from this oilseed feedstock. Longer-term agronomic and genetic improvements have the potential to more than double this impact.

While pennycress holds much agronomic promise, economically-viable varieties remain to be developed. Current varieties are hampered by suboptimal seed germination and stand

establishment, un-optimized maturity for a given growth zone, high seed glucosinolate and fiber content, and significant harvest loss due to pod shatter. We will provide highlights of our progress employing modern forward and reverse genetics and genomics strategies to rapidly generate and identify lines of pennycress that harbor mutations/natural gene variants conferring superior agronomic traits. These trait-improving alleles are being incorporated into breeding programs located in the Midwest. Our goal is to help develop elite pennycress varieties for commercialization thereby launching pennycress as a profitable oilseed-producing winter cover crop in the 2020's.

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