The 2022 World Congress on
The 2022 Structures Congress (Structures22)
16-19, August, 2022, GECE, Seoul, Korea

Optimal leaf vein thickness design principle

Sungdo Hong[1)] and *Keunhwan Park[2)]

[1), 2)] *Department of Mechanical Engineering, GachonUniversity, Seongnam-si 13120, Korea*
[1)] *ooings52@gachon.ac.kr,* [2)] *kpark@gachon.ac.kr*

ABSTRACT

The leaf vein system facilitates the transport of energy generated from photosynthesis and signaling molecules in plants, thereby permitting long-range communication within the organism and the growth of non-photosynthesizing organs such as roots and fruits. Leaf veins have a skeletal structure and can be bent such that the center of the leaf faces sunlight with appropriate bending to support the leaf. Leaf vein patterns are intricate, and its structural diversity is ambiguous. In this study, we investigate the central vein design: sharp at the tip and untapering to the base of leaf. We measure the midvein structure in 147 leaf species representing a diverse set of habitats and leaf sizes, from 30 mm (*Poncirus trifoliata* (L.) Raf.) to 307 mm (*Aesculus turbinata* Blume). We show that the leaf vein shares common traits across species and that the shape of its central vein obeys the theory we developed. We establish a model of hydraulic resistance and tolerable gravitational loads as a function of variation of vein sectional diameter with its position, which allows us to predict optimal untapering ratio of central vein depending on leaf shape of each species that maximize sugar transport rate under stable mechanical support. This minimal model predicts a power law of leaf midvein shape consistent with energy minimization, suggesting that translocation is important at the tip and mechanical support becomes more important to the base.

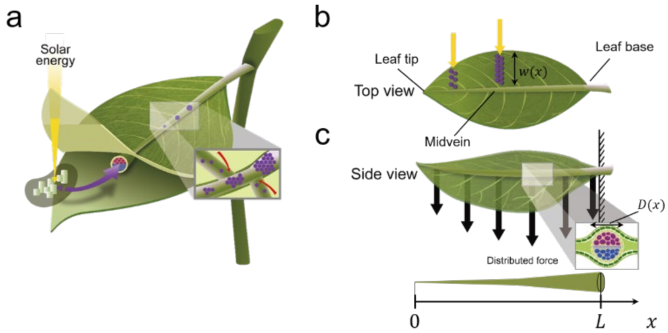

Fig. 1 Leaf vein geometry in a leaf.

REFERENCES

[1)] Under graduate student
[2)] Assistant professor

Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant physiology and development* (No. Ed. 6). Sinauer Associates Incorporated.

Brodribb, Tim J., and Taylor S. Feild. (2010) "Leaf hydraulic evolution led a surge in leaf photosynthetic capacity during early angiosperm diversification." *Ecologyletters* 13.2: 175-183.