



Diversity, functional traits, and ecosystem processes: Cause or coincidence?

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Abstract

We conducted a field experiment where diversity was indirectly manipulated by altering the number of initially planted species (6-30 species). We followed the communities for four years, allowing both species gain and loss to occur. Within the diversity treatments, we nested nitrogen addition and fungicide (to suppress mycorrhizal fungi). We collected biomass two weeks after a spring burn, and again in August. Above-ground Net Primary Productivity was determined from dry biomass as $g\ m^{-2}\ d^{-1}$, and as $g\ g^{-1}\ d^{-1}$. Nested ANOVA showed that diversity manipulations increased species richness and fungicide reduced MF colonization of plant roots by about 40%. The diversity manipulations significantly increased ANPP. Fungal suppression reduced ANPP; the reductions were slightly larger if Nitrogen was also added. The diversity manipulations and chemical treatments may have indirectly affected ANPP via community composition. ANPP was correlated with plant richness ($r = .53$), mycorrhizal fungal richness ($r = .37$), prokaryotic diversity ($r = -.18$). ANPP was correlated with community functional parameters (mean leaf DMC $r = -.44$, height = $.56$) and simple measures of functional diversity (ranges of height $r = .46$, SLA $r = .33$). These relationships may be causal or coincidental due to shared common causes.

Introduction

For many years biodiversity has been thought to be an essential part of a healthy ecosystem. This idea has been backed up by many controlled experiments using plant biomass production as an indicator of productivity. In these experiments as diversity increases primary production also increases. Other uncontrolled field studies show that biodiversity and biomass production covary because they are affected by the same environmental drivers. The disparities between the controlled experiments and the field studies have yet to be reconciled. This leads to confusion over whether biodiversity really does affect the productivity of an ecosystem.

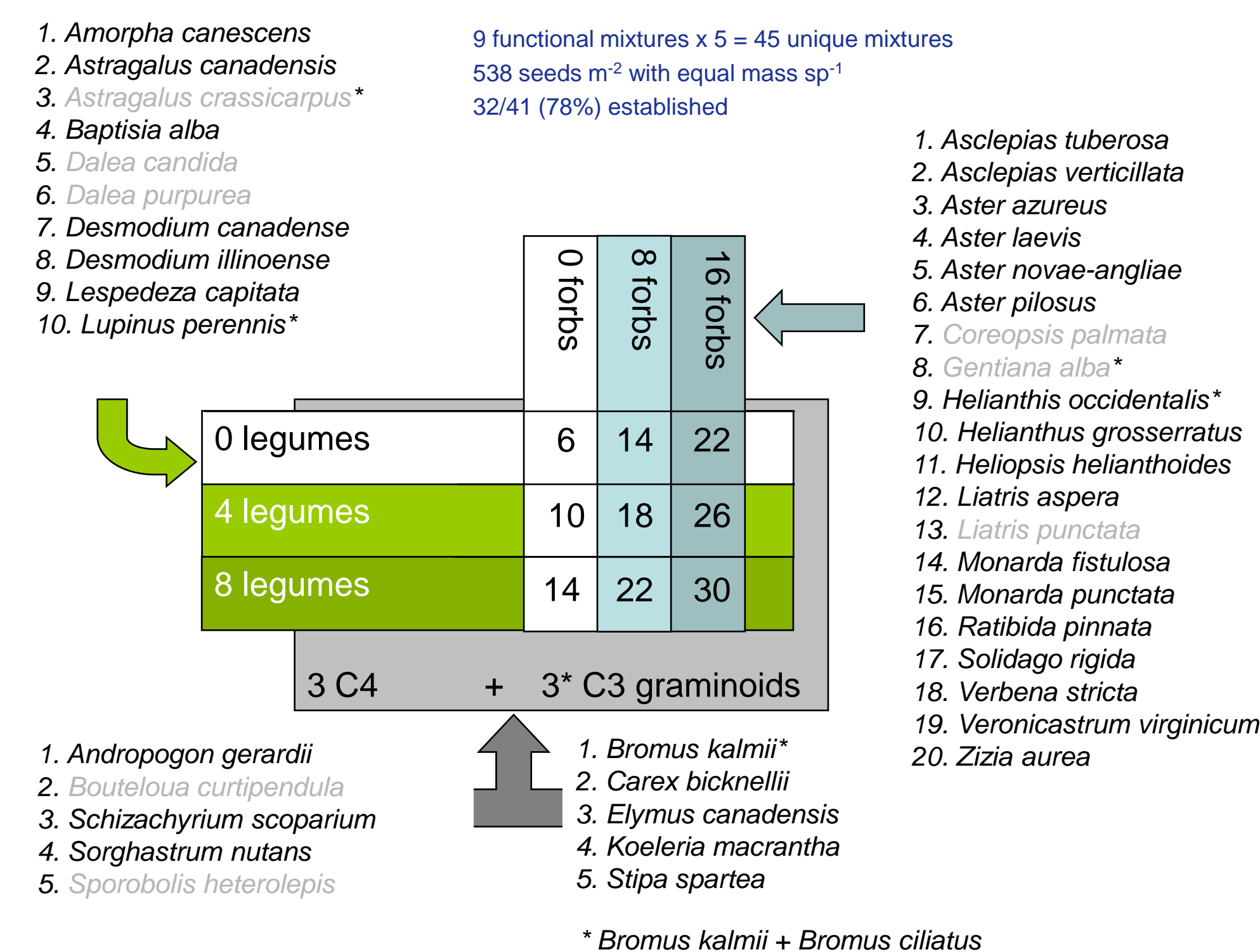
In the past it has been found that when nitrogen is added to a system the diversity decreases. However, productivity also increases because nitrogen increases the growth of all plants.

It has been found that suppression of mycorrhizal fungi (MF) can lead to more diversity because of the suppression of C4 grasses, which are often highly dependent on MF (Hartnett and Wilson, 2002).

In this experiment we looked at how varied planting mixtures, nitrogen availability, and fungal suppression affected productivity and diversity.

Experimental Design

The experiment was conducted on a 6 ha former hayfield which we divided into 45 0.1 ha plots. Prior to planting in 2003, glyphosate herbicide was used to kill or suppress the existing vegetation. In November, 2003, each plot received 1 of 45 unique planting mixtures determined by factorially adding either 0, 8, or 16 forbs and 0, 4, or 8 legumes to 6 grasses from a species pool:



Species were chosen based on their known and historical distribution in western Wisconsin and their availability. The species pool included a range of tolerances for wet and dry soils and affinities for wet-mesic to dry-mesic prairies, and a range of functional traits (e.g. height).

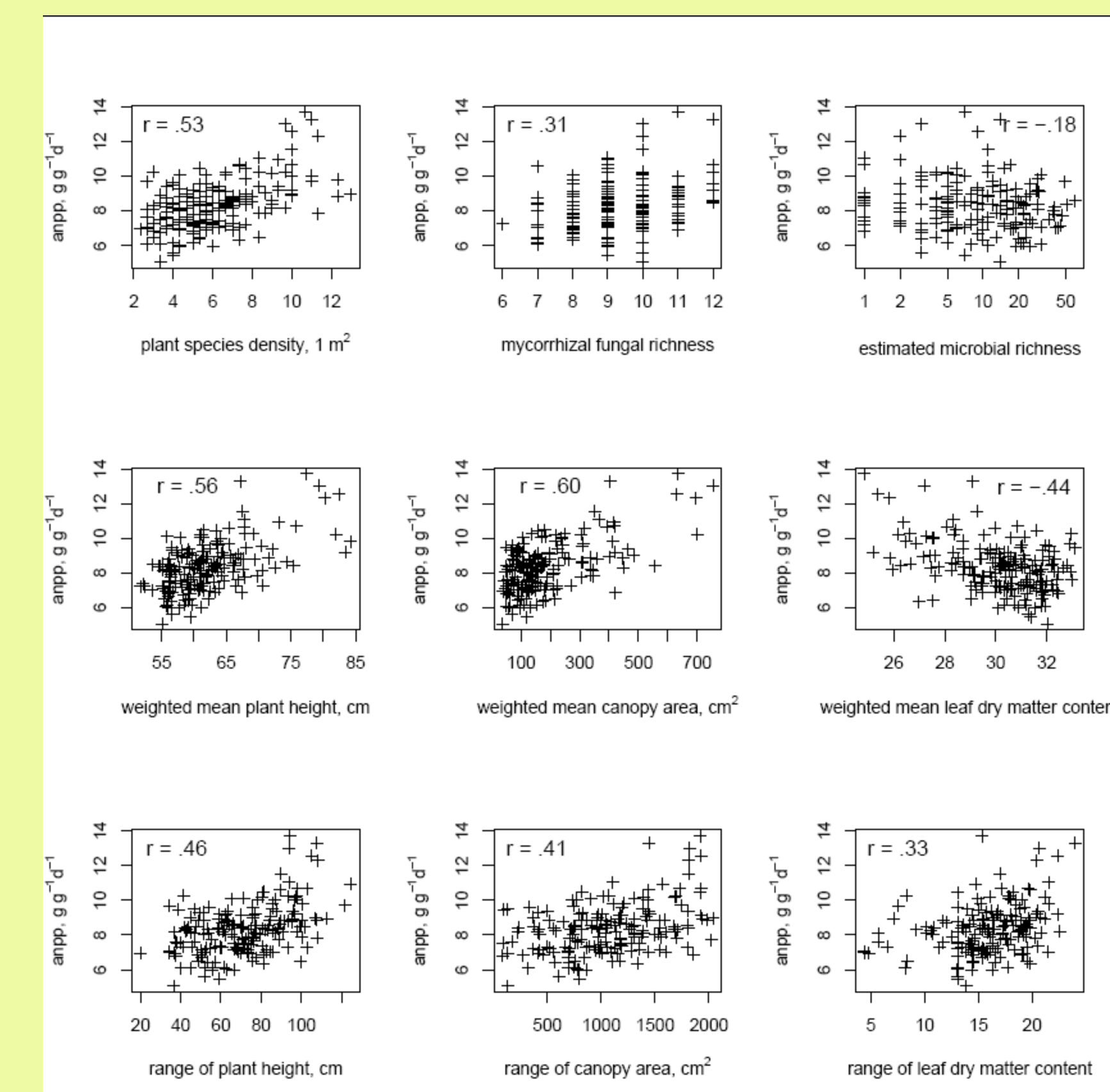
The plots were then divided into four nested subplots, which had a factorial combination of fungicide treatments (which reduced plant root colonization by mycorrhizal fungi by about 44%) and nitrogen fertilizer (ammonium nitrate) treatments.

In the third year of growth (2006), cover data was collected from three 1 m² quadrats located at random points in each subplot. These data were used to determine the functional composition of the subplot. Species richness, nativity (percent native), and conservatism of native species were based on censusing each 246 m² subplot.

In the spring of 2007 the field was burned. After the burn, at the end of April, biomass samples were taken. Biomass samples were again taken in mid-August.

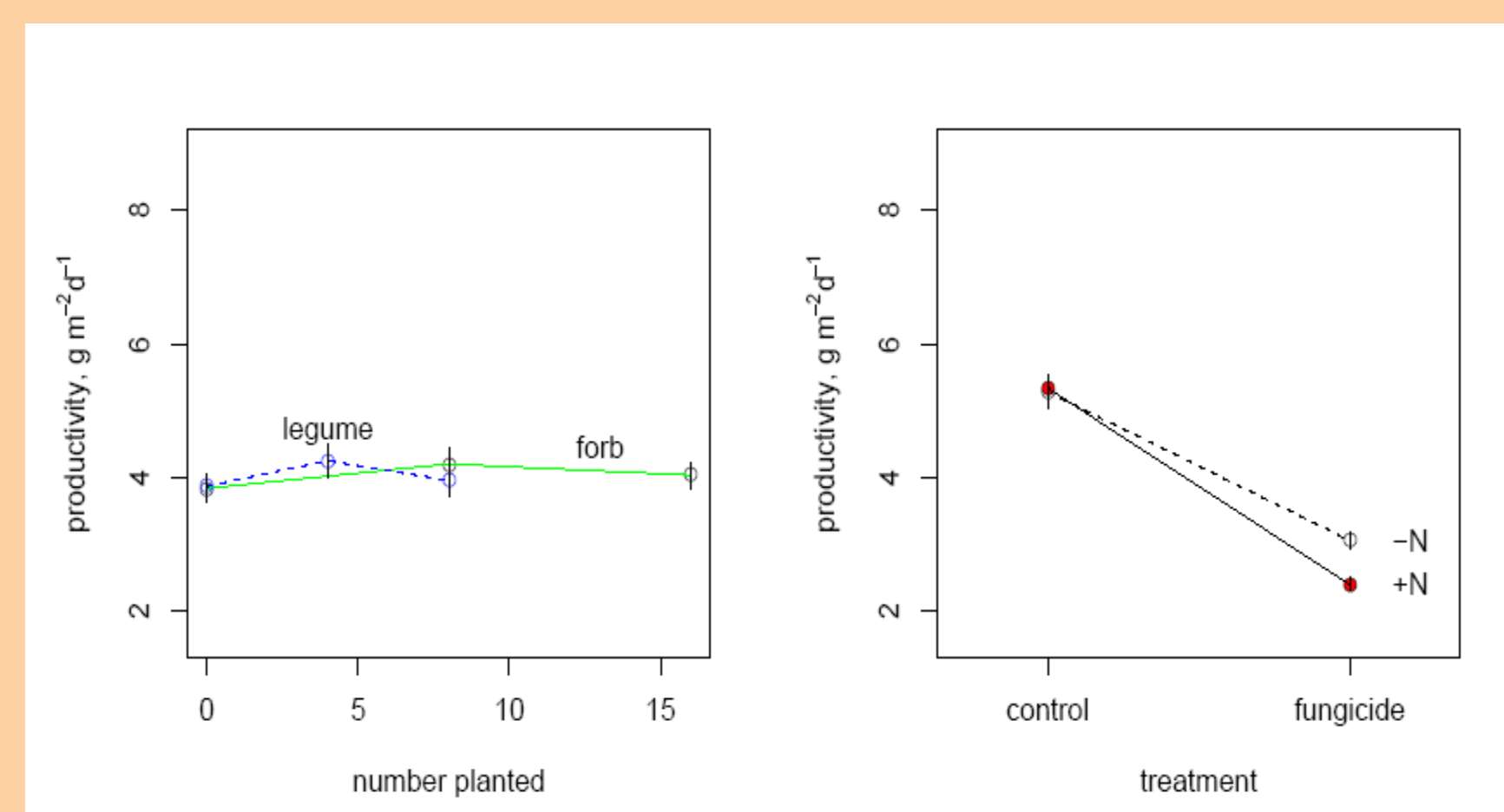
We used nested ANOVA in R for statistical analyses.

How is Annual Net Primary Production related to diversity and functional traits?

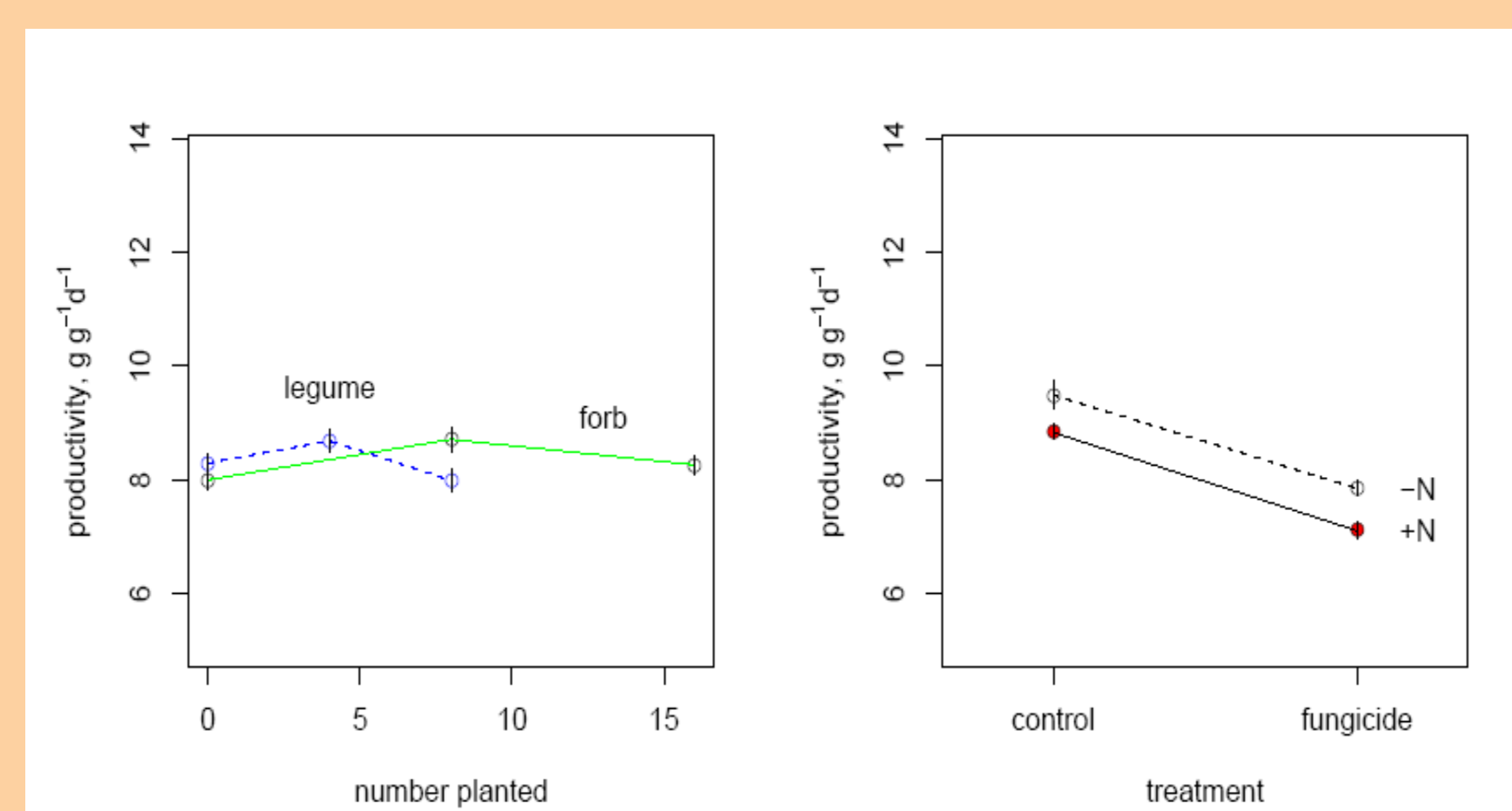


Annual net primary production (ANPP) was positively related to species diversity and mycorrhizal fungal richness. ANPP was also positively related to weighted mean plant height and weighted mean leaf dry matter content. ANPP was also positively related to the range of plant heights, range of canopy area, and the range of leaf dry matter content.

What effect did the treatments have on productivity?

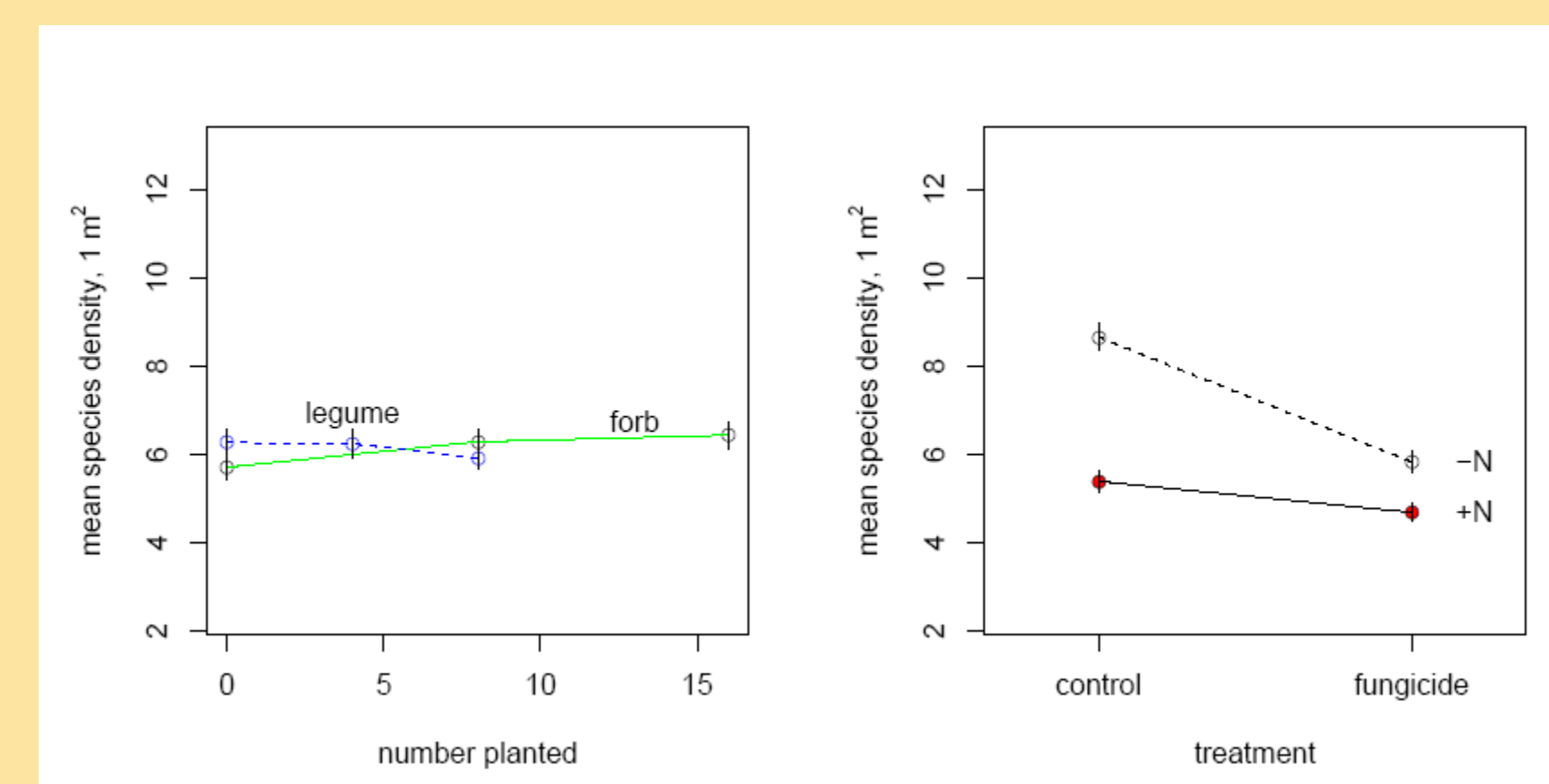


The number of species planted had no effect on the productivity. When nitrogen and fungicide were added, whether by themselves or in combination, productivity significantly decreased.



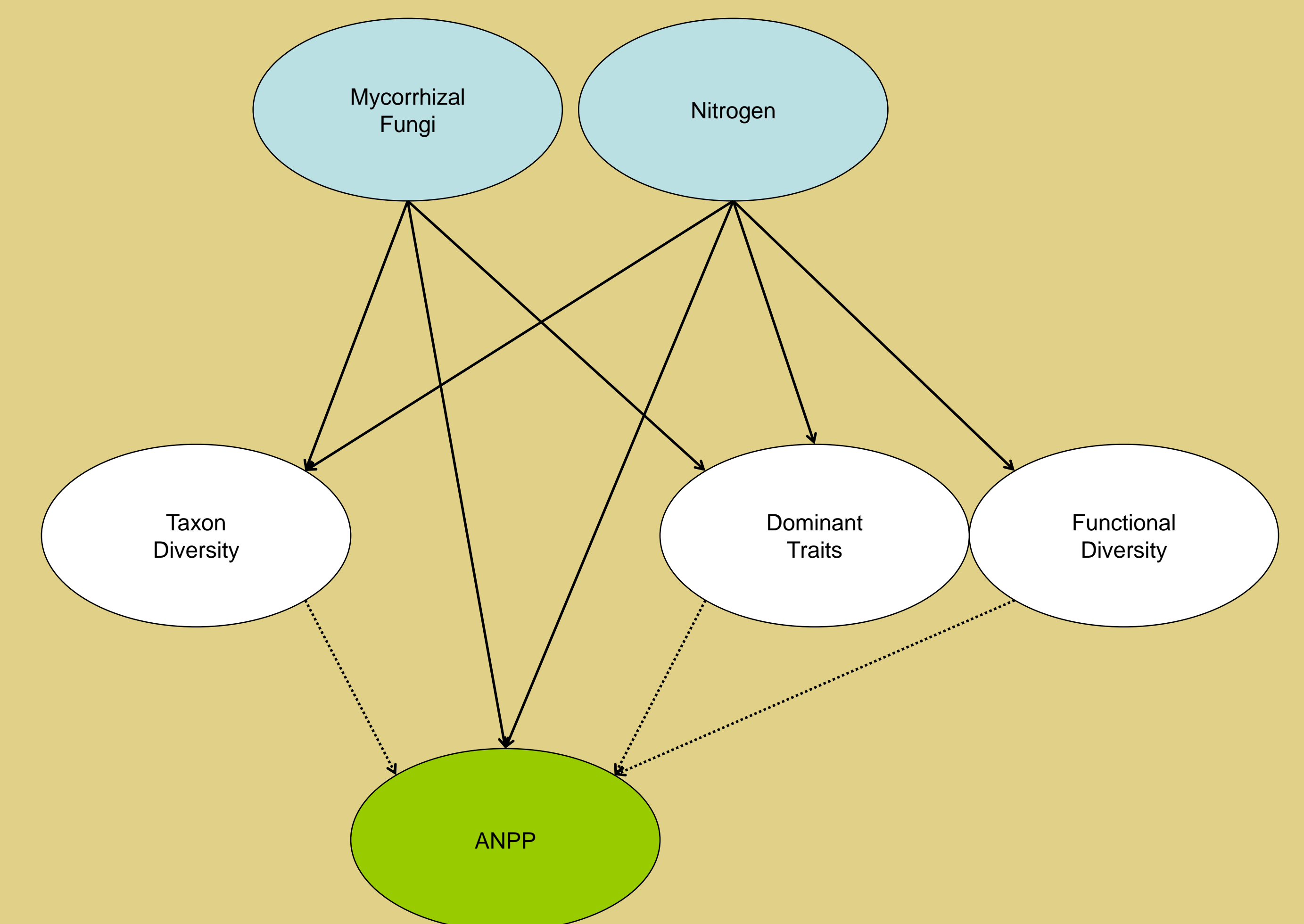
The number of species planted had little effect on the productivity. The nitrogen plots had lower productivity because they had more growth before the first biomass samples were taken than the other plots. Fungicide plots have a lower productivity because the MF interactions with the plants had been suppressed.

How was species density affected by the treatments?



The number of species planted had little effect on the mean species density. In the fungicide plots the mean species density significantly decreased. The mean species density also decreased when nitrogen was added. The mean species density of the nitrogen and fungicide plots was also lower than the control but not much lower than either the fungicide or nitrogen by themselves.

Many factors can either directly or indirectly affect ANPP. When experimentally adjusting variables such as mycorrhizal fungi and nitrogen levels you have to take into account what else may be having an effect on what is being measured. Since there are so many different relationships between mycorrhizal fungi, nitrogen, taxon diversity, dominant traits, functional diversity, and ANPP it can be difficult to find the causal factors of an increase or decrease in ANPP.



Acknowledgments

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