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Breeding tomato hybrids for flavour: comparison of GWAS on lines and F1 hybrids

Estelle Bineau^{1,2}, José Luis Rambla³, Santiago Priego³, Alexandre Hereil¹, Frédérique Bitton¹, Clémence Plissonneau², Antonio Granell³, Mathilde Causse¹

1. INRAE, UR1052, Génétique et Amélioration des Fruits et Légumes, 67 Allée des Chênes, Centre de Recherche PACA, Domaine Saint Maurice, CS60094, Montfavet, 84143, France, 2. GAUTIER Semences, route d'Avignon, Eyragues, 13630, France, 3. Instituto de Biología Molecular y Celular de Plantas, CSIC, Universidad Politécnica de Valencia, Valencia, 46022, Spain

Email: estelle.bineau@inrae.fr

While breeders face consumer expectations regarding tomato flavour in the F1 hybrid varieties commercialised, no data are available on the inheritance of QTLs for flavour-related trait in heterozygous plant material. Volatile organic compounds (VOCs) are major determinants of tomato flavour. We quantified 46 VOCs in (1) a panel of 121 small fruited tomato accessions (15 *S. pimpinellifolium* and 106 *S. lycopersicum* var. *cerasiforme*) and (2) in a test cross panel involving the previous panel plus 44 elite cherry tomato lines crossed with a common big fruited line. High and consistent heritabilities were assessed for most VOCs in the two panels, and the line and test cross values for VOC content were strongly correlated. In the two panels, cluster analysis on 46 VOC content matched the metabolic pathways known from the literature. Results suggested a global additivity pattern for most VOC genetic control. We performed genome wide association studies (GWAS) on the line and test cross panels separately, along with a third GWAS on the test cross subset carrying the subset of 121 F1 hybrids corresponding to the line panel. We identified 205, 183 and 138 associations, respectively. Although less than 10% associations overlapped between line and F1 hybrid panels, we identified numerous overlapping associations for VOCs belonging to the same metabolic pathway within each panel. With this study, we highlighted the interest of testcross panel to create tasty F1 hybrid varieties. The clusters of associations in the F1 hybrid panel are new levers to improve tomato flavour by regulating several key VOCs simultaneously, while following only a few genomic regions in the breeding material. We selected seven chromosome regions fitting numerous criteria meant to facilitate breeding. For instance, a 4Mbp region on chromosome 3 carried F1 specific associations for 14 different VOCs derived from the lipid metabolism, eight of which having an impact on tomato overall flavour. This region is supported by several candidate genes also highlighted in previous studies.

Key words: Tomato, breeding, flavour, volatiles, GWAS.