Genetic variation of thermotolerance in spring canola (*Brassica napus* L.)

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Abstract

❖During the growing season in western Canada, high temperatures coincide with the reproductive stage of *Brassica napus* L. (spring canola) thereby limiting yield and minimizing the expansion to southern climates.

❖Multiple long-term field studies and lab experiments have demonstrated that heat stress during reproduction results in significant yield reduction.

❖This research will determine if there is significant genetic variation within elite spring canola germplasm to facilitate genetic improvement of theremoterance.

Introduction

❖Heat stress in spring canola has been shown to limit yield by more than 30% in western Canada.

❖Genetic variation of thermotolerance has been demonstrated in other species (*Lycopersicon esculentum* L. Mill., *Cicer arietinum* L. and *Vigna unguiculata* L. Walp.).

❖Differing responses to heat stress within Brassica species exist, with *Brassica juncea* being the most tolerant, *Brassica napus* showing moderate tolerance, while *Brassica rapa* is the most sensitive.

❖Discovering and utilizing variation to heat stress within the primary spring canola gene pool could significantly expedite genetic improvement within this crop.

Objectives

❖Determine the genetic variation for thermotolerance within a subset of elite spring canola inbreds.

Figure 1. a) Normal flowers opening following heat stress. b) Flowers aborting during heat stress.

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Materials and Methods

❖5 restorer (Rf), 5 maintainer and 2 checks were selected from a broader subset of genotypes based their response to heat stress.

❖5 replicates of each genotype were grown in a greenhouse until the green bud stage (BBCH 53).

❖At BBCH53, each genoptype was placed in a growth chamber with 16/8hr light/dark for 14 days and subjected to either a heat stress or control treatment.

❖Control treatment (22/10C) and heat treatment (31/13) followed a diurnal pattern so the highest temperature for each treatment lasted 4hrs.

❖After 14 days in the growth chamber the pots were placed back in the greenhouse until harvest.

Figure 2.. Two genotypes with significantly different H.S.I. for seed yield 14 days after heat treatment.

❖Data collected: flower number, flower duration, pod number, flower:pod, pollen count, seed number/plant, dry biomass (whole plant), floral bud metabolite content, seed yield (grams/plant).

❖Impact of the heat treatment on each genotype is presented as a Heat Susceptibility Index (H.S.I.) which is standardized to the overall impact of the heat treatment or the Heat Intensity Index (H.I.I.)

Heat Susceptibility Index

$$H.S.I. = 1-(Y_h/Y_c)/HII$$

Y_h - yield of a genotype in the heat treatment

Y_c - yield of a genotype in the control treatment

Heat Intensity Index

$$H.I.I. = 1-(X_h/X_c)$$

X_h - mean yield of heat treatment

X_c - mean yield of control treatment

Adopted from Fischer and Maurer, 1978

Results and Discussion

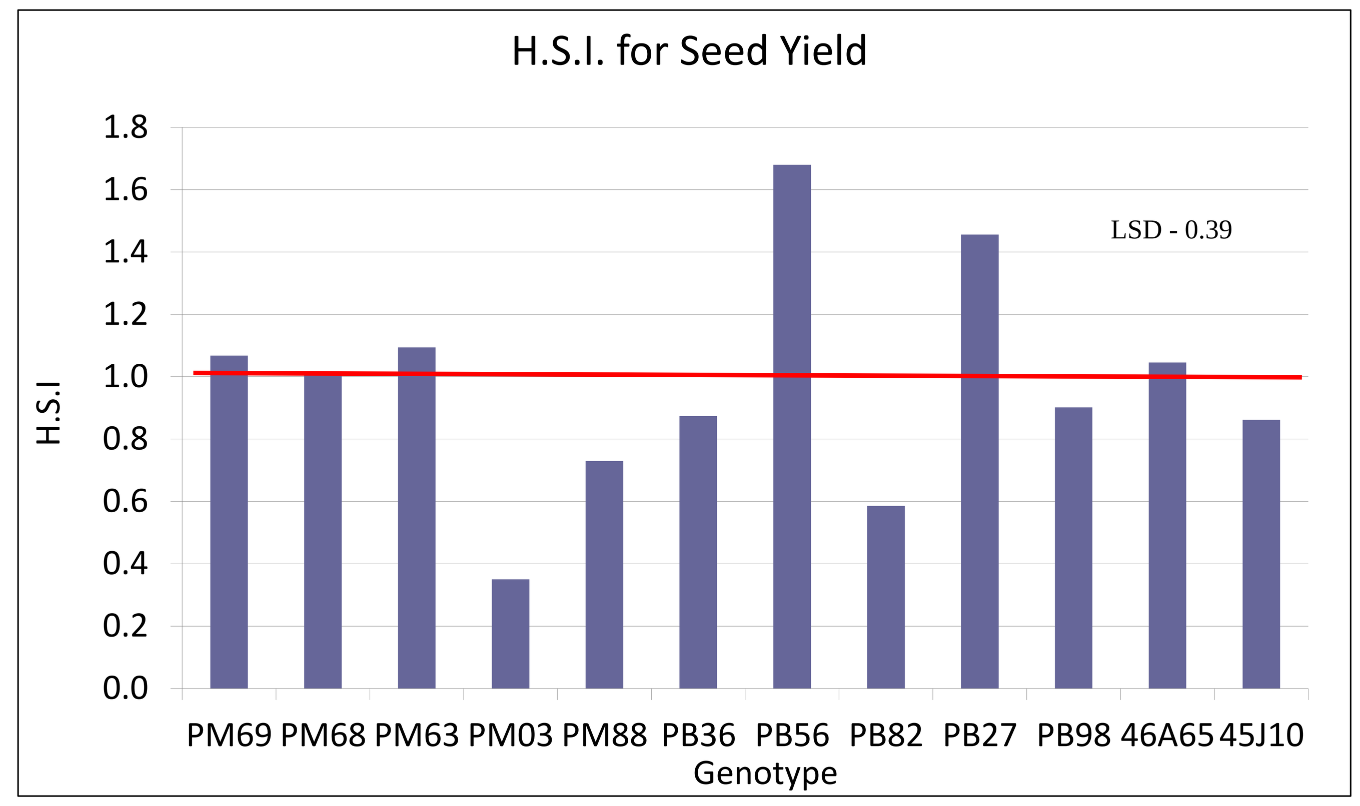

Figure 2. H.S.I. for seed yield. Genotypes above the red line preformed worse than the average of the group and those below the red line preformed better than the average of the group.

❖The H.S.I. for seed yield was closely related to the yield components (pod count, seed count) with R^2 values of 0.61 and 0.89, respectively.

❖No relationship was noted between H.S.I. for seed yield and flower number, flower duration, pollen number, biomass or flower:pod ratio.

❖There were significant differences in metabolite content of the floral buds between treatments, but no relationships were found between H.S.I. for seed yield and any specific metabolite changes.

Figure 3. a) flower from a heat stressed genotype with better than average H.S.I. for seed yield B) flower from a heat stressed genotype with a below average H.S.I. for seed yield.

Conclusions

❖Significant thermotolerance variation exists within this subset of spring canola genotypes.

❖There is a significant shift in the flower bud metabolome when subjected to heat stress.

❖Continued research is required to discover secondary traits for theremotolerance.

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