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Application of three sap flow techniques for Japanese cedar: attempting to estimate the characteristics of sap movement

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Forests cover about 66% of land area of Japan, and Japanese cedar (*Cryptomeria japonica*) occupies 18% of total forested area. Recently, the water balance of a stand of Japanese cedar has been made clear quantitatively by using eddy-covariance method and sap flow technique in Kyushu Island, Japan (Kumagai et al., 2014; Shimizu et al., 2015). Although Japanese cedar is one of the most representative planted species in Japan, few studies have been carried out except in Kyushu Island. The most common technique of sap flow is thermal dissipation method (TDM, Granier, 1985) in Japan. Heat ratio method (HRM, Burgess et al., 2001) and heat field deformation method (HFD, Nadezhdina et al., 2012) have been widely used among foreign countries, and advantages and disadvantages of these techniques were described (e.g., Vandegehuchte and Steppe, 2013). However, HRM and HFD have not been applied for Japanese cedar in Japan. In this study, we applied TDM, HRM and HFD for a tree of Japanese cedar, and carried out preliminary comparison among three techniques. Based on field measurements, we attempted to estimate the sap flow characteristics within the target tree by three techniques.

We conducted measurements in a mature stand of Japanese cedar, whose age is 62, within Tsukuba Experimental Watershed located in southern part of Mt. Tsukuba, Japan. We picked up a tree of Japanese cedar whose height is 24.9 m and diameter at breast height is 40.4 cm, and applied sensors of TDP, HRM and HFD. We used handmade sensors for TDM (e.g., Iida et al., 2013) and sensors for HRM and HFD manufactured by ICT international Pty Ltd (type SFM1 and HFD8, respectively). Japanese cedar has white zone, in which water movement stops, near the sapwood area. We injected acid fuchsin into a stem, and determined colored area as sapwood. The length of TDM sensor was 20 mm, and sap flux density, which is mean value along the sensor length, was computed by the calibration equation by Granier (1985). The width of sapwood was 44 mm, and additional TDM sensor was inserted into the sapwood at the depths from 20 to 40 mm. On the other hand, the length of HRM sensor was 35 mm, and the sap flow movement was detected at the depths of 12.5 and 27.5 mm. For HFD, the sensor length was 96 mm, and the depths of sap flow detecting were 20, 30, 40, 50, 60, 70, 80 and 90 mm.

The sap flux densities measured at the depth from 20 to 40 mm with TDM was larger than that at the depth from 0 to 20 mm. Similar trend was found in the outputs of HRM and HFD. The results of measurements by three techniques show that active sap flow movement occurred up to the depth of 40 mm of sapwood. The diurnal variations in sap flow movement measured by three techniques were almost same, suggesting the applicability of these techniques to evaluate the characteristics of sap flow for a Japanese cedar. However, additional measurements including thermal diffusivity of wood are necessary to obtain sap flux density by HRM and HFD (e.g., Vandegehuchte and Steppe, 2013): in current stage, we have only qualitative comparisons among three techniques. Moreover, to compare the sap flux densities measured by TDM, HRM and HFD, we have to make clear the azimuthal changes in sap flux density within the target tree: three sensors inserted into different part of a stem in this study. We will present the results including these topics.

Cited paper
Burgess, 2001. Tree Physiol., 21:589-598.
Granier, 1985. Ann. Sci. For., 42: 193-200. [English translation, in Evaporation, Benchmark Papers in Hydrology 2. Gash JHC, Shuttleworth, WJ (eds). IAHS Press: Oxfordshire; 61-63].
Iida et al., 2013. JARQ, 47: 319-327.
Kumagai et al., 2014. J. Hydrol., 508: 66-76.
Nadezhdina et al., 2012. Trees, 26:1439-1448.
Shimizu et al., 2015. J. Hydrol., 522: 250-264.
Vandegehuchte and Steppe, 2013. Function. Plant Biol., 40: 213-223.

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