"Teacomposition" in three global change experiments at HBR

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Why use tea bags as litter bags?

Keuskamp et al (2013) proposed a low-cost method for assessing decomposition rates across sites using nylon teabags as pre-bagged, highly uniform substrate. Pairing the more labile green tea (*Camelia sinensis*) with the more recalcitrant "red" rooibos tea (*Aspalathus linearis*) allows a rapid assessment of both the early, rapid phase of decomposition, as well as the later, asymptotic phase in a single 90-day incubation period. This method allows the comparison of decomposition rates not only across sites and manipulated treatment plots, but also across years.

teacomposition.org

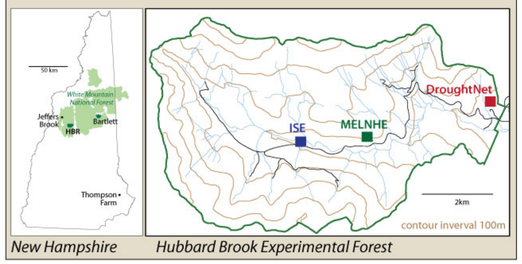
TeaComposition
Global Litter Decomposition Study

The ILTER "Teacomposition" initiative (teacomposition.org) is a global study of decomposition rates that uses the two teabag types as uniform substrates, with collections scheduled over three years. The goal is to assess patterns in the decomposition rates of labile and recalcitrant substrates across global climate gradients. Teabags from a single production batch were mailed to collaborators at 190 institutions worldwide.

A total of 570 study sites reported 3-month decomposition data, which were analyzed with respect to global climate gradients by Djukic et al. (2018). Teabags were also collected at 1- and 2 year time steps, and the final round remains to be collected (summer 2019).

Deployment at HBR

In 2016, we initiated this protocol in three ongoing experiments at HBR: a simulated ice storm (canopy disturbance), a simulated drought (throughfall exclusion), and a N, P, and Ca fertilization experiment. Altogether, we buried 672 teabags at HBR, and more at other sites in New Hampshire that are part of these experiments. Specifically, we also studied fertilized stands at Jeffers Brook and the Bartlett Experimental Forest, both in the White Mountain National Forest, as well as a drought experiment at Thompson Farm near the University of New Hampshire's Durham campus.



New Hampshire *Hubbard Brook Experimental Forest*

Experiments and individual results:

Disturbance

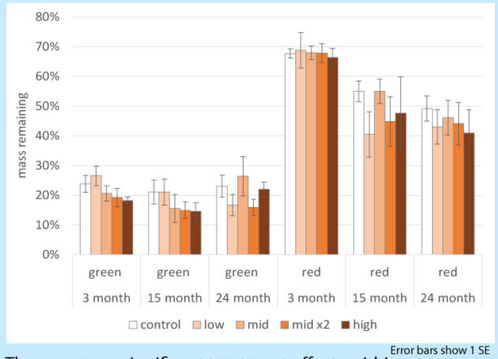
ISE - the Ice Storm Experiment

Joe Klementovitch

Joe Klementovitch

The Ice Storm Experiment is designed to simulate the canopy disturbance effects of a major ice storm in a controlled way in plots with pre-treatment data, something that is not possible in taking advantage of natural icing events. Five ice accumulation treatments (control, low = 6 mm radial accumulation, mid = 12 mm, mid X2, and high = 25 mm) were randomly assigned in two blocks to ten 375 m^2 plots. Treatments were applied in January 2016, and the mid X2 plots were treated again in 2017. Ice was applied to tree canopies using a fire hose on nights with temperatures averaging -25ºC (Rustad and Campbell, 2012).

The canopy was substantially damaged and LAI reduced, with the greatest damage seen in the high-ice plots, followed by the mid X2 plots. We deployed 4 tea bags of each tea type per treatment per collection date in July 2016.



Error bars show 1 SE

There were no significant treatment effects within a tea type within a time step detected by ANOVA. However, we did see an apparent pattern of greater green tea decomposition in the more disturbed plots at 15 months, (Spearman p= 0.02) and similar though non-significant patterns at other time steps.

Nutrients

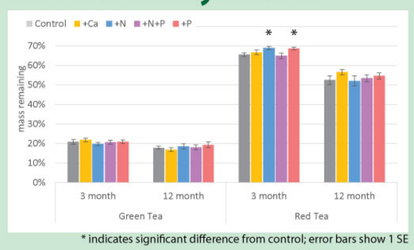
MELNHE - Multiple Element Limitation in Northern Hardwood Ecosystems

Amos Lim

Matt Vadeboncoeur

MELNHE is a factorial NxP fertilization experiment, replicated across 13 hardwood stands of various age classes in the White Mountain National Forest. Nitrogen is applied at 30 kg/ha/yr as ammonium nitrate, and phosphorus at 10 kg/ha/yr since 2011. Eight stands also have plots where calcium was added once at a rate of 1150 kg/ha as calcium silicate, to replicate the 1999 experiment at HBR (Battles et al., 2014; Green et al., 2013). We selected six stands for the Teacomposition experiment, one of each age class (mid and mature) at HBR, in addition to the same age classes at Bartlett Experimental Forest and our Jeffers Brook site, 35 and 9 km from HBR respectively.

In August 2016, we deployed 4 teabags per tea type per collection date per treatment plot (control, +N, +P, +N+P, and +Ca). We have previously detected treatment effects on microbial dynamics and C mineralization (Fisk et al., 2015, 2014; Ratliff and Fisk, 2016), and aboveground production (Goswami et al., 2018) in this experiment. More information can be found at www.esf.edu/melnhe



* indicates significant difference from control; error bars show 1 SE

At 3 months, we observed that both N and P fertilization (alone) significantly slowed the decomposition of rooibos tea, though there was no effect when added together. There were no siginificant effects on the decomposition of green tea or of either tea at 12 months. Note that the 24-month MELNHE samples are still being processed, so the data are not shown here.

Drought

DroughtNet

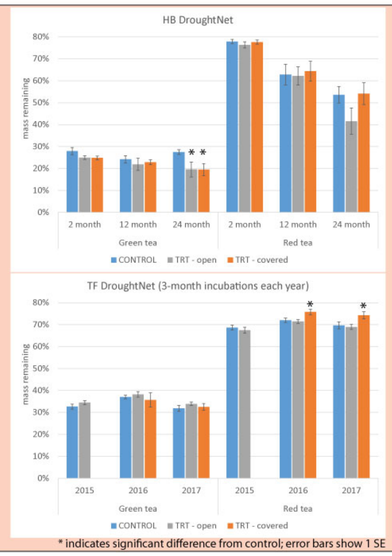
John Chappell

Rebecca Sanders-DeMott

We have two New Hampshire sites participating in the International Drought Experiment coordinated by the DroughtNet RCN: drought-net.colostate.edu (Asbjornsen et al. 2018).

Hubbard Brook: This experiment excludes 50% of throughfall in two 225 m^2 plots to simulate a 1-in-100-year drought, assuming average ambient precipitation. Treatments started in May 2015, and tea bags were buried at 5 cm depth (in the Oa horizon) in July 2016. Because the throughfall exclusion structure creates wet and dry microsites (alternately under 38-cm wide troughs and gaps), we stratified the teabags across these two positions in the treatment plots. We deployed 8 teabags per tea type per collection date per treatment (control, open microsites in treatment plots, and covered microsites).

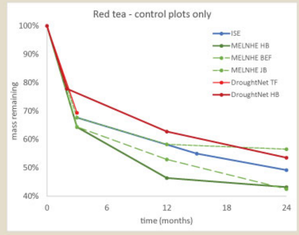
Thompson Farm: A similar experiment with two 900 m^2 plots was established in oak-pine forest at Thompson Farm (112 km from HBR) in May 2016. This site is not a participant in the Teacomposition Initiative, but we implemented the Keuskamp protocol (90 day incubations) each year of the study, including our pre-treatment year (2015). Troughs and gaps average 52 cm wide, and throughfall is only excluded from mid-May through November. On June 1 each year, we deploy 12 teabags per tea type per treatment each year at 8 cm depth (A horizon), stratified by microsite as at HBR.

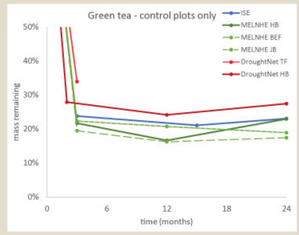


* indicates significant difference from control; error bars show 1 SE

Site-level differences

We observed persistent (though generally non-significant) decomposition curve differences across sites. For example, control plots in HB DroughtNet showed the least amount of decomposition in both tea types, while control plots in the MELNHE stands generally showed the greatest degree of decomposition. These differences may be due to soil chemical (pH, %OM, C/N) and physical (temperature and moisture) differences, which we are currently exploring further.





Methodological Lessons

- Our results so far suggest that the method is most sensitive in short incubations.
- Over time, there was an increasing rate of teabag failure (broken bags, string detachment from anchor flags or lines), as well as greater infiltration of fine roots and proliferation of fungal mats in the bags. These effects reduce the ability to detect treatment effects.
- Knowing the weight of each component (string, tag, bag) allows for correction in bags not recovered fully intact (e.g. with a broken string).
- Teabags are inexpensive, so it's ideal to start with a large number, recoginzing that not all will be recovered.
- It is important to position the bags systematically, as any labeling may no longer be readable at collection, and to minimize soil disturbance at the time of collection.

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