The Power of Plasticity in Polyploid Persimmon

Most plants are hermaphrodites, producing perfect flowers with both male and female functions. In roughly 6% of plants, however, male (usually XY) plants produce only male flowers and female (XX) plants produce only female flowers. These dioecious plants cannot self-pollinate, ensuring genetic diversity and facilitating the breeding process. In the dioecious diploid persimmon (*Diospyros lotus*), sex is determined by the autosomal gene *MeGI* (Japanese for female tree) and the Y-encoded pseudogene *OGI* (male tree) (Akagi et al., 2014). *MeGI* encodes a homeodomain transcription factor that regulates flower development and anther fertility in a dosage-dependent manner, acting as a feminizing agent. In females, *MeGI* builds to high levels, repressing pollen formation. In males, *OGI* produces a small RNA (smRNA) that targets and represses *MeGI*, thereby preventing the accumulation of *MeGI*.

The situation is more complex in the autohexaploid persimmon species *D. kaki*. These trees are either fully female or monoecious (male and female flowers on separate branches). Monoecious trees are genetically male, prompting Akagi et al. (2016) to wonder how plants with Y chromosomes produce female flowers. Their analysis uncovered an intriguing epigenetic regulatory mechanism not found in *D. lotus*.

The authors began by comparing three types of flowers: female flowers from female trees, female flowers from monoecious trees, and male flowers from monoecious trees. Like *D. lotus* flowers, male *D. kaki* flowers harbor *MeGI* targeted by smRNA, with all six copies of this gene equally targeted. As expected, *OGI* expression was completely undetectable in female flowers from both female and monoecious *D. kaki* trees. Surprisingly, *OGI* expression was also undetectable in male flowers from monoecious trees. It turns out that the *OGI* promoter in *D. kaki* is interrupted by a 268-bp insertion resembling a SINE (short interspersed nuclear element)-like retrotransposon element, which appears to be unique to monoecious *D. kaki* cultivars. This element exhibits heavy smRNA accumulation, along with strong cytosine methylation, in both male and female buds and flowers from genetically male plants, suggesting it represses *OGI* expression in *D. kaki*.

The position of a *D. kaki* bud on a branch affects the sex of the resulting flowers the following year (see figure). In June, each branch bears only male or female flowers and developing buds of unknown sex. The following year, the buds on these parental branches develop into new, secondary branches, each bearing only male or female flowers. Apical buds on female branches almost always give rise to female secondary branches, whereas medial buds on the same branches have a nearly equal chance of forming male or female branches. By contrast, buds from male parental branches almost always develop into male branches, regardless of their position on the parental branch. This pattern suggests that an epigenetic mechanism is at play. Indeed, the methylation pattern across *MeGI* in *D. kaki* strongly mirrors this trend, with the highest methylation levels found in mature male flowers and buds and the lowest in their female counterparts. Therefore, gene silencing by methylation appears to regulate sex determination in *D. kaki*. This differential methylation pattern is much stronger in *D. kaki* than in *D. lotus*, which mainly uses *OGI* to silence this feminizing gene, suggesting that methylation of *MeGI* represents an alternative mechanism for sex determination in this hexaploid persimmon.

Treatment with the nonspecific methylation inhibitor zebularine helped confirm this model: Zebularine treatment tended to promote pistil development and inhibit anther development in male flowers of male-based and female flower development in monoecious *D. kaki*. For each branch, the relative percentages of male (blue) branches, female (pink) branches, and branches with no flowers (gray) are represented as stacked bars. (Adapted from Akagi et al. [2016], Figure 3B.)
monoeccious *D. kaki* cultivars, but it had no effect on female flowers. Methylation marks could also be removed in nature, inducing a switch from male to female flower production. Such plasticity would allow plants to optimize female flower (and fruit) production based on environmental conditions. This elegant mechanism has possible implications for fruit production in *D. kaki*. More generally, this work sheds light on the influence of methylation on gene function and phenotypic variation in polyploids.

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**REFERENCES**


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*Plant Cell* 2016;28;2885-2886; originally published online December 15, 2016;
DOI 10.1105/tpc.16.00936

This information is current as of September 20, 2017