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Optimising genetic gain in canola breeding – the model comes to life in a global canola breeding program

Wallace Cowling[1]

[1] University of Western Australia, Perth, Australia

Background:

Genetic gain is rarely measured in crop breeding programs, but monitoring past genetic gain is an essential part of optimising future genetic gain. A stochastic model for breeding a self-pollinating crop with optimal contributions selection (OCS) suggested that rapid genetic gain could be achieved for multiple economic traits during global warming (1).

Objective:

The objective was to achieve a rate of genetic gain in grain yield (GY) and several important economic traits including seed oil, protein in meal and Phoma (blackleg) disease resistance to meet commercial outcomes in a spring canola breeding program, based on processes developed in a stochastic model with OCS and optimised mating designs (1).

Methods:

OCS was modelled in crop breeding during global climate change (1), and the methods were applied to a global canola breeding program during three cycles of S0,1 family selection in 2016, 2018 and 2020 with several field trials per cycle in Australia and Canada. Economic weights in the index were designed to promote increases in GY, stable GY, higher seed oil, higher protein in meal and increased Phoma (blackleg) disease resistance. Factor analytic modelling of the genotype-by-environment interaction allowed estimation of overall performance for GY, stability of GY across global environments, and estimation of the linear rate of genetic gain in GY across cycles for all traits.

Results:

The linear rate of genetic gain in GY across cycles was 0.059 or 0.087 t ha-1 y-1 (2.9% or 4.3% y-1) based on overall performance and average predicted breeding values across environments, respectively (2). Both GY and yield stability, defined as the root mean square deviation from the regression line associated with the first factor in factor analytic modelling, were predicted to improve in the next cycle with a low achieved mean parental coancestry (0.087) (2). Concurrently, seed oil and protein in meal also increased, resistance to Phoma increased and seed glucosinolates decreased, while flowering time and plant height were maintained. These rates of genetic gain matched those achieved in a model for optimising genetic gain during climate change (1).

Conclusions:

Rapid cycles of S0,1 family selection with OCS resulted in high rates of genetic gain in GY and other commercial traits in spring canola in Australia and Canada (2), thereby confirming the predictions of stochastic modelling of the same process with OCS and optimised mating designs (1). These rates of genetic gain exceed published rates of genetic gain in most self-pollinating crops and support the testing of early generation canola in target global environments for global genetic gain.

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References:

(1) Cowling, W.A. *et al*. 2019. Modelling crop breeding for global food security during climate change. *Food and Energy Security* 8:e00157

(2) Cowling, W.A. *et al*. 2023. Optimal contribution selection improves the rate of genetic gain in grain yield and yield stability in spring canola in Australia and Canada. *Plants* 12:383.