Impact Of Land Use On Arbuscular Mycorrhizal Fungal Communities In Machinga District, Southern Malawi

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Background

- The influence of land use on soil bio-resources in Sub-Saharan Africa is largely unknown.
- There is ever increasing pressure on the natural resource base in the region, and the trend of converting natural forests to croplands is only expected to increase.
- Natural forests in sub-Saharan Africa harbor a rich source of biota which include arbuscular mycorrhizal fungi (AMF). Yet, very little is known about the effects of natural forest conversion to agricultural land uses on AMF community structure and composition in the region.
- This study conducted in Machinga district, southern Malawi, aimed at addressing this research gap.

Figure 1. Part of Malosa Forest Reserve in Machinga District, Southern Malawi

Objectives

The objectives of the study were to:

a) evaluate the impact of land use type on AMF community composition and structure in a tropical setting

b) investigate the effects of continuous maize cultivation over maize- pigeon pea intercropping on AMF diversity and abundance

Research Questions

Question 1: What are the impacts of land use changes on abundance and diversity of AMF in a tropical setting?

Question 2: What effects do maize monoculture (MM) and maize pigeon pea (MP) systems have on the community composition and structure of AMF?

Predictions

1. Agricultural crop lands will be associated with low diversity and abundance of AMF.

2. Increasing crop biodiversity (Maize- Pigeon Pea) will enhance AMF abundance and diversity.

Methods

We investigated the impact of land use on the community composition and structure of AMF by examining spores from 3 land use types. Soil samples were collected from undisturbed natural forest (NF) sites and nested agro-ecosystems comprising of continuous maize monoculture systems, and *Cajanus cajun (pigeon pea)* maize intercrop systems. For each site, sampling was done in plots measuring 30m x 30 m and each land use category had three plots as replicates. AMF spores were extracted using the sucrose gradient-centrifugation method described in Gerdemann and Nicholson (1963). Morphospecies groups were identified based on AMF functional differences of AMF at the family organizational level as described by Morton and Redecker (2001), Schüßler, A. and Walker, C. (2010) .

Statistical Analysis

Dominant AMF species were determined according to relative abundance (RA>5%) and isolation frequency (IF >50%). ANOVA was performed on soil data with PROC MIXED procedure in SAS v 9.4 (SAS Institute, Cary, NC). Significant differences were determined at α = 0.05 and means separated by LSD procedure.

Results

Table 1. Soil characteristics (0-10 cm depth) in three land use types in Machinga, Malawi

Land use type	Soil Parameter	pH	Bulk density (Mg m $^{-3}$)	SOC (g kg^{-1})
Forest reserve		6.77 (0.15)	1.22 (0.02)	11.9 (1.0)
Monoculture maize		6.64 (0.19)	1.37 (0.02)	8.3 (0.8)
Maize –Pigeon Pea Intercrop		6.78 (0.20)	1.40 (0.01)	9.2 (0.6)
ANOVA	*p value*			
Land use type (LUT)		NS	<0.0001	0.0074
Site (S)		NS	NS	NS
LUT x S		NS	NS	NS

Means with standard errors in parenthesis
NS = non-significance (α = 0.05)

Table 1. Soil characteristics across three land use categories in Machinga District, Southern Malawi

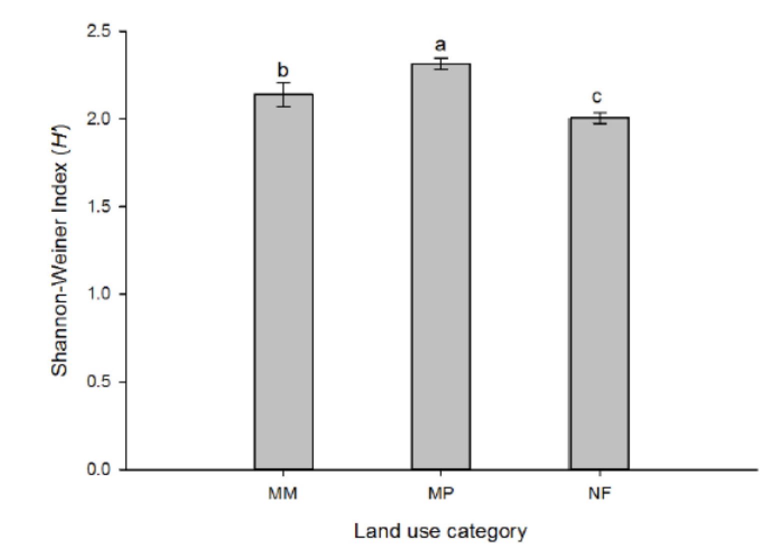

Figure 2. Shannon-Weiner index of AMF in three different land use categories in Machinga Forest Reserve, Southern Malawi. Error bars represent standard errors (SE). (p<0.05). Different letters denote significant differences (p<0.05).

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Fig. 2. Shannon-Weiner index of AMF across three land use types in Machinga District, Southern Malawi

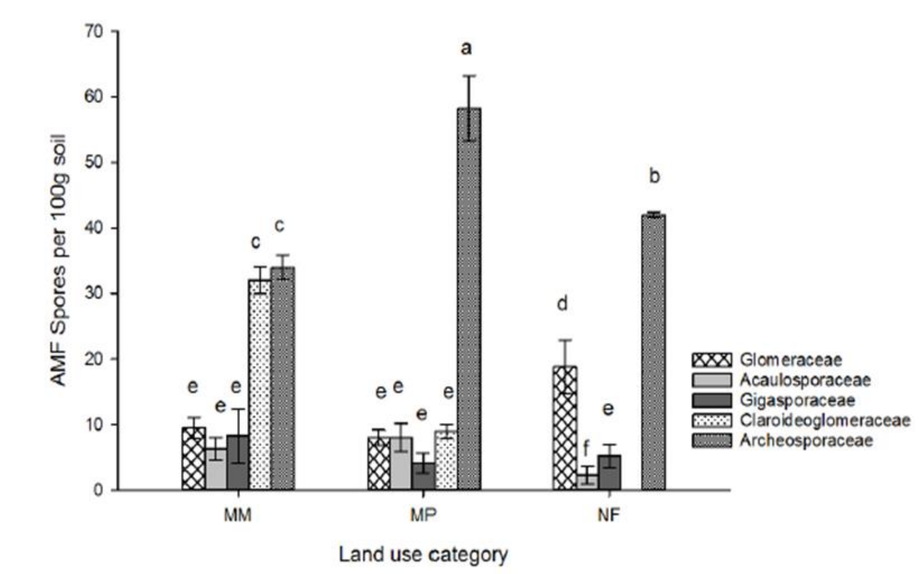

Figure 3. Mean AMF spore density in soils sampled from different land use categories in Machinga Forest Reserve, Southern Malawi. Error bars represent standard errors (SE). (p<0.05). Different letters denote significant differences (p<0.05).

Fig. 3. Impact of land use type on spore density and diversity of AMF across various families

Table 2. Diversity measurements of AMF communities in different land use types (0-10 cm soi depth) in Machinga, Southern Malawi

Land use type	Description	Richness	Evenness (*E*)	Biovolume (Biovol)	MBP (*d*)
Monoculture maize	Crop land	17	0.77 ± 0.03	0.60 ± 0.19	0.08 ± 0.03
Maize-pigeonpea intercrop	Cropland	19	0.80± 0.01	0.40 ± 0.09	0.15 ± 0.04
Natural Forest	Miombo woodlands	11	0.85± 0.01	0.67± 0.18	0.11± 0.03
ANOVA	*p value*				
Land use type (LUT)		<0.0001	0.0023	NS	NS
Site (S)		NS	NS	NS	NS
LUT x S		NS	NS	NS	NS

Data are means ± Standard Error (SE)
NS = non-significance (α = 0.05)

Table 2. Measures of AMF species diversity across three land use categories in Machinga District, Southern Malawi

Conclusion

AMF species composition and structure varied significantly across land use types. Species richness was greatest in Maize-Pigeon pea plots and lowest in natural forest areas. The abundance of species varied with land use types. Contrary to ecological predictions, there was no evidence of negative impact on the taxonomic diversity of AMF attributable to crop production in the study.

References

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