Winter Oilseed Research Update #16: Pennycress breeding program update.

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The UMN pennycress breeding pipeline begins with crosses between wild collected accessions, elite breeding lines, and mutant selections in growth chambers. Progenies from these crosses are advanced multiple generations in the greenhouse before being tested for winter survival, emergence, and early flowering in a single row in the field. The best selections from these single rows are advanced to an un-replicated preliminary yield trial (PYT) planted in St. Paul, MN followed by several advanced yield trials (AYT1, AYT2, BAYT) that are replicated and planted in multiple Minnesota test locations. The 2020 breeding program trials were planted in September 2019 and were subjected to a mild winter followed by a hot, dry spring in 2020. All trials were harvested in June 2020 using a small plot combine.

Pennycress yields were lower at all Minnesota test locations in 2020 compared to 2019; average yield, oil, and protein content for the 2020 trials are in Table 1. We believe the lower yields were likely caused by limited rainfall in the early spring and hot temperatures during the seed filling period. This suggests that identifying heat or drought tolerant genotypes that maintain yield and experience less stress should be considered as a future breeding target. Yields were particularly low at Morris because most of the plots emerged in the spring rather than in the fall due to dry and cold fall weather. This limited the amount of vegetative growth that occurred before flowering, therefore, reducing the amount of seed the plants could produce. Despite the environmental challenges, oil and protein content were similar to previous years. We also tested the high oleic and reduced shatter lines rod1/fae1 and rod1/fae1/ind1 with the MN106 genetic background described in Chopra et al. (2020) in multiple locations. The two gene combination rod1/fae1 eliminates erucic acid and generates high oleic oil while the gene ind1 reduces pod shatter. Both lines had higher oleic acid (48%) compared to the wild type MN106 (17%). Increased oleic acid in the seed did not affect fall establishment or reduce winter survival. The reduced shatter phenotype was confirmed- no pod shatter was observed across the multiple experimental sites.

		Yield (lb. ac^{-1})			Oil Content (%)			Protein Content (%)		
Trial	Genotypes	RMT	MOR	STP	RMT	MOR	STP	RMT	MOR	STP
PYT	82	-	-	607 ±175	-	-	31.6 ±1.2	-	-	24.9 ±1.1
AYT1	36	420 ±149	-	785 ±236	33.1 ±1.1	-	32.8 ±0.73	22.5 ±0.53	-	23.3 ±0.83
AYT2	24	441 ±176	449 ±167	725 ±175	32.4 ±0.98	31.8 ±2.1	32 ±0.89	23 ±0.53	23.8 ±0.67	24 ±1.0
BAYT	10	716 ±138	200 ±69	1133 ±146	33.2 ±0.97	32.3 ±0.76	32.0 ±0.81	23.4 ±0.74	23.2 ±0.77	23.6 ±0.76

Table 1. Summary of mean seed yield, oil content, and protein content at the Rosemount (RMT), Morris (MOR), and St. Paul (STP) breeding trial locations during the 2020 growing season.

2020 Advanced yield trial results

Each year, our most elite pennycress lines are tested in a big plot advanced yield trial (BAYT) in 5’ x 15’ plots with a 10 lb. per acre seeding rate. The 2020 trial identified several promising lines for variety development. Results are presented in Figure 1. MN16172 performed well in our trials and in collaborator trials in Illinois. MN17077-2 was the earliest maturing line and reached harvest maturity nearly 5 days before other lines. This early maturity led to significant yield loss due to pod shattering especially in St. Paul. The lines rod1/fae1 and rod1/fae1/ind1 are mutant lines created from the MN106 genetic background. Both lines out yield the parent line MN106 due to reduced lodging, and rod1/fae1/ind1 also exhibits higher yield due to less pod shatter during combine harvest. These genes will be introgressed into the higher yielding lines MN16172 and MN17077-2 in preparation for a future variety release.

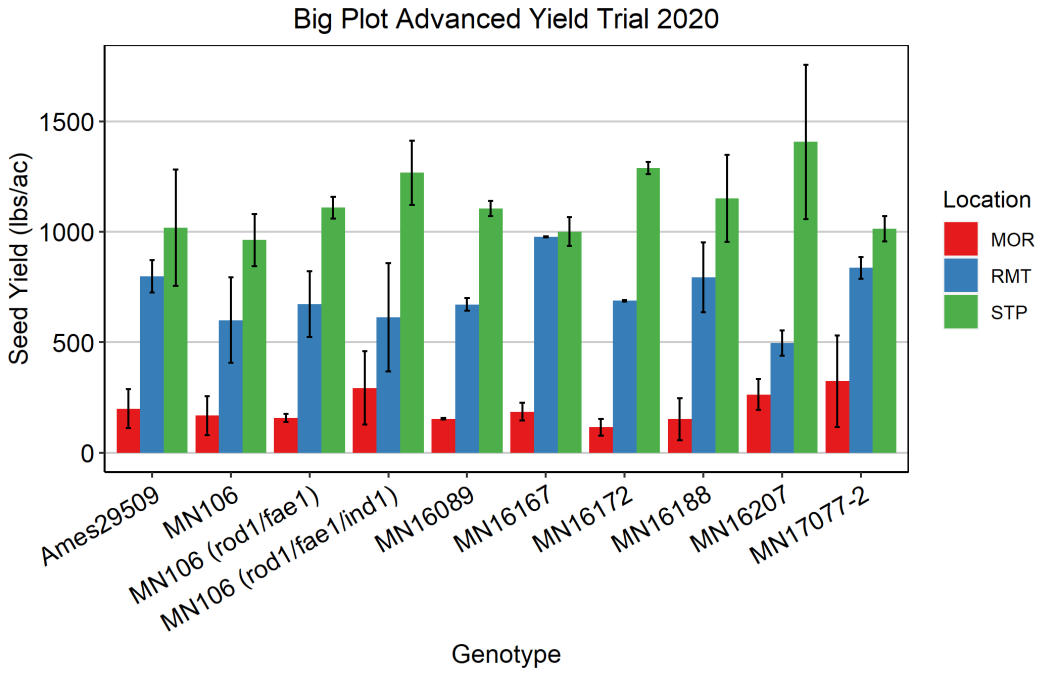

Figure 1. Average seed yield of eight advanced pennycress breeding lines and two check lines (MN106 and Ames29509) in the 2020 Big Plot Advanced Yield Trial. The trial was planted in Morris (MOR), Rosemount (RMT), and St. Paul (STP), MN.

Reference

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