

The apple refpop - A multi-environment reference population for genomics-assisted breeding in Apple

Abstract:

Apple (*Malus × domestica* Borkh.) is one of the most economically and culturally valuable fruit crops in temperate regions. Its breeding is a long-term and costly process due to the time and space requirements for screening of new selection candidates. To increase efficiency of breeding programs, genomics-assisted breeding can be utilized on diverse germplasm. A diverse set of genotypes together with a large number of genetic markers and phenotypes estimated in different environments is required to make the approach feasible and applicable under various climate conditions. Here we present the apple reference population (apple REFPOP), a large collection formed of 536 genotypes planted in a multi-environment design at six European countries, as a tool to facilitate progress in modern apple breeding. The population is divided into (i) accessions representing a wide range of genetic diversity in the cultivated apple and (ii) progenies of 27 full-sib families developed in several current European breeding programs. Genotypic data for a high-density genomic marker set of more than 300,000 single nucleotide polymorphisms (SNPs) are available for the apple REFPOP. To reach this density, data produced with a 480K SNP genotyping array were combined with data from a 20K array using genotype imputation whereby a high imputation accuracy of 0.95 was reached. Based on the genome-wide marker data, we found a low linkage disequilibrium and weak population structure in the apple REFPOP. We demonstrate the potential of a coordinated and multinational effort for successful application of genome-wide association studies and genomic prediction on two previously well-described phenotypic traits, i.e. flowering begin and harvest date. The apple REFPOP, together with its large phenotyping design and genomic resources, has a strong potential to become a means of apple breeding improvement when responding to changing climate and market demand.