historically and aesthetically valuable forest landscape, recognizing that carefully maintained deciduous broadleaf stands are essential to preserving the scenic quality that visitors seek. This underscores how maples can anchor regional landscape character when their seasonal color traits are systematically considered in planning and management.

More broadly, research on autumn-color slope forests shows that configurations rich in red and yellow foliage, with clear yet harmonious color contrasts, are particularly effective for improving visual aesthetic quality and supporting tourism and local economies (Liu et al., 2019; Mu et al., 2022). In Japan, autumn leaf-coloring events are timed to phenological stages of maple foliage to maximize tourism benefits, confirming that maple color dynamics are integrated into destination management and marketing strategies. Arashiyama exemplifies how the genetic and phenological properties of maples-stable, vivid autumn coloration and predictable timing-can be translated into landscape-scale color design, producing spaces that are both ecologically meaningful and culturally and economically valuable.

4 The Genetic Basis of Maple Leaf Color

4.1 The influence of genes related to anthocyanin synthesis on leaf color

The formation of maple leaf color is mainly controlled by some key genes, which are involved in the production of related enzymes during anthocyanin synthesis. Studies have shown that changes in the expression of genes such as CHS, CHI, F3H, DFR, ANS, and UFGT are closely related to the increase or decrease of anthocyanin content during the color change of leaves (Li et al., 2025). For example, 20 genes related to anthocyanins were discovered in the study of false-colored maple leaves. Most of these genes have the highest expression levels during the most red stage of the leaves, indicating that they play an important role in the formation of red leaves (Figure 2) (Gong et al., 2025). In red maples, the expression of these genes is usually higher in red leaves than in green and yellow leaves, thus affecting the accumulation of pigments and the manifestation of leaf color (Chen et al., 2019).

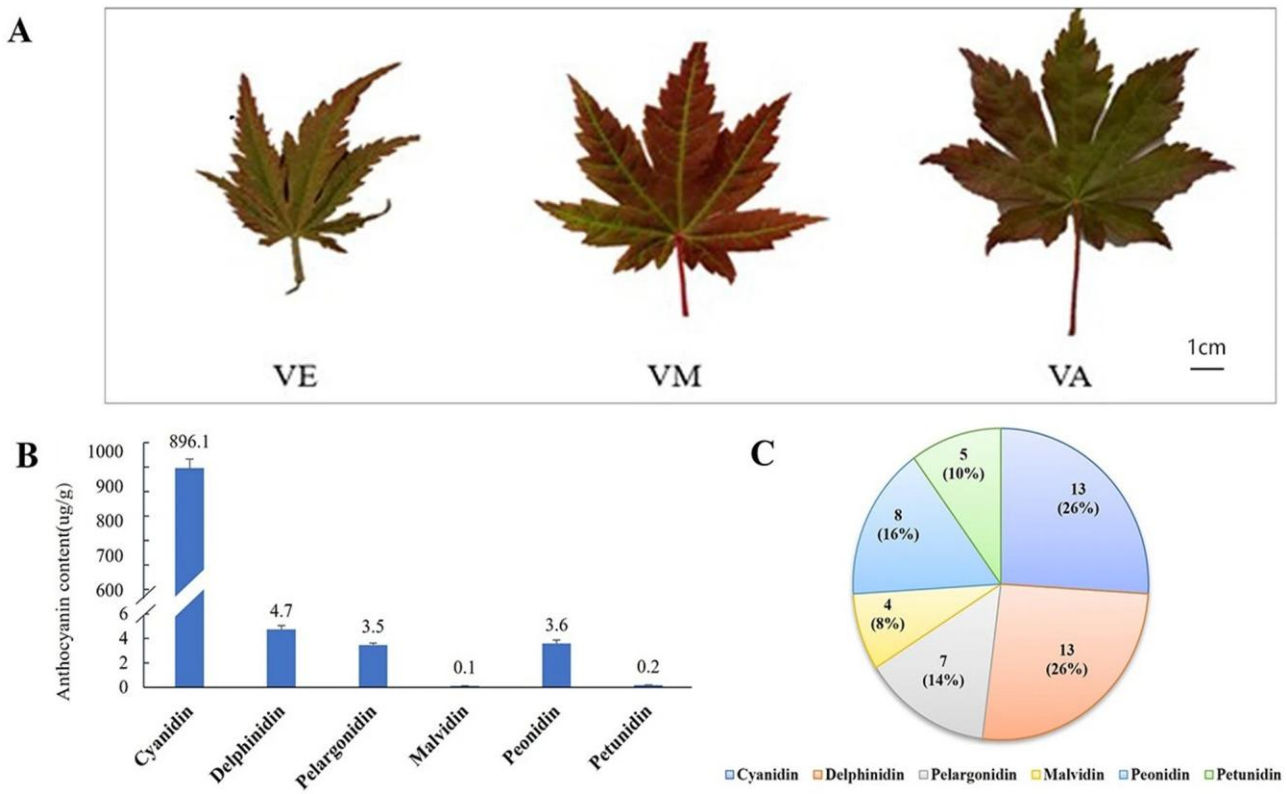

Figure 2 The leaf morphology during development (A), anthocyanin content (B) and classification (C) of *A. pseudosieboldianum mutant* (Adopted from Gong et al., 2025)

Image caption: VE (Early stages), VM (Middle stages), and VA (Late stages) represent three stages during leaf discoloration (Adopted from Gong et al., 2025)