Genetic underpinnings of trade-offs in plants

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Abstract

Trade-offs between traits arise and reflect constraints imposed by the environment and physicochemical laws. Trade-off situations are expected to be highly relevant for sessile plants, which have to respond to changes in the environment to ensure survival. Despite increasing interest in determining the genetic and molecular basis of plant trade-offs, there are still gaps and differences with respect to how trade-offs are defined, how they are measured, and how their genetic architecture is dissected. The first step to fill these gaps is to establish what is meant by trade-offs. In this review we provide a classification of the existing definitions of trade-offs according to: (1) the measures used for their quantification, (2) the dependence of trade-offs on environment, and (3) whether data based on which they are inferred are from a single individual across different environments or a population of individuals in single or multiple environments. We then compare the approaches for quantification of trade-offs based on phenotypic, between-individual, and genetic correlations, and stress the need for developing further quantification indices particularly for trade-offs between multiple traits. Lastly, we highlight the genetic mechanisms underpinning trade-offs and experimental designs that facilitate their discovery in plants, with focus on usage of natural variability. This review also offers a perspective for future research aimed at identification of plant trade-offs, dissection of their genetic architecture, and development of strategies to overcome trade-offs, with applications in crop breeding.

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