Winter Annual Oilseed Quarterly Update #12: Advances in developing early Winter Camelina lines

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Camelina, a Brassicaceae oilseed plant, is emerging cash cover crop that can also help feed the rapidly growing world population. Winter camelina can be processed into carbon-neutral biodiesel and it has the capacity to uptake excess soil nitrogen[1]. In addition to contributing to food, feed, and fuel, camelina has the potential to improve the soil and water quality by reducing the nutrient leaching through winter and early spring. Despite the benefits of winter camelina, challenges remain for the adoption of this cover crop. Breeding for early maturity is among the improvements needed for camelina to fit into relay cropping systems. We evaluated a collection of wild camelina accessions and only 5 out of 439 accessions were winter hardy and displayed phenotypic variation for maturity. These lines were sequenced to assess the genetic diversity, and we found that these lines were genetically distant based on principal components analysis (PCA) analysis (Figure 1). We crossed two of early maturing accessions (Acsn-216 and Acsn-293). F_4 progenies from these crosses were planted in the field in fall 2018 and were evaluated for early maturity in spring 2019. Selections from these progenies will be tested for earliness again in spring 2020 (Figure 2) and will be subjected to yield trials within the next two years.

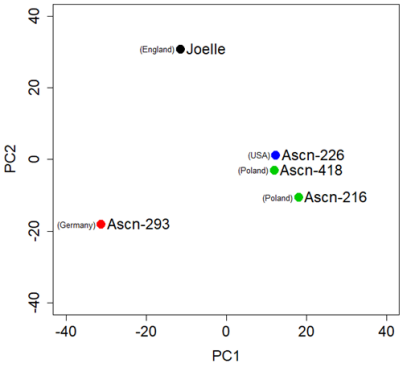

Figure 1. PCA analysis using SNP data. Five genotypes analyzed, which included lines from USA, Poland, Germany and England. These lines showed phenotypic variation for establishment and early maturity.

Figure 2: Comparison of the advanced F_5 lines with the check line "Joelle" and the parental Ascn 293 used in the crossing block.

In addition to testing wild camelina accessions, we also used an EMS (Ethyl methanesulfonate) mutagenesis approach to induce variation for maturity and other traits in one of the winter camelina lines – "Joelle". Using this approach we screened ~800 M_3/M_4 lines and identified plants displaying phenotypic variation for plant architecture, development, oil, and protein content (Table 1 and Figure 3). One of the lines (RMT-Elf9) showed successive inheritance of earliness (8-10 days earlier than the wild-type) and a dwarf phenotype over two years (Figure 4). This early mutant has been crossed to some of the early flowering accessions and F_3 seeds will be available for testing in fall 2020. Lines identified from this experiment will be propagated until the F_5 generation for a seed increase and yield trials. Yield trials of the early maturity lines will be

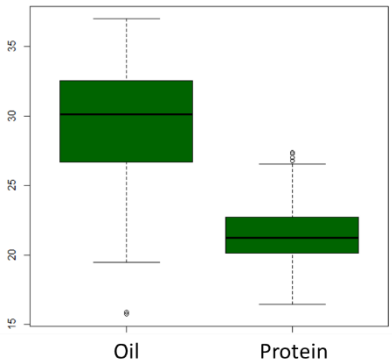

Figure 3: Box plot representing variation in the EMS derived populations for oil and protein

performed. Overall, we have been successful in identifying some variation in key traits for winter camelina, but we still need to continue our testing and incorporate multi-faceted strategies to develop germplasm for release to farmers.

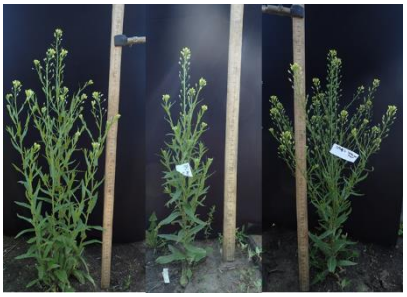

Figure 4: Comparison of earliness mutant in the St. Paul Field 2018-2019.

Our strategy for improving traits in camelina is multi-faceted. We will continue to evaluate wild-germplasm and their progenies for variation in key traits, and develop variation using mutation breeding. Our goal for moving this project forward is to generate elite germplasm for winter camelina that will help us solve ecosystem and food security challenges.

Table 1: Summary of lines that displayed phenotypic variation in EMS population during spring 2019.

Trait	No. Lines
Early Flowering/Senescing	6
Dwarf	9
Reduced/Non-Tillering	6
Increased Tillering	2
Large Leaf	5
Pale	6
Dark Green	1
Erect Architecture	2
Narrow Leaf	3
Waxy	6
Bushy	4
Branchy	3
Wrinkled Leaf	4

References:

1. Ott, M. Four Cover Crops Dual-Cropped With Soybean: Agronomics, Income, And Nutrient Uptake Across Minnesota. (University of Minnesota, 2018).