

# The compensation effect between safety and efficiency in xylem and its role in photosynthesis of gymnosperms

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## Abstract

The safety-efficiency trade-off (SETO) hypothesis is a common theme in plant sciences. Despite safety and efficiency are physiologically compensated for each other, they are always mathematically described into trade-off against one another. However, the compensation effect has never been defined and quantified. What remains unclear is how compensation effect has influenced the xylem water transport and subsequently photosynthesis. Here, we proposed that the compensation effect between safety and efficiency was actually a safety-efficiency tie-up strategy (SETU; a positive relationship between safety and efficiency) within xylem functions. Then we proposed a theoretical framework that integrated the compensation effect into the xylem hydraulic functional strategy to quantify SETU and SETO. Finally, we tested SETO- and SETU-photosynthetic rate relationships across different levels, based on a common garden experiment using nine conifers and published data for gymnosperms. The results demonstrated that the compensation effect in xylem functions was the dominant force in facilitating photosynthetic rates at scales from the species to the phylum. By integrating the compensation effect into the xylem hydraulic functional strategy, our study clearly indicates that the compensation effect is the evolutionary basis for the coordination of xylem hydraulic and photosynthesis physiology.

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