Study on isoprene emission from leaves of bamboo species(Digest_要約)

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(Abstract of the thesis)

Isoprene (2-methyl-1,3-butadiene) emitted from terrestrial vegetation can be considered as a large carbon emission from ecosystem. The chemistry of isoprene can potentially worsen air quality and impact climate change. This study measured leaf-scale isoprene emission rates for multiple bamboo species. For this, the responses of leaf isoprene emission rate to potential meteorological, morphological, and physiological controllers such as leaf temperature, light intensity, leaf mass per area, leaf nitrogen concentration, photosynthetic rate, and electron transport rate were examined. This study verifies the relationships of isoprene emission flux from bamboo leaves with these factors controlling representative flux of isoprene emission, and aids in a better estimation of bamboo isoprene emissions.

Chapter 1 of this study introduces the biochemical process of isoprene synthesis in plant leaves, the reason of isoprene emission by plants, the history of model development of isoprene emission from plant leaves, and the isoprene emission capacity of multiple plant species reported by previous studies. Also, the importance of bamboo species on global isoprene emission amount that motivate a further research on bamboo species is described. Understanding isoprene emission dynamics from bamboo leaves can provide critical information on mitigating its negative impact on atmospheric chemistry. However, lack of further data leads to a main obstacle for reliable estimation of isoprene emission dynamics from bamboo species.

In Chapter 2, the isoprene emission rate of the leaves of *Phyllostachys pubescens*, an invading bamboo, in response to varied leaf temperature and light intensity was examined. The results confirm that *P. pubescens* is a major isoprene emitter, equivalent to or even stronger than previously reported emitters. When validating the reproducibility of an existing isoprene emission model, the isoprene emission rate in response to light intensity was well reproduced. However, the model did not reproduce the response to leaf temperature owing to overestimation of isoprene emission rates under low temperatures. Although the issue was substantially corrected by applying an optimization on certain parameters in the model, the large variation among leaves led to difficulties in reproducing isoprene emission rate from *P. pubescens* with a constant basal isoprene emission rate. Further investigation of the controlling factors by considering the seasonal and inter-leaf variation in isoprene emission is needed.

In Chapter 3, the results of Chapter 2, and knowledge of the process-based sense, were used to determine the morphologic and physiologic factors that could alter the isoprene emission capacity of bamboo leaves. A strong correlation between leaf mass per area and area-based isoprene emission rate was found. On the other hand, mass-based photosynthetic rate and leaf nitrogen concentration did not exhibit any correlation with mass-based isoprene emissions. By combining data from *P. pubescens* across the three sites in this study, under constant light (1000 μmol m^{-2} s^{-1}) and leaf temperature (30 °C), a correlation was demonstrated across these sites. This result partly explains the inter-leaf variation in isoprene emission rate, and suggests that detection of leaf mass per area can effectively determine the representative isoprene emission rate of bamboo leaves.

In Chapter 4, isoprene emission rate, leaf temperature, leaf mass per area, photosynthetic rate, and electron transport rate were recorded for 18 bamboo species within 5 genera, incorporating different growth types (woody and dwarf) and climates of the region of origin (temperate, warm-temperate, and subtropical). Dwarf bamboos showed negligible to no emissions of isoprene under any leaf temperature; in contrast, woody bamboos demonstrated considerable isoprene emission rates, mainly in August and September, at leaf temperatures higher than 30 °C. For woody bamboos, area-based isoprene emission rate generally showed a positive correlation to leaf mass per area across species. Mass-based isoprene emission rate showed a positive correlation to mass-based electron transport rate across species. Since no difference in leaf mass per area and electron transport rate was found between the woody species and dwarf species, different isoprene emission traits between them were independent of leaf mass per area, and electron transport rate.

Finally, Chapter 5 summarizes the findings in the above chapters. The results of this study show that bamboo species categorized as woody bamboos emit a considerable amount of isoprene. This emission amount is comparable to those of known high-emitter species. By quantifying the variability of isoprene emission rates, in response to factors such as leaf temperature, light intensity, leaf mass per area, and electron transport rate, from bamboo leaves of different species, this study allows us to achieve a better estimation of isoprene emission from leaves of bamboo species.