



**Supplementary Fig. S11** Loci screened based on LFMM. Gray and orange points represent all tested SNPs, while red points indicate outlier SNPs with significant associations (LFMM,  $p < 0.001$ ). The X-axis shows the genomic position of SNPs along the chromosomes, and the Y-axis displays the negative logarithm of the association  $p$ -value ( $-\log_{10}(p\text{-value})$ ). The dashed line marks the statistical significance threshold ( $-\log_{10}(0.001)=3$ ).