Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-358
Manuscript under review for journal Biogeosciences
Discussion started: 25 August 2017

Biogeosciences Discussions
Open Access

Comment on "Growth responses of trees and understory plants to nitrogen fertilization in a subtropical forest in China" by Tian et al. (2017)

Taiki Mori[1]

[1]Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto, Japan

Abstract

Negative effects of over-fertilization have been long reported in agricultural field, which is known as fertilizer burn. A recent paper by Tian et al. (2017) reported a result of simulated nitrogen (N) deposition experiment and demonstrated that application of NH_4NO_3 solution significantly reduced small trees, understory saplings, shrubs, seedlings, and ferns, while large trees were not affected by the application. They discussed that the result was due to the reduced light availability and intensified N saturation. I challenge this view, because it is more likely that the negative effects were caused by the monthly application of NH_4NO_3 solution with high concentration (as high as 0.4 *M* and 0.8 *M*). Since experiments using liquid NH_4NO_3 are common, careful interpretations are also required for other experiments.

Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-358
Manuscript under review for journal Biogeosciences
Discussion started: 25 August 2017

Key words: fertilizer burn; nitrogen deposition; nitrogen fertilization; nitrogen saturation

Text

For testing the impacts of elevated nitrogen (N) deposition on ecosystems, including the impacts on forest understory, plenty of manipulating experiments have been performed, some of which applied high concentration of NH_4NO_3 solution as N source. A recently-published paper by Tian et al. (2017) is one of them. They reported a remarkable negative effect of NH_4NO_3 application on small-sized plants including trees, understory saplings, shrubs/seedlings, and ferns, while the effect on large trees was not clear. Tian et al. (2017) attributed the result to the reduced light availability and intensified N saturation.

However, I suspect that the negative impact on understory observed by Tian et al. (2017) was due to the high concentration of the added N solution. Nitrogen is one of the most important nutrients for plants, and often applied as a fertilizer in agricultural practices. However, too much usage of the fertilizer can damage or even kill plants, which has been known as "fertilizer burn." In the case of the Tian et al (2017)'s experiment, it is likely that the high concentration of NH_4NO_3 solution caused foliar fertilizer damage (Neumann *et al.*, 1981), reducing understory vegetation. The NH_4NO_3 solution applied

Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-358
Manuscript under review for journal Biogeosciences
Discussion started: 25 August 2017

by authors were around 0.4 *M* and 0.8 *M* (0.48 and 0.95 kg NH_4NO_3 dissolved in 15L of fresh water) in N50 (50 kg N ha^{-1} yr^{-1}), and N100 (100 kg N ha^{-1} yr^{-1}) sites, respectively (materials and methods 2.1 in their paper). According to Neumann *et al.* (1981)'s experiment, the concentration at which 20 µl droplets of NH_4NO_3 solutions applied to leaf surface began to induce damage was 0.40 *M*. Therefore, it is very natural to assume that monthly application of 0.4 *M* and 0.8 *M* NH_4NO_3 solution can damage forest understory.

Authors tried to explain the decrease in understory vegetation in several parts of the manuscript, but their hypotheses seem less likely compared with the "foliar fertilizer damage" hypothesis. In the discussion section, authors mentioned "*results showed a remarkable negative effect of N fertilization on small-sized plants including trees, understory saplings, shrubs/seedlings, and ferns. During our field investigation, we also found that the average proportion of dead trees (Fig. 2d) tended to increase in N-fertilized plots although the result was not statistically significant (p =0.50). Additionally, the ground-cover ferns in N100 plots almost disappeared after 3.4-year N fertilization (personal observation). Given the high stand density in this mature subtropical forest, we suggest that N fertilization might potentially lead to increased self- and alien thinning of individuals through decreasing understory light availability* (discussion 4.2 in their

Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-358
Manuscript under review for journal Biogeosciences
Discussion started: 25 August 2017

Biogeosciences
Discussions

paper).” However, the data provided by the Tian et al. (2017)’s experiment did not support this idea. The canopy cover did not increase in their experiment (Table 2 in their paper), indicating that the reduced light availability is not likely to explain the reduced understory.

Compared with the suggested mechanism above, another explanation by authors are more plausible. By referring to the stage 3 of Aber *et al.* (1989)’s concept, authors suggested that the decline in understory was due to the intensified N saturation: “*In our experiment, the soil acidification and increased soil N concentration in high-N-fertilized plots combined with the negative responses of understory plants suggest that the 3.4-year N fertilization in this mature subtropical forest site has potentially caused N saturation* (discussion 4.3 in their paper).” However, soil total N content and understory biomass were not correlated (Fig. S1, drawn using data in Tian et al. (2017)’s Supplement), indicating that the elevated N content in their experiment does not necessarily explain the decrease in understory. The direct negative impact of high concentration of NH_4NO_3 solution seems to explain the understory decline more successfully.

In this note, I suggested a possibility of the direct negative impact of NH_4NO_3 application on understory vegetation. This suggestion is important because if this is the case, the negative impact of experimental N application on understory may have been over-estimated in several case studies using liquid NH_4NO_3 application (for example

Rainey *et al.*, 1999; Lu *et al.*, 2010). The prediction of the impact of elevated N deposition on understory may be required to be re-considered.

References

Aber JD, Nadelhoffer KJ, Steudler P, Melillo JM (1989) Nitrogen Saturation in Northern Forest Ecosystems Published by : University of California Press on behalf of the American Institute of Biological Sciences Stable URL : http://www.jstor.org/stable/1311067 . *BioScience*, **39**, 378–386.

Lu X, Mo J, Gilliam FS, Zhou G, Fang Y (2010) Effects of experimental nitrogen additions on plant diversity in an old-growth tropical forest. *Global Change Biology*, **16**, 2688–2700.

Neumann PM, Ehrenreich Y, Golab Z (1981) Foliar Fertilizer Damage to Corn Leaves: Relation to Cuticular Penetration. *Agronomy Journal*, **73**, 979–982.

Rainey S, Nadelhoffer K, Silver W, Downs M (1999) Effects of chronic nitrogen addition on understory species in a red pine plantation. *Ecological Applications*, **9**, 949–957.

Tian D, Li P, Fang W et al. (2017) Growth responses of trees and understory plants to nitrogen fertilization in a subtropical forest in China. 3461–3469.