Winter Oilseed Quarterly Report #5: Mutant resource exhibits the phenotypic variation for pennycress improvement

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The ability to obtain net financial returns from new cash cover crops is expected to facilitate more widespread adoption among growers. Successful cover crops require several key traits to become widely implemented in Minnesota, including winter hardiness, an early harvest date, a high rate of N uptake, and substantial production of a high-value raw material. This has severely limited the adoption of traditional cover crop species in Minnesota, to an extent that domestication of a new crop species that already meets many of these requirements may be a viable alternative.

As part of the Forever Green Initiative, the University of Minnesota had initiated a pennycress improvement program with the goal of domesticating field pennycress (*Thlaspi arvense* L.). Pennycress is already winter hardy, produces high oilseed yields, has a short lifecycle, and has been shown to capture excess nitrate in the soil. However, wild populations of pennycress exhibited limited phenotypic and genotypic variability for many of the crucial domestication traits such as reduced pod shatter and improved oil quality (Altendorf et al. 2018; Frels et al. unpublished). To identify these key domestication traits a mutagenized population was developed using the chemical and irradiation treatments (Chopra et al. 2018). These populations exhibit a range of altered phenotypes for plant development (Chopra et al. 2018) and seed compositions (Chopra et al. 2019).

For example, the mutant population showed alterations in seed coat color (Figure 1). These lighter seed coats are desirable as they are associated with important traits such as increased seed oil content, reduced seed coat fiber, higher protein content, improved germination, and improved seed crushability. Likewise, broad variation for economically valuable oil composition traits such as oleic, linoleic, linolenic, eicosenic and erucic acids (Figure 2) was observed. In addition, agronomically important traits such as reduced pod shatter required for increased harvestability have been identified (Figure 3)

This will allow for selection of lines carrying essential traits for pennycress domestication. Development of pennycress lines with these improved traits can create a wide-range of opportunities for both industrial and edible markets that will increase the value of pennycress seed. In addition, these genetic materials are a valuable genetic reservoir for additional trait diversity that may be useful for pennycress domestication.

Figure 1. Range of seed coat color variation from the normal black color exhibited by check line MN106. Lighter color seed coat lines have shown increased oil content and better germination.

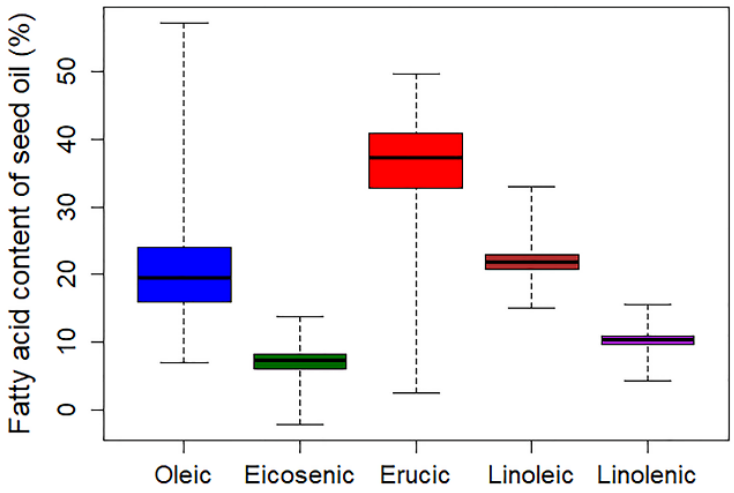

Figure 2: Boxplots representing the variation from 15,000 M_3 families predicted using the related *Brassica* calibration equations for Oleic, Eicosenoic, Erucic, Linoleic, and Linolenic acids.

Figure 3: Pennycress plants showing differences in pod shatter at maturity. Wild-type (left) and mutant (right)

References

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