Arrangement of litter types can influence mass and N dynamics in litter-mix experiments

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INTRODUCTION

Recent studies show that decomposition in mixtures of multiple litter types can differ from predictions based on components species decaying alone[1]. One aspect of litter mixing that has not been emphasized is the predictable, physical layering of leaves of different types in natural litter mixes. This physical distribution, driven e.g. by topography or species-specific timing of leaf release, could influence mass and nutrient dynamics during leaf decay via moisture and temperature distributions in litter layers. We examine decomposition in northeastern forests, where sugar maple is naturally layered beneath red oak.

QUESTIONS

1) Does mixing sugar maple and red oak leaf types influence mass and N dynamics during decomposition?

2) Does the vertical distribution of leaves influence mass and N dynamics?

3) Can the arrangement of litter types influence our evaluations of litter-mix experiments?

MATERIALS AND METHODS

Freshly senesced sugar maple and red oak leaf litter was gathered from the forest floor of 4 secondary forests in northwestern Connecticut in October and November 2000. Litter was sewn into compartmentalized litterbags (1 mm mesh) and deployed December 2000 in a cross-site block design. Litterbags contained 1.5 grams (dry wt) of:

Oak in both upper and lower compartments

OR

Maple in upper and lower compartments

OR

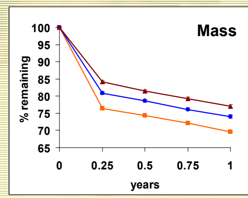
Oak in upper, maple in lower compartment

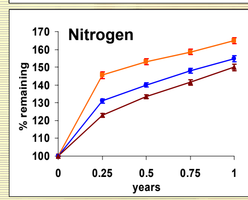
Compartmentalized litterbag

Litterbags at Lower Canaan

RESULTS

1. Single- and mixed-species litter decay



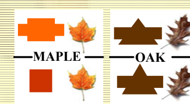


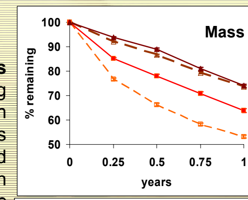
Across **all litterbags** decaying at all sites, maple litter lost more mass and gained more N than oak litter. Mass and N for the mix was intermediate (Fig. 1).

FIGURE 1

2. Influence of litter arrangement

In **all single-species litterbags** , decaying at all sites, litter in upper compartments lost more mass and gained more N than litter of the *same* species in the lower compartment (Fig. 2).





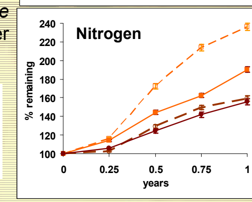


FIGURE 2

3A. Predicting mixed litter dynamics

To know if decay was influenced by mixing, observed dynamics are compared to predicted amounts calculated as:

Using entire-bag dynamics

For each block we calculate predicted mass and N for the mixture using **observations of entire single-species bags**:

Predicted fraction of mass for the mix at harvest (FM_{Xp})

$$FM_{Xp} = \frac{(m_{AXo})*FM_{At} + (m_{QXo})*FM_{Qt}}{m_{AXo} + m_{QXo}}$$

where

m_{AXo} and m_{QXo} = initial maple and oak mass in mix, respectively

FM_{At} and FM_{Qt} = fraction of maple or oak mass remaining in single-species bags$_{AND}$ respectively (upper+lower compartments)

Predicted fraction of N for mix at harvest (FN_{Xp})

$$FN_{Xp} = \frac{(m_{AXo}*FM_{At})*FN_{At} + (m_{QXo}*FM_{Qt})*FN_{Qt}}{(m_{AXo})*FM_{At} + (m_{QXo})*FM_{Qt}}$$

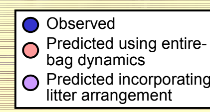
where

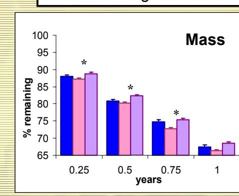
FN_{At} and FN_{Qt} = total N fraction in maple and oak single-species bags, respectively (upper+lower compartments)

Incorporating litter arrangement

If entire-bag values for FM_{At}, FM_{Qt}, FN_{At} and FN_{Qt} in the above equations are replaced with **observed single-species dynamics from only the lower compartment of maple bags and only the upper compartment of oak bags** (reflecting arrangement in mixed litterbags), conclusions about influences of mixing can significantly differ (Fig. 3).

3B. Observed vs. predicted mixture dynamics





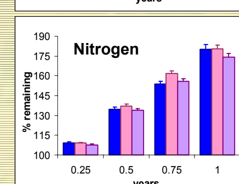


FIGURE 3 * indicates significant differences between the two predictions

Across **all litterbags**, mass and N predictions differed using the two methods of calculation. Observed mass tended to be greater and N less than predicted when entire-bag single-species information was used, while opposite trends were seen if litter arrangement was added into the analysis (Fig. 3). Similar trends are evident when individual sites are analyzed separately (data not shown).

SUMMARY

1) Mass loss and N retention in sugar maple and red oak litter mixtures are intermediate but not always an average of the responses of the two litter types decaying separately

2) Both maple and oak litter types are sensitive to arrangement, with litter in upper layers decaying more slowly within each species

3) As a result, decomposition of mixed litters is sensitive to the physical litter arrangement; predictions vary when position is considered

CONCLUSIONS

Considering leaf arrangement may improve predictions of mixed-litter decomposition dynamics in naturally stratified systems. Since leaf arrangement will differ among sites, arrangement of litter in experimental litterbags or microcosms should be carefully considered to best match the natural conditions.

View of Cobble Hill

ACKNOWLEDGEMENTS

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WORK CITED

[1] reviewed by Gartner TB and ZG Cardon 2004. Decomposition in mixed-species litter decomposition. Oikos 104: 230-246.