Flowering Time in 5-Azacytidine Mutants of Oilseed Flax (*Linum usitatissimum L.*)

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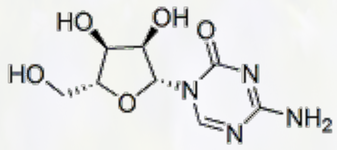
Introduction

- Canada is the world's largest producer of flaxseed (average >700,000 tonnes/annum 2000-2010), most of it is produced in Saskatchewan (SK).
- Flaxseed is rich in oil and alpha-linolenic acid (ALA), a polyunsaturated n=3 (omega-3) fatty acid.
- In Canada, oilseed flax (*Linum usitatissimum L.*) takes 90-125 days to reach maturity.
- SK has a short growing season, 105-135 frost-free days annually. Frost and freezing that occurs during the early fall will reduce crop quality and yield.
- Earlier crop maturity can prevent damage from early fall frost to the flax crop.
- 5-azacytidine (5-azaC) is a chemical that hypomethylates DNA. It induced early flowering and reduced plant height in flax cultivar "Royal". Three 5-azaC treated epimutant lines RE1, RE2 and RE3 were derived. They flowered 7-13 days earlier than the original material "Royal".



5-Azacytidine
Chemical formula: $C_8H_{12}N_4O_5$

Objectives

- Study the effect of 5-azaC on oilseed flax flowering time and height.
- Develop early flowering lines suited for short growing season in the Canadian prairies.

Methods

Original Germplasm

CDC line	CDC Sorrel
Mutant Royal lines	Royal (M_0), RE1, RE2, RE3

Population I: Mutant Population

M_0 CDC Sorrel treated with 5−azaC (2011)

↓

M_1 derived from 5-azaC treatment grown in growth chamber (2011)

↓

M_2 rows grown at high latitude field conditions in a MAD design (2012),100 earliest individuals selected to be M_3 (2013)

↓

M_3 lines grown at high latitude in the field in a MAD design (2013), 100 earliest individuals selected to be M_4 (2014)

Population II: Crossing Population

Reciprocal crosses between:
- CDC Sorrel and Royal;
- CDC Sorrel and 5-azaC treated mutant Royal M_9 lines (RE1, RE2 and RE3) (2011)

↓

F_1 plants grown in the growth chamber (2011)

↓

F_2 rows grown at high latitude in the field in a MAD design, 25 earliest individuals from each row selected to be F_3(2012)

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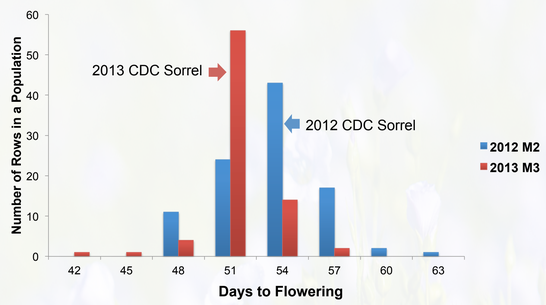
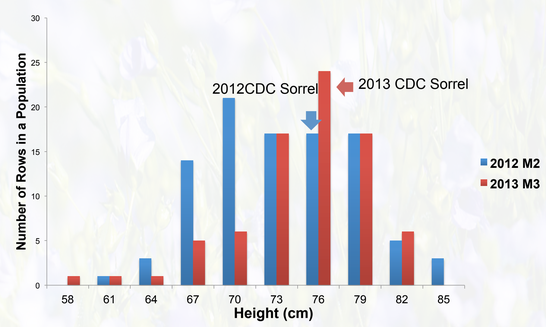
F_3 lines grown at high latitude in the field in a MAD design(2013) , 3 earliest individuals from each line selected to be F_4 (2014)

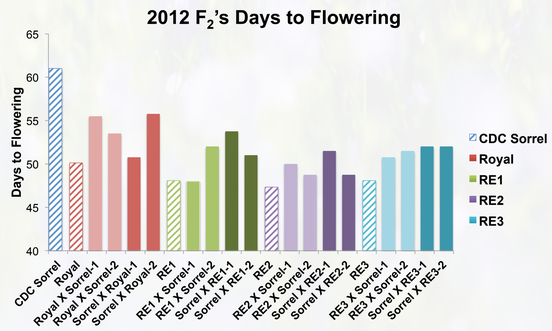
Results

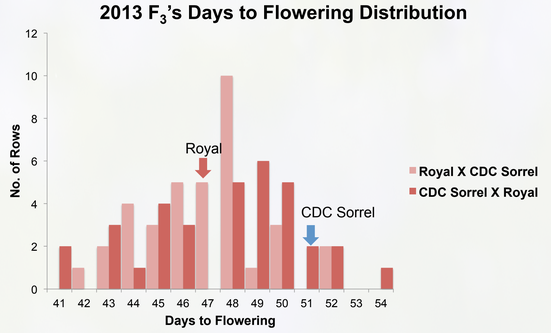
Population I: Mutant Population

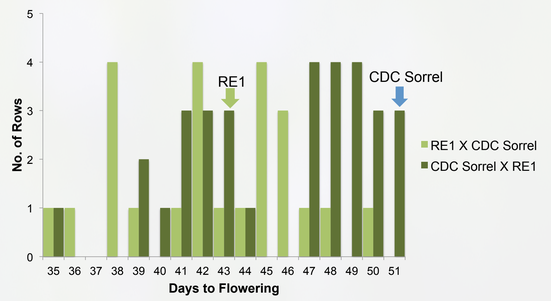


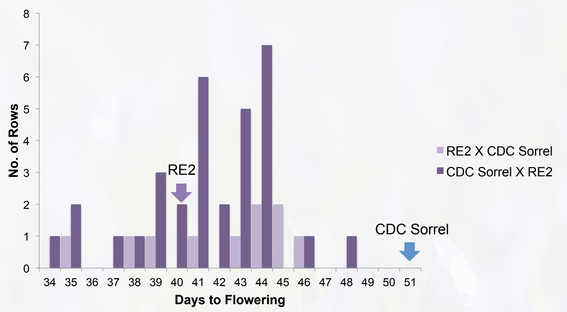


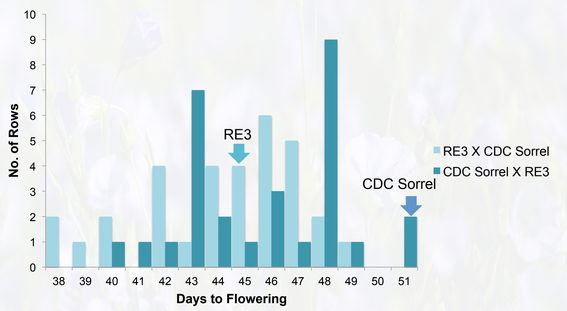
Population II: Crossing Population











Conclusions & Future Work

- Variations in DTF and plant height were observed under field conditions in both populations. F_2 rows presented intermediate phenotypes while selected F_3 lines showed intermediate or transgressive phenotypes compared to parental lines (CDC Sorrel and Royal mutant lines).
- 5-azaC increased variability in DTF and plant height which indicates that 5-azaC treatment could induce early flowering in flax.
- Earliest lines were selected from both populations to be advanced in the next year's field tests.
- Future work includes advancement and selection of M_4 and F_4 and mutagenesis of other CDC oilseed flax varieties.
- Other investigations underway include: characterization of the Royal epimutants under controlled short and long day environments; flowering time gene expression studies comparing early flowering 5-azaC treated with untreated flax lines.

Acknowledgements

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References

1. Ehrensing D.T. (2008). Flax. Corvallis: Oregon State University.
2. Fieldes, M. A. (1994). Heritable effects of 5-azacytidine treatments on the growth and development of flax (Linum usitatissimum) genotrophs and genotypes. *Genome*, 37(1), 1-11.

Image source: Saskflax