How do nitrogen and phosphorus affect the density of sugar maple and American beech germinants?

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Introduction

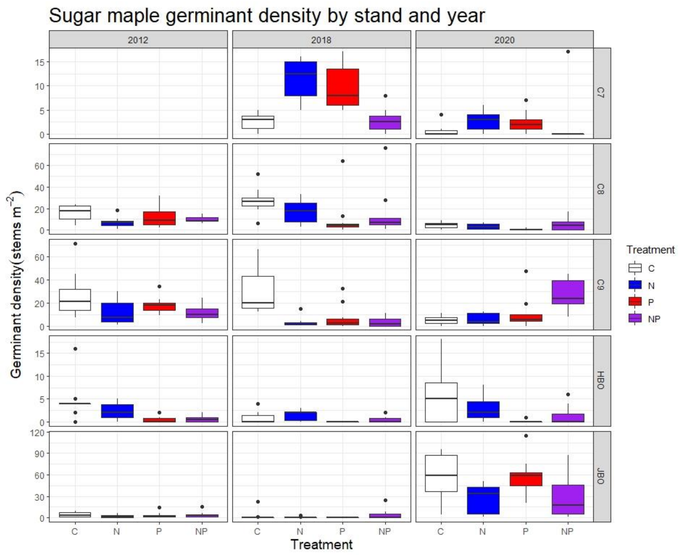
The composition of forest communities depends upon the germination, recruitment, and survival of seeds, a sequence of processes whose ecological controls have been shown to be complex and obscure. Nutrient availability has been shown to influence germinant and seedling success beginning with seed development and continuing through the critical first few years of the plant's life (Cleavett et al., 2011; Goswami et al., 2020). However, the extent to which nitrogen (N) and phosphorus (P) control the population density of germinants shortly into the growing season has not been explored. Studying germinants at this particular moment in their development will help to inform the outcomes of long-term survival studies and will provide a snapshot of germinants at the crossroads of multiple interrelated processes and properties that affect their survival.

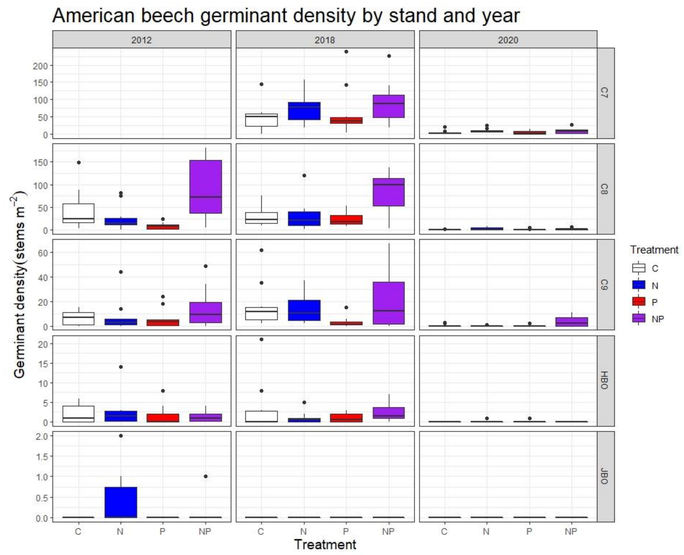
Objective

- To measure whether N and P additions affected the population densities of two cohorts of sugar maple *(Acer saccharum)* and American beech (*Fagus grandifolia* Ehrh.) germinants following mast years for both species.

Methods

- 5 mature forest stands (C7, C8, C9, HBO, and JBO) distributed across 3 sites in the White Mountains of New Hampshire were used in this study.
- Within each stand were four 50m x 50m plots, each of which was randomly assigned one of four nutrient treatments: N addition (30 kg N ha^{-1} yr^{-1} in the form of NH_4NO_3), P addition (10 kg P ha^{-1} yr^{-1} in the form of NaH_2PO_4), N plus P addition (NP), or neither.
- In each treatment plot, ten 1m x 1m germinant subplots were systematically arranged within the innermost 20m x 20m of the treatment area to monitor germinant appearance.
- Newly germinated sugar maple and beech germinants were counted within the germinant subplots during the summers of 2012, 2018, and 2020 to calculate the population density, or the spatial density of germinants of each species at the beginning of the growing season.





Sugar Maple

- N addition **reduces** germinant density by a magnitude of between 1 to 11 stems m^{-2} (95% CI).
- The interaction effect of stand and year appears to be noteworthy in certain circumstances given the high germinant densities observed in JBO in 2020.

American Beech

- No N or P effects were detected
- 2020 was not a mast year for beech

Conclusions

- Effects of N and P additions are species-specific. N addition reduces sugar maple density but has no effect on American beech.
- Mast years are not completely synchronous across these two species. While 2020 was an abundant mast year for sugar maple, it was a less productive year for American beech.
- Mast years—particularly for sugar maple—are not synchronous across the White Mountains of New Hampshire. Note the relationships between the JBO sugar maple cohorts and those of the other four stands. While the 2012 and 2018 cohorts in JBO were small relative to those of other stands, the 2020 cohort in JBO was a bumper crop. Perhaps the noteworthy behavior of the JBO stand is related to the amphibolite-rich parent material on which it sits, which is relatively abundant in base cations when compared to the granite and mica schist underlying the other stands.

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References

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