



Pennycress

A POTENTIAL NEW SHORT SEASON WINTER ANNUAL OIL SEED CROP FOR USE IN MINNESOTA CROPPING SYSTEMS

Overview

The University of Minnesota is a leader worldwide in developing winter hardy cash cover crops as new agricultural opportunities. Field pennycress (*Thlaspi arvense*) is a winter annual oilseed showing great promise as a new crop for growers to adopt that will keep the soil in continuous living cover, protect water quality and increase profitability.

The seeds of field pennycress are oil-rich (>30%) and contain specific fatty acids that can be used for select purposes. Rapid advances have been made in identifying different genetic lines (non-GMO) in pennycress, allowing researchers to earmark the traits for healthy edible oils, novel plant proteins, biodegradable (plastic) packaging materials, lubricants, and biofuels. The seed meal that remains after oil processing also has important uses as highly nutritional food and animal feed (rich in protein, essential fatty acids, and fiber), and soil amendments (organic nitrogen fertilizers). All of these products and

uses equate to additional economic returns for Midwest farmers.

Pennycress can be sown after harvesting crops like spring wheat or silage corn, or interseeded during summer in growing field corn, soybean, or sunflower. The emerged seedlings form rosettes in the autumn and cover the soil surface prior to entering winter dormancy. As rosettes they protect the soil surface from erosion caused by high winds, intense rains, or snow melt. Additionally, the rosettes absorb soil nutrients, like nitrates, in autumn and spring, thereby almost completely eliminating nitrate and phosphorus contamination of ground and surface waters. This keeps well water safe for drinking and improves the quality of water in our wetlands, streams, rivers, and lakes. Furthermore, the pennycress rosettes compete effectively with autumn- and spring-emerging weeds, which lessens the need for herbicides.

In spring as the rosettes bolt (elongate) to form flowering stems, summer crops like soybean can be

interseeded into the pennycress crop. The pennycress plants continue to mature and flower as the soybean germinates and emerges. Pennycress flowers throughout the month of May in Minnesota, thereby providing large quantities of nectar and pollen to hungry pollinators. Seeds are harvested in June while the understory soybean plants are still short enough not to be damaged by the cutting bar of the combine harvesting the pennycress seeds. The soybean continues growth after pennycress harvest and matures at the normal time in September.

Successful development of adapted pennycress varieties and planting of those varieties in millions of acres across Minnesota and surrounding states has enormous potential to generate significant economic rewards for farmers while simultaneously alleviating water contamination. It also will showcase the University of Minnesota as one of the leading institutions committed to promoting agriculture as a force for protecting and enhancing our soil, water and natural resources.

Research Status and Goals

Investing in people, tools and research drives the mission of the Forever Green Initiative forward.

AGROECOLOGY

Deploy pennycress production to the Minnesota landscape and measure the environmental benefits possible from this new crop.

Activities: More than ten experiments currently underway address pennycress agronomic needs and include method and timing of pennycress planting, in season management, and harvest; the effect of pennycress on following crops, water quality, weeds, and other pests; and economic and environmental benefits. More years, environments, and experiments are needed to determine best practice guidelines for integrating pennycress into cropping systems in Minnesota and throughout the Midwest.

Outcomes: Best management guidelines for pennycress production and integration into Minnesota cropping systems; Extension documents and workshops to address pennycress production; scientific reports identifying the ecosystem services provided by pennycress; and the knowledge necessary for farmers to improve their land and increase profit margins.

BREEDING AND GENETICS

Activities: Initial efforts have focused on domestication traits such as reduced seed shatter, early maturity and edible oil. In addition to these traits, we are also breeding for higher oil content, reduced glucosinolate content, and larger seeds which will improve the marketability of pennycress. Thousands of lines have been screened for these valuable traits with the most promising lines undergoing further testing. The UMN pennycress genetics program has successfully sequenced the pennycress genome which has been key to developing domesticated pennycress using non-GMO techniques. These new lines are being tested in several locations in Minnesota and represent the first generation of domesticated pennycress breeding lines. With further investment in research sites with diverse soils and environments, we can identify the top performing lines to maximize oil and seed yield for Minnesota producers.

Outcomes: New and improved pennycress germplasm and variety releases within five years. Trait development will be an on-going activity.

Pilot Studies

A number of plot-scale pennycress research projects are distributed throughout central and southern Minnesota. These research projects include optimization of pennycress planting and harvesting methods and improvement of relay cropping system performance.

Plans are underway to expand this research throughout Minnesota and the Upper Midwest. Research trials to determine the environmental and economic impacts of pennycress are underway.

COMMERCIALIZATION PLAN

Industry has expressed interest in pennycress oil as a feedstock for biofuels, biopolymers for bioplastics and novel plant proteins for food production, and a healthy and sustainable food grade oil. Pennycress meal is also being tested as a feed source in aquaculture and other sectors.

A significant, federally-funded partnership known as IPREFER (Integrated Pennycress Research Enabling Farm and Energy Resilience) between the Forever Green Initiative and a handful of industry and university partners in the Upper Midwest has been launched with a mission to optimize and launch pennycress production as a cash cover crop. Agricultural Utilization Research Institute (AURI) is an important partner in seed processing, product testing and industry partnership development. Small samples of oil and meal have been provided to bioplastic, food and biofuel companies to conduct product R&D at lab bench and pilot run scales.

The release of selected lines will be managed by UMN and MN Crop Improvement Association. Improved pennycress traits are yet to be licensed in the Upper Midwest. Commercializing pennycress at scale will require investment and partnership with growers and industry. Preferred partners are those that can achieve landscape-scale change while delivering integrated economic, environmental, and social benefits to Minnesota.

UMN is also working with state agencies and conservation organizations to prototype policy solutions that will help growers manage risk, maximize and compensate growers for ecosystem services, and support commercialization.

TIMELINE

2020–25 AND BEYOND

- Agroecology research to improve agronomics and track long-term environmental impacts
- Breed for early maturity, low seed shattering, improved seed yield and oil quality traits resulting in new varieties for release to farmers
- Develop lead partnerships with grower and industry groups, spurring investment
- Cultivate industry partnerships to spur collaborative product development and innovation
- De-risk crop adoption for growers, support investments for ecosystem services
- Secure GRAS (Generally Recognized as Safe) status for pennycress food grade oil