Estimation of net primary production(NPP) including belowground production in mangrove forest in Okinawa

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1. Introduction

Forests fix carbon by photosynthesis and store carbon in their biomass. This helps to regulate atmospheric CO_2 concentration and migrate global warming. Mangroves inhabit tropical and subtropical coastlines. Although they are expected to be a large carbon sink, they are disappearing. To protect mangrove forests, accurate quantification of their productivity is necessary. In this study a forest's net primary production(NPP) was estimated as an index of forest's production. When estimating NPP, belowground production is rarely included, because of the difficulty to measure. Mangroves inhabit muddy soil which are periodically inundated by seawater, then they need to allocate much carbon to their roots. Therefore, belowground production is expected to be high and should be included in NPP estimation. Moreover, although fine root biomass does not contribute to the total standing biomass, fine root production contributes largely to NPP. Then it is important to analyze fine root carbon dynamics continuously. In Okinawa, typhoons bring strong wind from July to October every year. Related wind disturbance in local forests may also influence fine root carbon dynamics. The objectives of this study are (1)to estimate the NPP of an Okinawa mangrove forest stand, (2)to calculate the proportion of belowground production in the NPP, and (3)to discuss the influence of environmental factors on belowground carbon dynamics.

2. Method and Material

The study was carried out from July 2014 to October 2016 in a pure *Kandelia obovata* stand in Manko Wetland, Okinawa. To estimate NPP, aboveground and belowground production were assessed separately. Aboveground production was calculated from vegetation census and litterfall data. For estimation of belowground production, roots were separated into thick coarse, thin coarse and fine roots. Thick coarse root production was calculated from vegetation census data. Thin coarse and fine root production were calculated from the data by sequential core method and litter bag method. Then NPP was estimated by combining aboveground and belowground production, and the proportion of belowground production in NPP was evaluated. The influence of environmental factors on fine root carbon dynamics was determined by correlation analysis. Studied environmental factors were average temperature, precipitation, average wind speed, max wind speed and the number of typhoon as an index of typhoon disturbance. Finally, the relationship between fine root carbon dynamics and environmental factors was also analyzed by multivariable analysis.

3. Results and Discussion

The NPP of the stand was 29.8~43.8 $Mg \cdot ha^{-1} \cdot year^{-1}$ and the proportion of belowground in NPP was 36.8~56.5%. This shows that it is important to include belowground production in NPP. Although fine root biomass was only 1.1% of total standing biomass, its production accounted for 16.8~32.1% of NPP. Fine roots play therefore an important role in belowground. Assessing belowground and especially fine root production helps to estimate NPP accurately and to demonstrate high productivity and carbon sink strength of mangroves. Fine root carbon dynamics were not influenced by single environmental factors, but combined effects of multiple factors were observed after time lag. Moreover, root production tended to increase after typhoons, which shows that although not damaged directly by typhoons, belowground parts of a forest might also be influenced by them. For further discussion, however, more long term data needs to be collected.