

Pennycress Breeding Program 2017 Year End Update

Project Title: Breeding Improved Pennycress Varieties

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Objectives:

- 1) Develop new breeding populations with domestication traits and oil quality traits
- 2) Develop high yielding pennycress lines with improved germination.

Objective 1

Development of new breeding populations:

During the Fall 2017 crossing cycle 11 out of 24 attempted crosses produced seed. Three elite breeding lines with good yield potential and excellent germination were crossed with five mutant lines with traits such as reduced seed shatter, early flowering, and improved oil quality. The F1 progeny of these crosses have been planted in the Winter 2017 crossing block and will be backcrossed with the elite parent to reduce background mutations present in the mutant parent.

Impact: The addition of the reduced seed shatter trait and early flowering trait to the high yielding and improved germination pennycress lines already in the breeding program is key to developing domesticated pennycress varieties that do not produce a seed bank, mature quickly, and are easier to harvest. The addition of oil quality traits will improve the market value of future pennycress varieties.

Objective 2

Development of high yielding pennycress lines with improved germination:

2016-2017 Growing Season

In September 2016, 437 new breeding lines representing 27 families were planted in single, unreplicated rows in St. Paul, MN, and 250 advanced breeding lines were planted in small plots in the 2017 Preliminary yield trial (PYT) at St. Paul and Rosemount, MN. However, we faced many challenges in the 2017 field season. Planting was delayed in from early September to late September 2016 due to heavy rain. The late planting may have contributed to poor germination of the majority of new breeding lines in St. Paul as well as many lines in the St. Paul PYT location (Figure 1). Germination was very low in the Rosemount PYT location, and the trial was abandoned due to the germination rates and by unexpected contamination by wild pennycress. Heavy rainfalls continued into the fall and winter leading to reduced germination and poor plant vigor in the wettest portions of the field. A 1.1" rain on December 25, 2016 froze into a thick ice sheet that covered much of the Preliminary Yield trial (PYT) through January 2017. Some winter killing due to the ice sheeting was observed. Only 18 of the 250 tested lines flowered before May 1, therefore, breeding for early flowering will be a key component of the pennycress breeding program (Figure 2). The average yield in the 2017 PYT was significantly lower than normal due to poor germination and low N availability in the soil. However, despite the low overall yields, almost 100 lines exceeded the yield of the check line MN106 suggesting that the new breeding lines have good potential for increased seed yield (Figure 3). Based on the germination, flowering date, and yield data, 30 lines were selected for entry into the 2018 Advanced Yield trial (AYT).

2017-2018 Growing Season

The 2018 Advanced Yield Trial was planted early September 2017 at St. Paul, Rosemount, Morris, and Waseca, MN. The 30 entries were replicated three times at all locations, and germination was good in all

locations. Due to low seed supply the 395 lines in the 2018 PYT were planted in single, unreplicated rows at St. Paul only. 433 F₄ lines were also planted in single, unreplicated rows at St. Paul. In a new collaboration between the Marks and Anderson labs, a replicated yield trial of 15 mutant lines was planted at St. Paul, Rosemount, Morris, and Waseca, MN. The objective of this trial is to determine the effect of environment on traits such as early flowering, reduced shatter, and improved oil quality improvements.

Impact: One major limitation of current undomesticated pennycress is the poor germination rate which leads to the development of a seed bank in the soil. The poor germination in the 2017 PYT was an excellent opportunity to select pennycress lines that germinate well even under difficult growing conditions. Based on the germination in the 2018 AYT locations, selection for improved germination was successful, and we will continue to exert selection pressure for rapid germination on all breeding lines in our program.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
20	3	1	4.5	4	6	1	6	2	1	7					
19	9	6	5	7	7	4	7	5.5	7	2					
18	8	8	5	7	1	1	4.5	3	6	7					
17	3.5	7	7	6.5	5	4	2	3	5	3					
16	4	1	5	6	3	6.5	6	5	5	7	7	6.5	3.5	5	7
15	3.5	8	3	5	5.5	7	4	5.5	4	4	6	2	7	4.5	7
14	4.5	2	2	8	8	5	3	3	3.5	3	5	4.5	2	2	2.5
13	8	1.5	9	2	9	6.5	2	6.5	4	2	7	3	2	4.5	2
12	7	9	4.5	8	3	5	2	8	6.5	5.5	1	3	8	4	2
11	4.5	4	3	4	8.5	4	9	6.5	8	7	9	6.5	4.5	3	2
10	7	6	6	4	1	8	4	7	2.5	5	7	6	4	7	1
9	9	2	3	2	8	8	1	4	7	6	4	8	5.5	6	5
8	9	8	4.5	4.5	6	4.5	7	7	7	7	4	5	7	7	2
7	9	2	6	6.5	6.5	4	4.5	7	5	5	8	2	2	4	1
6	5.5	5.5	4.5	5.5	1	3	1	7	6.5	2.5	2	2	5.5	5.5	2
5	4.5	5.5	5.5	7.5	2	3.5	3	4	3	3.5	4.5	4	4	5	2.5
4	6.5	8.5	3	8.5	4.5	5.5	8	6	5.5	6.5	4	6	4	8.5	7
3	8	2	8	3.5	3.5	3	1	2.5	1	4.5	6	9	3	9	5
2	9	9	0	10	3	6	0	4	8	6	6	6	5	4	2
1	1	3	1	9	2	1	0	4	3	4	4	6	4	3	2

Figure 1. Germination scores of the 2017 St. Paul Preliminary Yield Trial collected approximately 6 weeks after planting in fall 2016. Scores are collected on a 0-10 scale where 0 represents no germination and 10 represents 100% germination. Each box represents one plot.

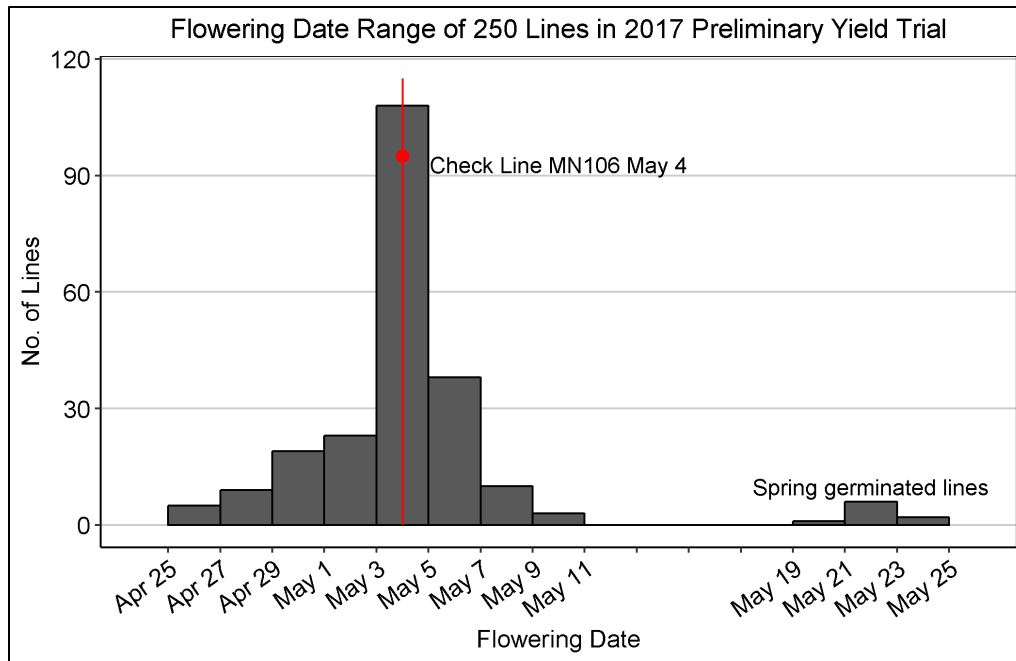


Figure 2. Range of flowering dates in the 2017 PYT. The red line indicates the flowering date for the check line MN106.

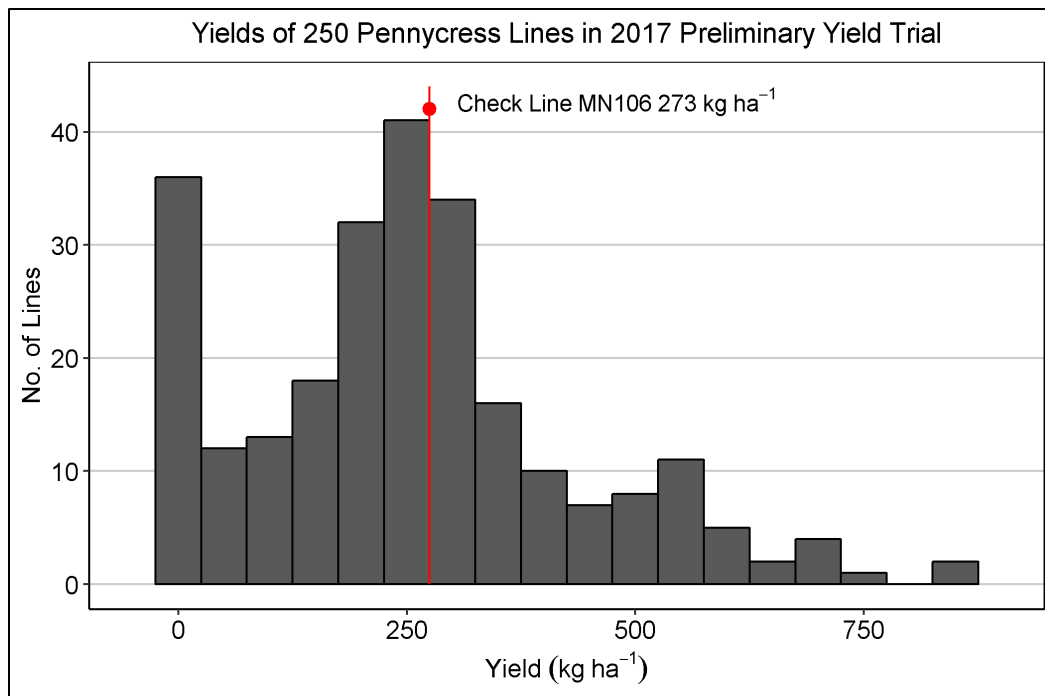


Figure 3. Range of yield data in the 2017 PYT. Data shown are spatially adjusted best linear unbiased predictors. The red line indicates the yield for the check line MN106.