



Genetic Parameters and Heritability Analysis of Physiological and Agronomic Traits in Rapeseed (*Brassica napus* L.) Genotypes: Implications for Breeding Program Design

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Abstract

This study evaluated genetic parameters for 12 traits in nine rapeseed genotypes. High heritability and genetic advance were found for net photosynthetic rate ($h^2 = 99.37\%$, GAM = 64.77%), number of siliques ($h^2 = 98.03\%$, GAM = 61.74%), and harvest index ($h^2 = 96.61\%$, GAM = 42.67%), indicating strong genetic control and good selection potential. Chlorophyll content traits had lower heritability (56.43-62.52%) and genetic advance (5.95-6.15%), suggesting greater environmental influence. Stomatal conductance traits showed high heritability (93.75-94.90%) and moderate to high genetic advance (24.98-32.54%), indicating good breeding potential. These findings help prioritize traits for rapeseed breeding programs.

Introduction

Plant breeding aims to develop superior cultivars using genetic variation in germplasm collections. Success depends on understanding the balance between genetic and environmental factors. Key parameters like heritability and genetic advance (GA) predict selection responses. High heritability indicates traits are suitable for selection, while low heritability suggests environmental influence limits effectiveness. GAM shows expected selection response, with high GAM traits responding better to selection. GCV and PCV quantify genetic and environmental variation, with their ratio indicating genetic contribution. This study aimed to estimate genetic parameters for 12 traits in nine rapeseed genotypes, partition phenotypic variance, identify traits with high selection potential, and recommend trait prioritization for breeding programs.

Materials and methods

This study evaluated nine rapeseed cultivars for twelve traits during the 2020-2021 growing season at Shahid Chamran University, Iran. Traits included physiological (e.g., photosynthesis, transpiration) and morphological (e.g., plant height, harvest index) characteristics. Genetic parameters like heritability, genetic advance, and coefficients of variation were calculated. Traits with high heritability ($h^2 > 60\%$) and genetic advance (GAM $> 20\%$) were classified as having high selection potential. Statistical analysis was performed using R software, with visualizations showing genetic vs. environmental variance and the relationship between heritability and genetic advance.

Results and discussion

This study identified Net Photosynthetic Rate, Number of Siliques, Harvest Index, and Stomatal Conductance as traits with high heritability and genetic advance, ideal for selection. First Branch Height and Relative Water Content had moderate selection potential for breeding. Chlorophyll Content showed low heritability and genetic advance, indicating limited potential for selection.

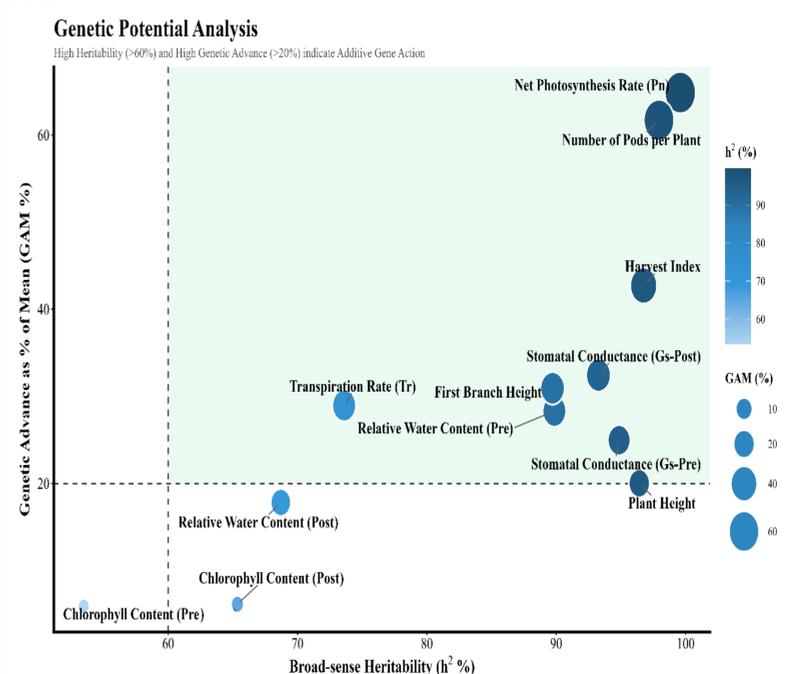


Figure 1 illustrates the relationship between broad-sense heritability (h^2) and genetic advance (GAM), with bubble size representing the magnitude of genetic advance. The green quadrant highlights traits with high selection potential ($h^2 > 60\%$ and GAM $> 20\%$).

Partitioning of Genetic and Environmental Variability

The grey bridge represents the environmental influence on each agro-physiological trait.

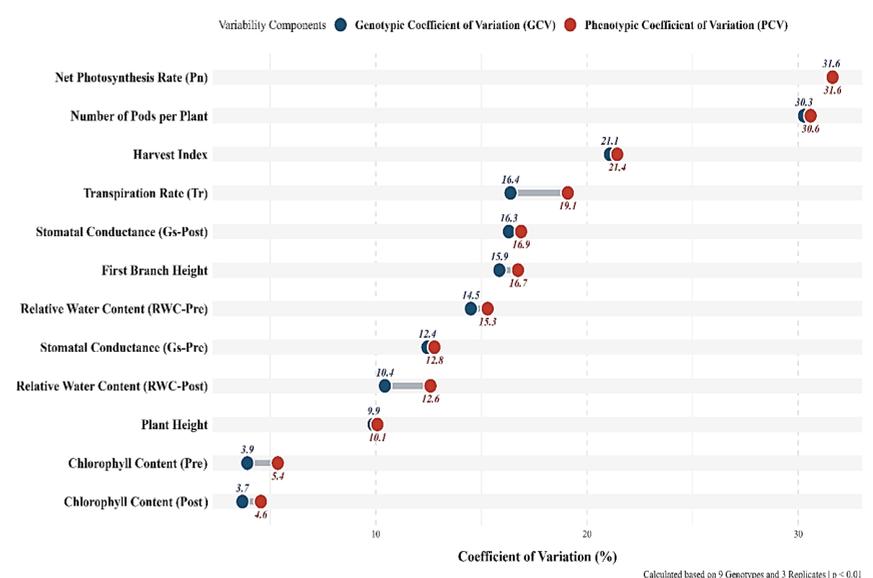


Figure 2 shows the genetic and environmental variability for twelve rapeseed traits, comparing the genotypic (GCV) and phenotypic (PCV) coefficients of variation to highlight the sources of variability.

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