Double-Cropping Pennycress (*Thlapsi arvense* L.) with High-Value Short-Season Crops in the Upper Midwest

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INTRODUCTION

- Winter annual cover crops are an important tool in combating issues with erosion and nutrient leaching in both the spring and fall[1]
- Pennycress is a recently developed winter annual oilseed that provides both ecological services and economic returns[1,2]
- Pennycress oil has potential uses as an industrial feedstock for biofuels, bioplastics, and lubricants[2]
- Pennycress matures in mid/late June, after full season corn and soybean planting dates[3]
- There is an opportunity to create double-cropping systems around pennycress maturity utilizing short-season high-value crops[4]

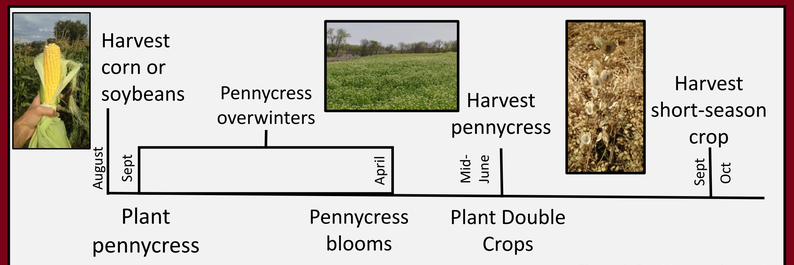

Figure 1. Double cropping cycle

OBJECTIVE

Evaluate the yield potential of short-season, high-value crops in a double-crop rotation with pennycress.

MATERIALS and METHODS

Experimental Design

- Randomized complete block design
- 7 crop varieties
- Four replications

Image 1. Double crops planted at Rosemount

Location

- Rosemount, MN

Management

- Pennycress direct-seeded into field Fall 2015 at 11 kg ha^{-1}
- Pennycress yield harvested June 15, 2016 with small-plot combine
- 7 crop varieties planted June 29, 2016, all with T_{base} =10°C
- 56 kg N ha^{-1} applied to short-season double crops pre-plant
- Plots were managed weed free
  - Glyphosate burn-down pre-plant
  - Dual II Magnum pre-plant herbicide
  - Pursuit herbicide applied to beans mid-season
  - Hand-weeding as needed
- Crops harvested at maturity
  - Sweetcorn October 6, 2016
  - Dry beans and soy beans October 20, 2016

Measurements

- Percent cover (using PAR meter)*
- Growth stage*
- Plant height*
- Soil moisture*
- Yield

*Data not presented.

Crops Planted	
Dry Bean	Montcalm Kidney Bean
	Eclipse Black Bean
Soybean	MG 1.4
	FT-MG 0.7
	MG 0.3
	FT-0.2
Sweetcorn	Gss1477

Table 1. Varieties of double-crops planted at Rosemount. MG – Maturity Group. FT– Food Type soybean for human consumption

MATERIALS and METHODS

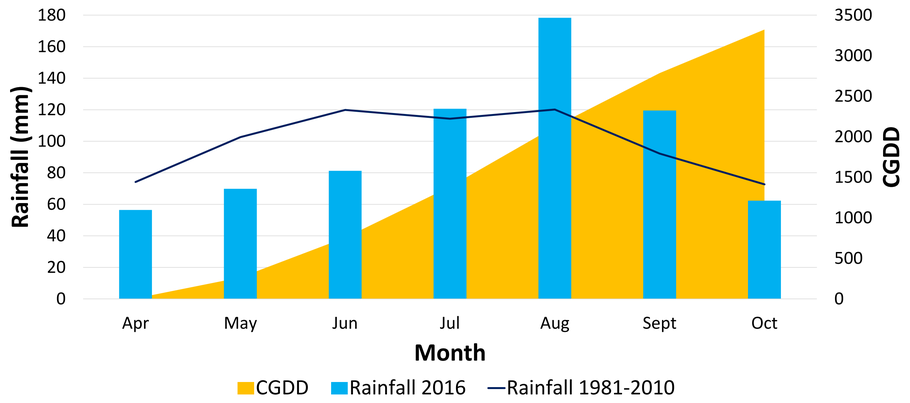

Figure 2. *Rosemount Weather Data:* Average rainfall by month at the plot site during the 2016 study period[6] is presented in bars, while the 30 year average[5] is represented by the line. The cumulative growing degree days (CGDD) throughout the study period is denoted on the secondary y-axis.

RESULTS

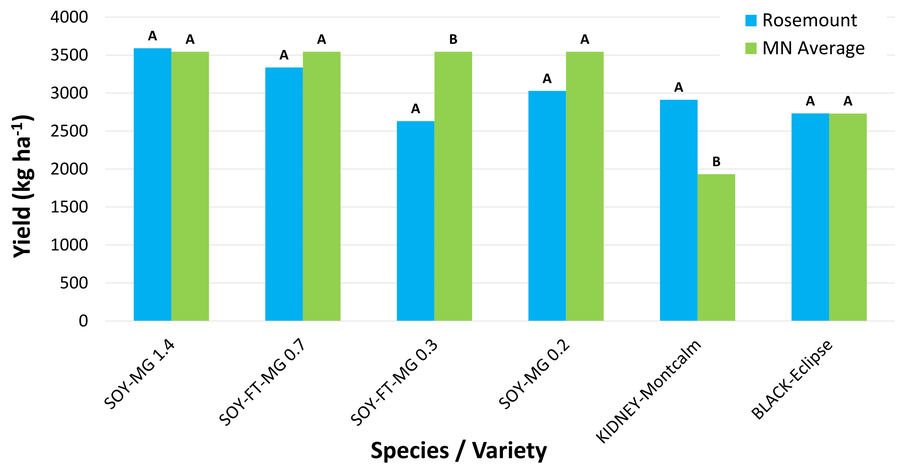

Figure 3. *2016 Yields.* Species/varietal yields for field site in Rosemount, MN, compared with Minnesota state average yield for that same year. Sweet corn green husk yields were 15,970 kg ha^{-1} and 15,536 kg ha^{-1} fresh market weight for Rosemount and MN average[7], respectively. Soybeans labeled with 'FT' are food types for human consumption. The interaction of location and species significantly impacted yield ($P < 0.06$). Mean values sharing the same letter within each species are not significantly different based on LSD ($\alpha = 0.10$).

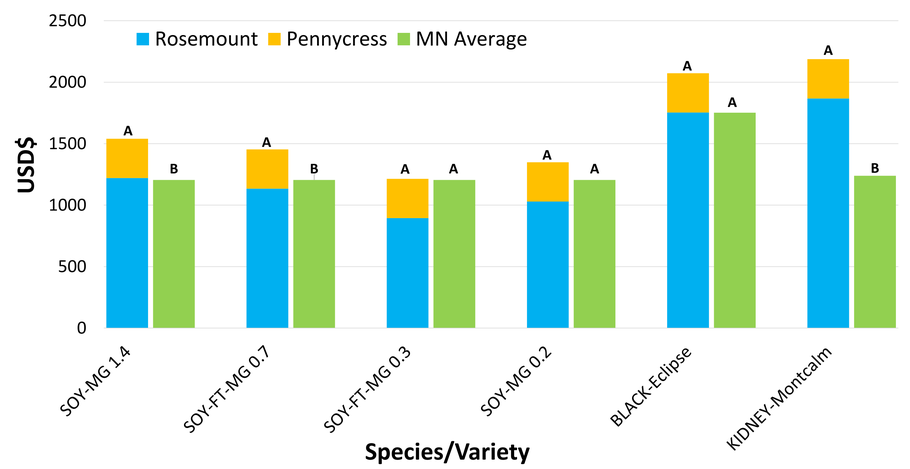

Figure 4. *2016 Gross Income:* Gross earnings per ha^{-1} in USD based on NASS statistics for market price in Minnesota in 2016. Pennycress yield in the spring prior to double-crop seeding was 1,028 kg ha^{-1} NASS[7] statistics for canola market price were used as a reference for pennycress in this figure. Gross earnings for sweetcorn were $11,508 and $12,150 per ha^{-1} for Minnesota state average and Rosemount double-crop + Pennycress, respectively, which were not statistically different. Location and Species/Variety both independently and interacting significantly impacted gross economic return ($P < 0.05$). Mean values sharing the same letter within each variety are not significantly different based on LSD (α =0.05).

DISCUSSION

Yield Performance

Image 2. Kidney beans in August

- The soybean variety for the 0.3 maturity group yielded significantly less than the Minnesota state average. This could potentially be a result of using shorter season soybeans, which traditionally yield less than full-season varieties; what is grown on most acreage in MN.
- Kidney beans had a significantly higher yield than the MN state average. This could be due to a difference in soil type between the experimental plots in this sample and where most dry beans are grown.
- All other crops showed no statistical difference in yield, meaning the double-cropping system has potential as an alternative to growing full-season crops.

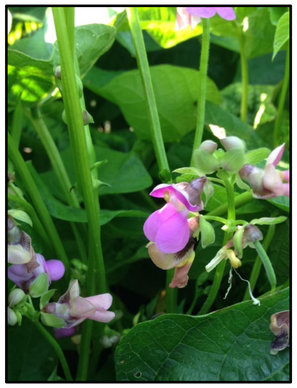

Image 3. Black beans blooming in August

Income

- SOY MG 1.4, SOY MG 0.7, and Kidney bean all had a higher total system gross income in a double-crop system than a single-crop system.
- A calculation of net income may provide slightly different results, owing to additional inputs needed to plant and harvest a second crop.

Future Work

This experiment will be repeated at two locations in 2017 with additional crop varieties to further expand our knowledge on pennycress double-cropping systems in the upper Midwest.

CONCLUSION

- **Several short-season crops can be grown successfully in rotation with pennycress**
- **Pennycress provides an additional source of income that makes double-cropping systems economically competitive with full-season single-crop systems**
- **Continuing research into tightening this rotational system may further decrease yield differences between short-season and full-season crops**

ACKNOWLEDGEMENTS

Thank you to the Forever Green Initiative for providing the funding to carry out this research. Also thank you to the crews at the University of Minnesota's Well's Lab, Rosemount Research and Outreach Center, and Swan Lake Research Center for all their help and hard work.

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