Teacomposition” in three global change experiments at HBR

Matthew A. Vadeboncoeur1,4, Katie A. Jennings1, Madison Morley2, Lindsey E. Rustad3, Cameron D. McIntire4, Laurel M. Brigham5, Ruth D. Yanai2, and Heidi Asbjornsen1

1. University of New Hampshire
2. State University of New York College of Environmental Science and Forestry
3. US Forest Service Northern Research Station
4. University of New Mexico
5. University of Colorado

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 substrates. Pairing the more labile green tea (Camellia sinensis) with the more recalcitrant “red” rooibos tea (Aspalathus linearis) allows a rapid assessment of both the early and later phases 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.

Experiments and individual results:

ISE - the Ice Storm Experiment

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 varying advent of natural ice 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 m2 plots. Treatments were applied in January 2016, and the mid X2 plots were treated again in 2017. Ice was applied five times per week on a continuous basis with temperatures averaging at -25°C (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 type per treatment per collection date in July 2016.

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.

MELNHE - Multiple Element Limitation in Northern Hardwood Ecosystems

MELNHE is a factorial N, P, and Ba fertilization experiment, replicated across 13 hardwood stands of various age classes in the northern hardwood forest. Nitrogen is applied at 30 kg/ha/year as ammonium nitrate, and phosphorus at 10 kg/ha/year since 2011. Eight stands also have plots where calcium was added once at a rate of 1150 kg/ha as calcium carbonate, to replicate the 1999 experiment at HBR (Battelle et al., 2014; Green et al., 2013). We treated six stands for the Tea-composition experiment, one of each age class (mid and mature) at HBR, in addition to the same age classes at the Experimental Forest in Maine.

In August 2016, we deployed 4 tea bags per type per collection date in treatment plots (control, +N, +P, +N +P, and +Ca). We have previously detected treatment effects on microbial dynamics and C mineralization (Fisk et al., 2015; 2017; Battelle and Fisk, 2016), and belowground production (Grewe et al., 2018) in this experiment. More information can be found at www.esf.edu/melnhe

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 significant 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.

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.
• Knocking the weight of each component (string, tag, bag) allows for correction in bags not recovered fully intact (e.g. with a broken string).
• Tea bags are expensive, so it’s ideal to start with a large number, recognizing that not all will be recovered.

It is important to note the bags systematically; any labeling may no longer be readable at collection, and to minimize soil disturbance at the time of collection.

References


Acknowledgements

The Tea-composition initiative is funded by NSF, OOST, and the Russian Environmental Agency, and was also made possible by kind in-kind support from Unilever North America and NFI.

MELNHE was funded by NSF Ecosec, and continues funding from CERF. DroughtNet was funded by USDA-NRI/EPSG: 2014-67013, the USDA Competitive Grants Program, and the USDA Forest Service.

The DroughtNet project is led by the Agricultural Experiment Station.

I am grateful for field funding from the LIHE Network Communications Office. We thank Emily Bond, Taylor Lindsey Bennington, Brendan Londrinn, and Gabriel Walk for assistance in the field and lab.

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. Additionally, we buried 627 tea bags 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.

DroughtNet

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 m2 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 Da horizon) in July 2016. Because the throughfall exclusion structure creates wet and dry microsites (alternately among 19 cm wide troughs and gaps), we stratified the teabags across these two positions in the treatment plots. We deployed 8 teabags per type per collection date per treatment (control, open microsites in treatment plots, and covered microsites).

Thompson Farm: A similar experiment with two 900 m2 plots was established in oak-pine forest at Thompson Farm (1 km from HBR) in May 2016. This site is not a participant in the Tea-composition Initiative, but we implemented the Reuskekamp protocol (60 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.