Overachieve and Retain the Leaves: Nutrients Affect Fall Leaf Retention in Northern Hardwood Species

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Introduction

Autumn leaf abscission in hardwood trees signals the end of the growing season. Trees risk the opportunity to resorbed nutrients if they retain leaves for too long and are damaged by frost.

Nitrogen (N) deposition has increased N availability in northern hardwood forests[1], making phosphorus (P) limitation more likely[2].

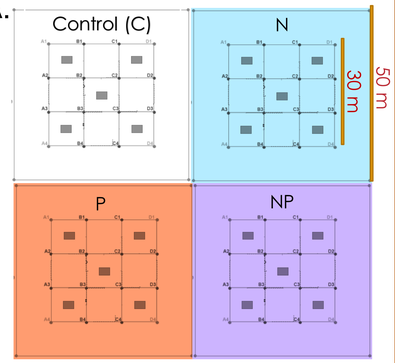
We recently investigated the effects of N and P additions on leaf abscission at a community-level and found that P and N fertilizations delay leaf abscission in hardwood forests.

Objectives

- Is autumn leaf abscission delayed with N and/or P additions in hardwood trees?
- Does autumn leaf abscission of different tree species respond to different nutrients?

Field Methods

- We worked in four Multiple Element Limitation in Hardwood Ecosystems (MELNHE) experiment stands in the Bartlett Experimental Forest in NH, USA.
- Stands contain four plots: an unfertilized control, a nitrogen (NH_4NO_3 at 30kg/h/yr), a phosphorus (NaH_2PO_4 at 10kg/h/yr), and a NP plot

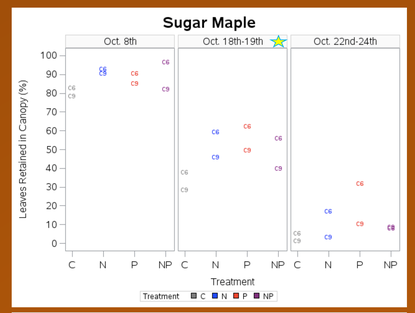


- After six years of fertilization, throughout fall of 2016 and spring 2017, leaf litter was collected four or five times from five systematically placed traps (0.23 m^2) in each plot.

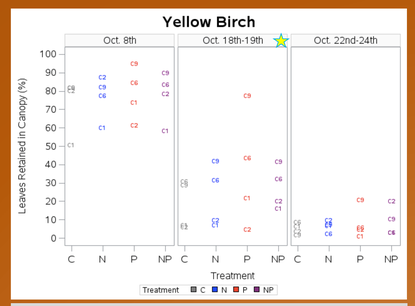
Stand Descriptions

Stand	Age (Cut date)		Species
C1	Young	(1990)	American beech, yellow birch, red maple, white birch, pin cherry
C2	Young	(1988)	American beech, yellow birch, red maple, white birch, pin cherry
C6	Mid-age	(1975)	American beech, yellow birch, red maple, white birch, sugar maple
C9	Mature	(~1890)	American beech, yellow birch, sugar maple

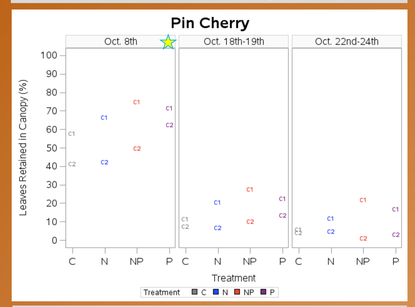
Results



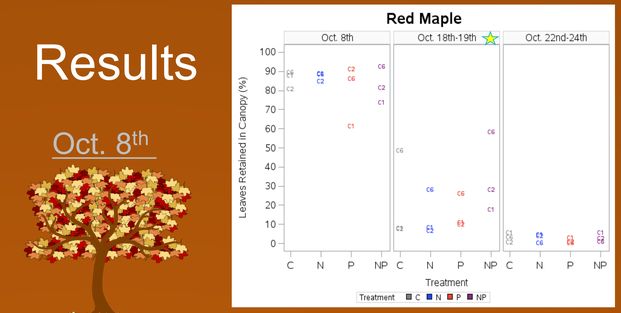
On Oct. 18th and 19th, there was a N*P interaction. NP fertilization increased leaf retention by 47% compared to unfertilized trees (n = 8, $p < 0.01$). Trees fertilized with N alone increased leaf retention by 59% (n = 8, $p = 0.03$). P fertilization alone increased leaf retention by 69% (n = 8, $p = 0.01$).



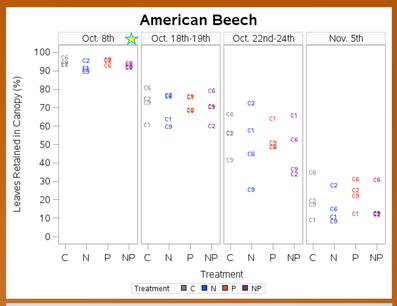
On Oct. 18th and 19th, yellow birch trees fertilized with P retained 15% more leaves than trees not fertilized with P (n = 16, $p = 0.05$).



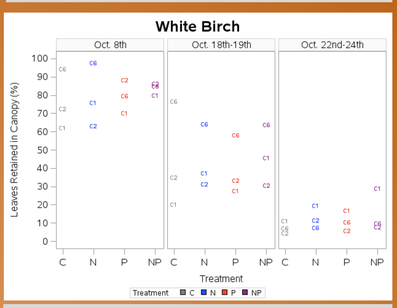
On Oct. 8th, pin cherry treated with P retained 26% more leaves than trees without P (n = 8, $p = 0.05$).



On Oct. 18th and 19th, there was a significant N*P interaction. Plots fertilized with both N and P retained 15% more leaves than trees in plots fertilized with N and P alone (n = 12, $p = 0.02$). N additions did not significantly change leaf retention. P fertilized trees did not change leaf retention.



On Oct. 8th, American beech trees treated with N dropped 49% more leaves than trees not treated with N (n = 16, $p = 0.02$).



There was no significant treatment effect observed for white birch (n = 12, $p > 0.1$).

Lab Methods and Analysis

- Leaf litter was sorted by species and oven dried (60ºC).
- A species was analyzed in a stand if its litter's mass was greater than 1% (minimum 3g) of each plot's total mass.

- The mass of litter falling at each collection date was divided by the total mass of the basket to describe the litterfall as a percentage of the total.
- We tested N and P fertilization effects on the percentage of fallen leaves for each species at each collection date with a factorial design randomized complete block analysis of variance in SAS Studio 3.71.

Discussion

Autumn leaf retention response to treatments differs by species. N fertilization promoted early leaf abscission in American beech trees which may be due to more N in leaves which lead to increased photosynthetic activity which shortens the 'payback period' of the leaf[3].

P fertilization increased leaf retention in multiple species. MELNHE stands have been found to be limited by P[4]. An increased P availability may lead to a reduced need for reabsorption of foliar nutrients before frost damage, so trees maintain their leaves and increase the duration of the growing season.

Conclusion

N deposition may have shifted the limiting nutrient to P. When limiting nutrients are added, trees retain their leaves longer in autumn which may promote more carbon sequestration.

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