Genotype mixtures as a tool to develop sustainable agriculture: elucidating the mechanisms that drive genotypic interactions in durum wheat

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Introducing genetic diversity within fields has been proposed as a way to take better advantage of biological and ecological processes naturally occurring in agro-ecosystems, allowing the development of more sustainable agricultural systems with reduced nutrient inputs. However, agronomic studies show both positive and negative effects of genotype mixtures on field production. Negative interactions among different genotypes may result from indirect genetic effects (IGEs) and kin selection, two mechanisms that have remained poorly explored in plants.

Natural selection can operate at the individual and group level in natural populations. Indeed, the fitness of an individual may depend on the phenotypes of interacting individuals. Selection at the group level can thus promote individual traits that optimize the collective performance at the expense of individual fitness. Under kin selection, a selection operating whenever interacting individuals are related, individuals are predicted to behave less competitively toward their relatives. Because agriculture has been maximizing group performance and human selection has occurred among groups of related individuals, one may hypothesize that human selection has been acting as kinship selection in domesticated species. Moreover, the trait value of an individual may be affected by genes in other individuals independently of their relatedness, an effect known as IGEs. Using durum wheat as a model species, we conducted an experiment where plants were grown in groups of five with different levels of relatedness, to test whether kin selection and IGEs may induce poorer performance of genotype mixtures.