Impacts of invasive plants on Nitrogen cycling in a montane tropical grassland

Manaswi Raghurama and Mahesh Sankaran

Biodiversity and Ecosystem Ecology Research Lab, National Centre for Biological Sciences (NCBS), Tata Institute of Fundamental Research, Bengaluru, India

E-mail: manaswir@ncbs.res.in

Abstract

N-fixing invasive plants can change ecosystem processes such as Nitrogen (N) cycling. We investigated how N-fixing invasive plant species change nutrient cycling in soils of the montane Nilgiri grasslands of the Western Ghats biodiversity hotspot, India. Invasion increased Total Inorganic Nitrogen (TIN) and Phosphatase Activity (PA). Although invasion did not significantly increase N-mineralization rates (N-MIN), average N-MIN was higher in invaded areas in the dry season. These changes can influence the success of restoration efforts, and should be considered while planning such activities.

Keywords: Invasive plants, Nitrogen cycle, Phosphatase activity, Western Ghats, Tropical Montane Grasslands

1. Introduction

N-fixing invasive plants can increase N-availability and N-MIN in soils, especially where basal N levels are low (Vitousek and Walker, 1989). This could aid further invasion, or create conditions unfavourable for native species – thereby making restoration efforts difficult (Yelenik and D'Antonio, 2013). Further, activity of N-rich phosphatase enzymes could be higher in invaded soils, giving invasives greater access to Phosphorus (P).

The Nilgiri grasslands are being invaded by three N-fixing species: *Acacia mearnsii*, *Cytisus scoparius* and *Ulex europaeus*. We investigated their impact on nutrient cycling in the soils of the Nilgiris.

2. Methods

In South-West Nilgiris (Latitude: 11°16'31"N; Longitude: 76°33'42"E), we selected 5 sites of uninvaded grasslands, and 5 sites of each of the three invasive species (i.e. 4 land cover types). In each site, we had 5 sampling locations.

We monitored TIN and *in-situ* N-MIN (difference between TIN initially and after ~ 2 months of field incubation) in each sampling locations from June 2017 to July 2018. Ammonium and Nitrate+Nitrite (NIT) concentrations was measured in each soil sample. In the same locations, we determined PA in May 2019.

We used linear mixed effect models to test for the effect of invasion on TIN (=Ammonium+NIT), Ammonium, NIT, and PA. We used a generalized least squares regression (allowing different variances for different land covers) to test for the effect of invasion on N-MIN.

3. Results

Invasion increased TIN, Ammonium, NIT and PA in the Nilgiri grasslands (Figures (a), (b), (c), (e)). Sites invaded by *A. mearnsii* had a significantly higher TIN and Ammonium concentration in most months (Figures (a), (b)). However, NIT was higher only in sites invaded by *C. scoparius* and *U. europaeus* in the dry season (Figure (c)).

Although invasion did not significantly change N-MIN (Figure (d)), the average N-MIN was higher in sites invaded by *A. mearnsii* and *C. scoparius* in the dry season. Further, N-immoblization by microbes was higher in invaded areas during the South-West monsoon.

4. Management Implications

The greater N-availability and PA in invaded areas during dry seasons could impart an advantage to invasives by providing them greater access to N and P in the beginning of monsoons (the growing season). These changes could persist even after restoration activities (e.g. clearing invasives). Therefore, restoration activities need to include soil N management strategies (e.g. adding Carbon substrate).

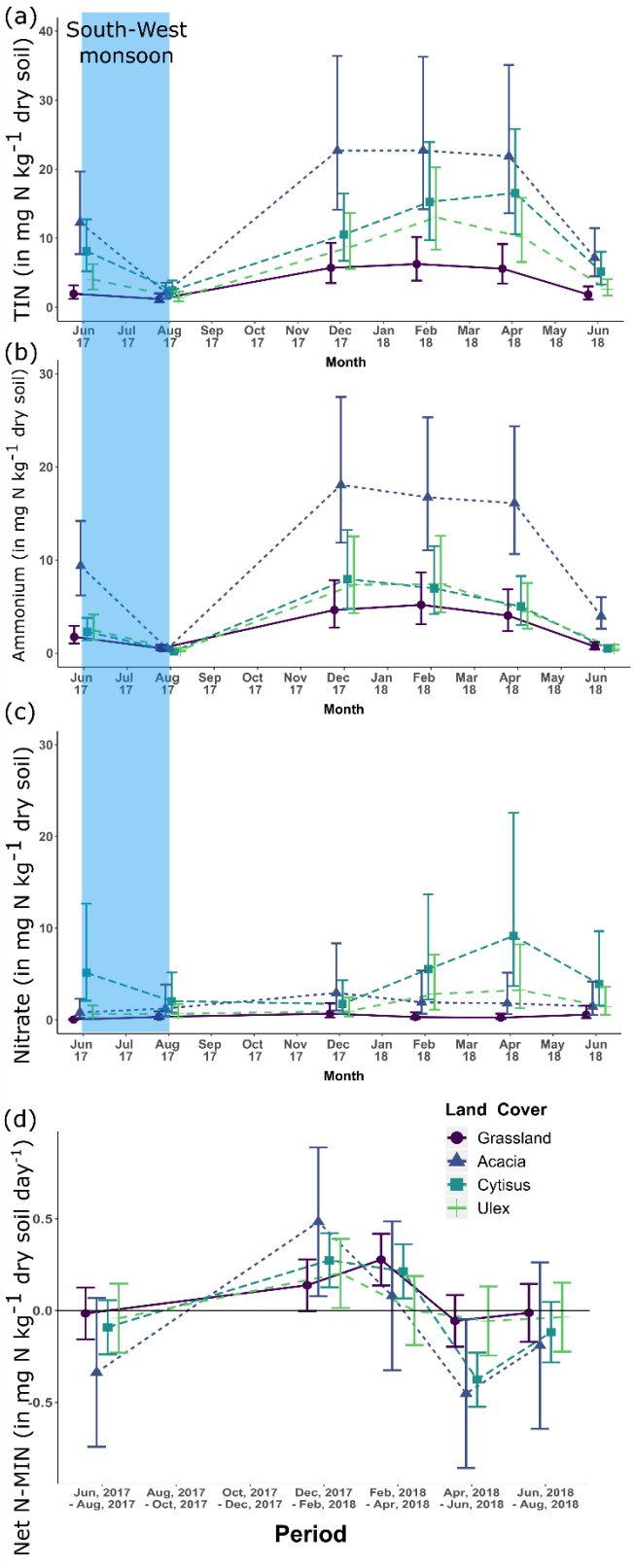
5. Acknowledgements

We thank Selva, Susilan, Kamal, Saravanan and Rasikapriyaa Sriramamurthy for assisting in the field work. NCBS funded this study.

References

Vitousek P M and Walker L R 1989 Biological invasion by *Myrica faya* in Hawai'i: plant demography, nitrogen fixation, ecosystem effects *Ecological monographs* ***59*(3)** pp.247-265.

Yelenik S G and D'Antonio C M 2013 Self-reinforcing impacts of plant invasions change over time *Nature* ***503*(7477)** pp.517.



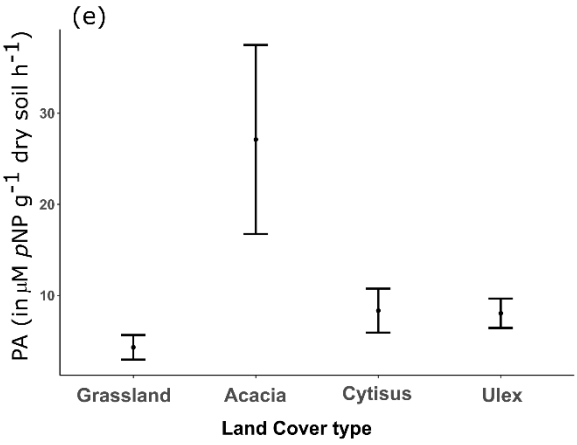


Figure.
(a) TIN concentration over a year in the four land covers.
(b) Ammonium concentration over a year in the four land covers.
(c) NIT concentration over a year in the four land covers.
(d) N-MIN rate over a year in the four land covers.
(e) PA in the four land covers on May 2019.