Scientific Reviews and Chemical Communications
ISSN: 2277-2669

Scientific Reviews & Chemical Communications

Research | Vol 7 Iss 2

Global Patterns in Nutrient Resorption of Mangrove Plants

Lili Wei[1,*], Ming Yang Bee[1,2,3], Tongtong Zhou[1,3,] Changyi Lu[4] and Chaoxiang Liu[1]

[1]Institute of Urban Environment, Chinese Academy of Science, Xiamen 361021, China

[2]School of Marine and Environmental Sciences, University Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia

[3]University of Chinese Academy of Sciences, Beijing 100049, China

[4]Department of Environmental Sciences, University of Helsinki, 15140 Lahti, Finland

[*]**Corresponding author:** Lili Wei, Institute of Urban Environment, Chinese Academy of Science, Xiamen 361021, China, Tel: 86-0592-6190533; Fax: 86-0592-6190533; E-mail: llwei@iue.ac.cn; l.l.wei@hotmail.com

Received: August 23, 2017; **Accepted:** September 08, 2017; **Published:** September 14, 2017

Abstract

Nutrient resorption defined as nutrient resorbing from senescent leaves before abscission is a key nutrient conservation mechanism which developed by plants occurring in nutrient-poor environment. There have been several meta-analyses targeting at nutrient resorption of global plants, but all of these studies excluded mangroves. Here we concerned about mangrove plants and overviewed their nutrient resorption efficiency (percent of leaf nutrient resorbed) at the global scale. Mangrove plants showed wide variation in resorption efficiency of both nitrogen (NRE, ranged at 26% ~ 84%, except extreme values: 3% and 95.36%) and phosphorus (PRE, ranged at 10% ~ 81%). Despite most of NRE were higher than the global mean value, the PRE (averaged 53.26%) was similar to that value. The sites in Florida and Panama were appeared to be P limit, whereas mangroves in China except Hainan Island showed N limitation. We did not find significant correlation between NRE and PRE as shown in many other studies. The ratio of NRE: PRE ranged 0.32 ~ 3.90 with average being 1.30, which was beyond the range (<1) of tropical systems. Our analysis did not support the long-standing view that mangroves had high resorption efficiency. This is probably due to the disturbance by human activities.

Keywords: Nitrogen: phosphorus resorption ratio; Nitrogen: phosphorus resorption relationship; Nutrient conservation

Introduction

Plants living in nutrient-poor environment have developed nutrient conservation mechanisms to minimize nutrient loss. Nutrient resorption defined as nutrient resorbing from senescent leaves before abscission (1–nutrient in senescent leaves/nutrient in green leaves)*100%) is an important strategy of nutrient conservation and mainly caused by nutrient limitation [1]. Nutrient resorption are commonly expressed on both mass and area bases, which could lead to underestimate resorption efficiency by 10% ~ 20% due to the delay of carbon translocation or leaf area shrinkage has not been taken into account [2,3].

Nutrient resorption of global terrestrial perennial plants have been analyzed, but these meta-analyses all excluded mangroves [1,3-5]. Mangrove forests covered 137,760 km^2 in 118 countries in the tropical and subtropical regions of the world. Approximately 75% of world's mangroves are found in just 15 countries [6]. Despite its coverage is much less than

Citation: Wei L, Bee MY, Zhou T, et al. Global Patterns in Nutrient Resorption of Mangrove Plants. Sci Revs Chem Commun. 2017; 7(2):110.

terrestrial ecosystems, mangroves provide important ecological functions and services, such as carbon storage and water purification, which are both closely related to its high nutrient resorption. Therefore here we particularly concerned about the nutrient resorption of mangroves and assembled data from global studies to analyze variations in resorption efficiency and relations to species and site location.

Mangrove species are characterized by high nutrient resorption as the consequence of the adaptation to oligotrophic environment [7]. NRE can be as high as 95.36% of *Rhizophora stylosa* [8] and PRE 81% of *Rhizophora mangle* [9]. However, extreme low resorption efficiency had been found in some mangrove sites as well, such as <5% of NRE [10] and ca. 10% of PRE [11].

Materials and Methods

We conducted searches through Google Scholar with the keywords of nutrient resorption, nitrogen resorption, phosphorus resorption, resorption efficiency, retranslocation, and mangroves or mangrove plants/species. We searched the data also from the references of reviews [7]. We excluded data from fast-growing mangrove species such as Sonneratiaceae, which do not have nutrient conservation mechanisms. Fertilized plants and extreme values after data analysis by SPSS (version 16.0) were also excluded. For literatures shown the data as figures, the values we obtained by roughly estimation. Our final analysis was performed with 128 values encompassed 16 species and 17 sites.

The outliers were found through Explore and then examined normality through Frequency analysis. Normality requires the Skewness and Kurtosis within ± 1.96. In addtion, the mean, std. effor of mean, median, mode, variance, and range including maximum and minimum were obtained. Due to the data did not match the normality requirment and then the following statistic analyses were all using nonparametric tests. To test the difference of NRE and PRE from the global everage values (e.g. ~50%), One-sample t-test was used. Comparison of NRE and PRE was analyzed by Wilcoxon Signed-Rank test. Nonparametric correlation between NRE and PRE was tested by the mehtods of Kendall and Spearman. Using Mann-Whitney compared the diffierences between species and between locations.

Results and Discussion

Mangrove wetlands occur originally in the oligotrophic environment. However, our analysis indicated that almost half of the global mangrove sites supplied phosphorus has matched plant demand, shown by around half PRE values (47%) below the global average value **(FIG. 1)**. This is most likely caused by human activities such as discharge of wastewater from industry, city sewage, agriculture, and aquaculture ponds etc. In contrast, the NRE data indicated nitrogen limitation in most sites (74%) and for seven species **(FIG.1)**. Despite the tightly correlation was found between NRE and PRE in global terrestrial plants [12], it was not the case of mangroves (Spearman correlation efficiency was -0.014, *P*=0.909). Less variation (26% ~ 84%, except extreme values: 3% and 95.36) and slight higher average value (57.20%) in NRE were found compared with PRE (ranged at 10% ~ 81%; average on 53.26%). Unrelated between NRE and PRE is likely the results of the imbalance of supply of N and P and the greater demand for N than for P by most mangrove species [11,13].

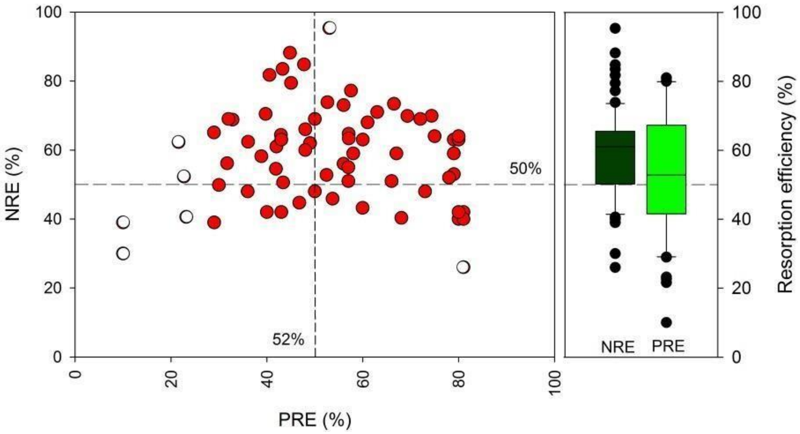

FIG. 1. Nitrogen and phosphorus nutrient resorption efficiency (NRE vs. PRE) of mangroves leaves. The white circle refers to the outliers. The reference lines are the average values of resorption efficiency for global perennials with ~50% for nitrogen and ~52% for phosphorus [1].

Studies on nutrient resorption have been focused on the species of *Rhizophora mangle*, *Avicennia marina* and *Kandelia obovata*. Resorption efficiency varied among species despite the Mann-Whitney results showed non-significance (*P*=0.789 for NRE and 0.493 for PRE). Seven species had greater NRE than PRE, with NRE above whereas PRE below the global average values **(FIG. 2)**, suggesting that these species, *Bruguiera gymnorrhiza*, *Bruguiera sexangula*, *Bruguiera sexangula var. rhynchopetala*, *K. obovata*, *Ceriops tagal*, *Rhizophora stylosa*, and *Aegiceras corniculatum*, were strongly demand for N.

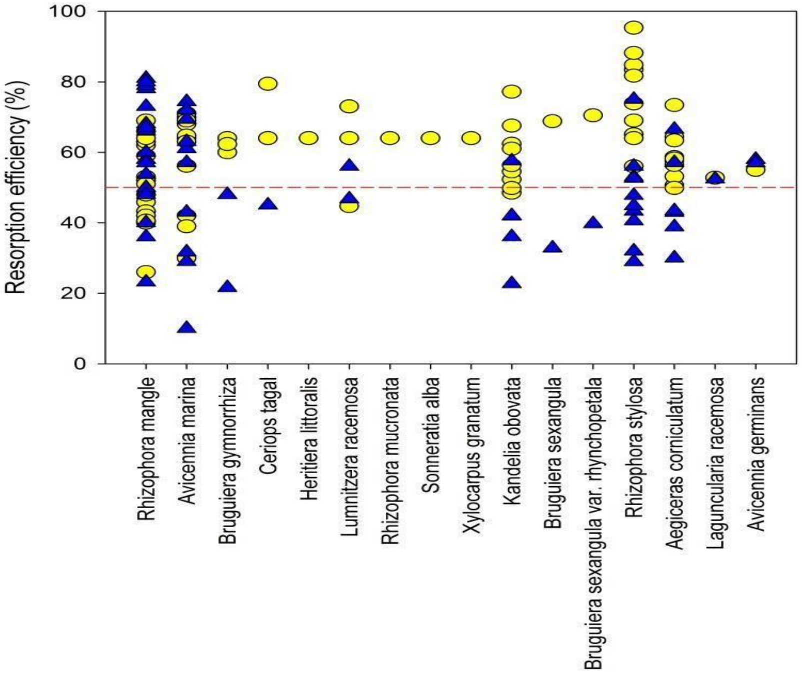

FIG. 2. Variation in NRE (circle) and PRE (triangle) among mangrove species.

Nutrient resorption also varied with locations. Mangroves in Florida (USA) and Panama were appeared to be P limitation, whereas mangroves in China except for one site on Hainan Island showed N limitation **(FIG. 3)**. The relationship between resorption efficiency and nutrient availability is actually complicated despite negative relationship observed by most studies [7]. Besides the controls by nutrient supply, other soil factors and climates can exert combined effects. For example, studies have found that salinity and frost dramatically reduced resorption efficiency through constrained the ability of root nutrient uptake [14,15]. We did not collect the data of soils (due to limited data available) and therefore cannot quantify the interaction of nutrient resorption and soil characteristics.

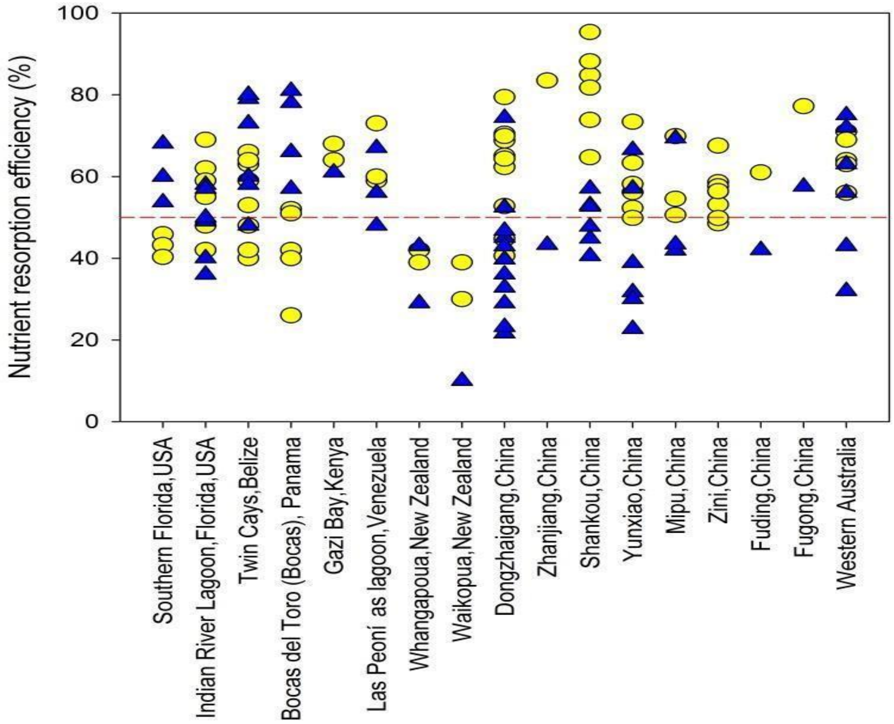

FIG. 3. Variation in NRE (circle) and PRE (triangle) with mangroves location.

In conclusion, mangrove had relatively high nitrogen resorption despite variations shown among species and locations. However phosphorus resorption was higher, similar and lower than the global mean value, which is contrast to long-standing view for mangroves.

Acknowledgements

We thank to National Natural Science Foundation of China (31570400) and Fujian Science & Technology program (2016I0016) for financial support.

REFERENCES

1. R Aerts. Nutrient Resorption from Senescing Leaves of Perennials: Are there General Patterns? J Ecology. 1996;84:597-608.
2. DM Alongi, BF Clough, P Dixon, et al. Nutrient partitioning and storage in arid-zone forests of the mangroves

Rhizophora stylosa and Avicennia marina. Trees. 2002;17:51-60.

3. IC Feller, KL McKee, DF Whigham, et al. Nitrogen vs. phosphorus limitation across an ecotonal gradient in a mangrove forest. Biogeochemistry. 2002;62:145-175.
4. IC Feller, CE Lovelock, KL McKee. Nutrient addition differentially affects ecological processes of Avicennia germinans in nitrogen versus phosphorus limited mangrove ecosystems. Ecosystems. 2007;10:347-359.
5. IC Feller, CE Lovelock, C Piou. Growth and nutrient conservation in Rhizophora mangle in response to fertilization along latitudinal and tidal gradients. Smithsonian Contributions to the Marine Sciences. 2009;38:345-359.
6. C Giri, E Ochieng, LL Tieszen, et al. Status and distribution of mangrove forests of the world using earth observation satellite data. Globe Eco Biogeograph. 2011;20:154-159.
7. KT Killingbeck. Nutrients in senesced leaves: keys to the search for potential resorption and resorption proficiency. Ecology. 1996;77:1716-1727.
8. RK Kobe, CA Lepczyk, M Iyer. Resorption efficiency decreases with increasing green leaf nutrients in a global data set. Ecology. 2005;86:2780-2792.
9. YM Lin, XW Liu, H Zhang, et al. Nutrient conservation strategies of a mangrove species Rhizophora stylosa under nutrient limitation. Plant Soil. 2010;326:469-479.
10. CE Lovelock, MC Ball, B Choat, et al. Linking physiological processes with mangrove forest structure: phosphorus deficiency limits canopy development, hydraulic conductivity and photosynthetic carbon gain in dwarf Rhizophora mangle. Plant Cell Environ. 2007;29:793-802.
11. R Reef, IC Feller, CE Lovelock. Nutrition of mangroves. Tree Physiology. 2012;30:1148-1160.
12. LM Van Heerwaarden, S Toet, R Aerts. Current measures of nutrient resorption efficiency lead to a substantial underestimation of real resorption efficiency: facts and solutions. Oikos. 2003;101:664-669.
13. L Vergutz, S Manzoni, A Porporato, et al. Global resorption efficiencies and concentrations of carbon and nutrients in leaves of terrestrial plants. Eco Monograph. 2012;82:205-220.
14. W Wang, S You, Y Wang, et al. Influence of frost on nutrient resorption during leaf senescence in a mangrove at its latitudinal limit of distribution. Plant Soil. 2011;342:105-115.
15. SC Reed, AR Townsend, EA Davidson, et al. Stoichiometric patterns in foliar nutrient resorption across multiple scales. New Phytologist. 2012;196:173-180.