The effect of genetic selection and fertilization on the constituents of soil organic matter in managed loblolly pine forests as determined with nuclear magnetic resonance (NMR)

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Introduction

Soil organic matter (SOM) chemistry is affected by physical, chemical and biological processes. Previous studies have demonstrated a relationship between the chemical composition and the stability of SOM. The chemical composition of SOM depends on the input from vegetation residues and forest management such as fertilization and weed control. Genotype selection and deployment of loblolly pine (*Pinus taeda* L.) families is also common, but the effects of this treatment on SOM is currently unknown.

Objective

Examine the relative effect of genetic control of planted seedlings and silvicultural intensity on chemical composition of SOM.

Sites Description

This study was conducted at two sites in north-central Florida near Gainesville (ACMF) and Sanderson (SAN) (Fig 1) in managed loblolly pine forests with different genotypes in each site. The high intensity silviculture treatment was repeated weed control and relatively high levels of fertilization, while the low intensity cultivation had initial weed control and less fertilization (Table 1). Each site has 4 blocks and plots for each treatment.

Soil Type

Site	Soil Series	horizon	Depth	Texture
SAN	Leon	A1	0 -10	sandy, siliceous, hyperthermic Ultic Alaquods
		A2	10 -15	
		Bh/Bt	70 -	
ACMF	Pomona	A1	0 -10	sandy, siliceous, thermic Aeric Haplaquods
		A2	10 -15	
		Bh	66 -	

Research Sites

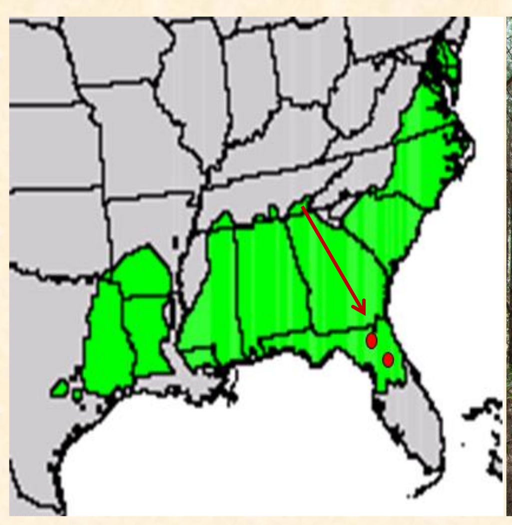

Fig. 1 Natural range of loblolly pine in the USGS. Red dots represent the location of our research sites.

Fig. 2 Ten year old loblolly pine forest at sampling.

Table 1 Fertilization levels (Kg/ha)

Site	Treatment intensity	N	P
SAN	H	760	180
	L	220	80
ACMF	H	450	100
	L	50	60

Soil Collection

Three soil cores per plot were collected from random locations from the beds, mixed and homogenized by horizon, weighed, and prepared for laboratory analysis.

Laboratory & Analysis Methods

(1) Light fraction (<1.6 g cm^{-3}) was analyzed for carbon-containing functional groups in soil organic matter (SOM) using nuclear magnetic resonance (NMR) spectra.

(2) A terrestrial molecular mixing model (Baldock et al., 2004) was used to calculate the main chemical components in the density separated 'light' fraction (LF). A1 and Spodic horizon (SAN only) analyzed.

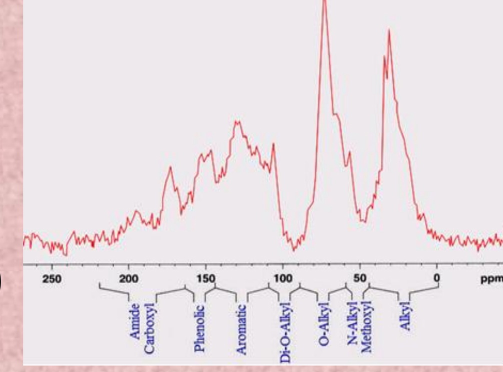

Fig. 3 ^{13}C NMR spectrum

Results

Table 2 Analysis of Variance results. Only significant (p<0.1) values are shown.

	Horizon	Effect	fraction	DF	F	P
ACMF	A1	family	Carbohydrate	1	4.875	0.047
	A1	family	lignin	1	3.678	0.079
	A1	intensity	carbonyl	1	3.282	0.095
SAN	A1	family	lignin	1	7.518	0.018
	A1	family	lipid	1	16.72	0.002
	A1	intensity	lipid	1	3.445	0.088
	SPO	family	Carbohydrate	1	3.583	0.088

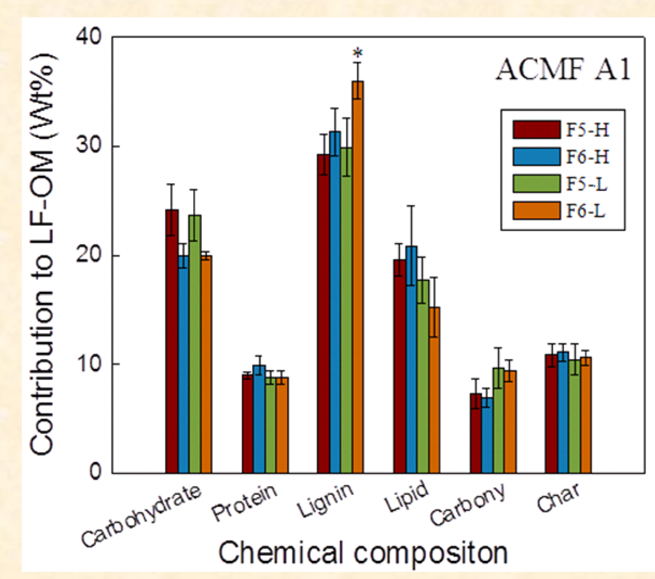

Fig. 7 Chemical composition of SOM for the A1 horizon in ACMF (p < 0.1).

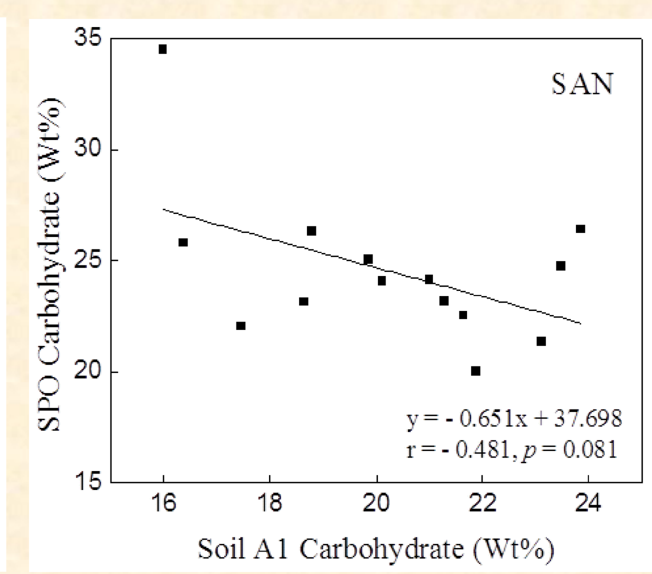

Fig. 10 Correlation of carbohydrate between spodic light fraction and A1 horizon light fraction in SAN.

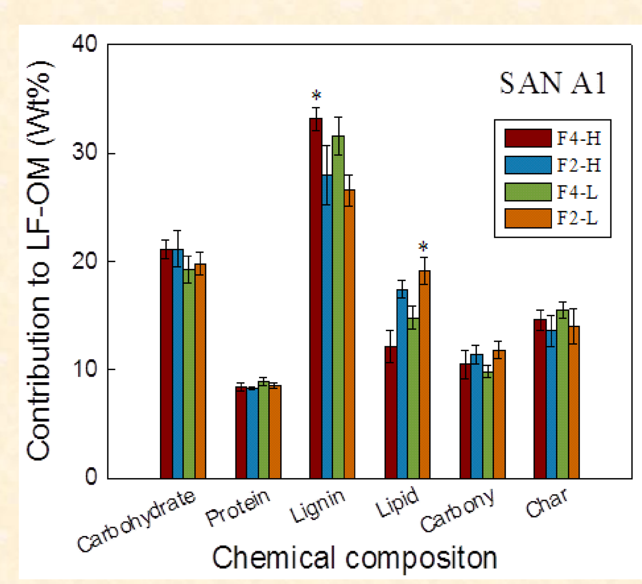

Fig. 8 Chemical composition of SOM for A1 horizon in SAN (p < 0.1).

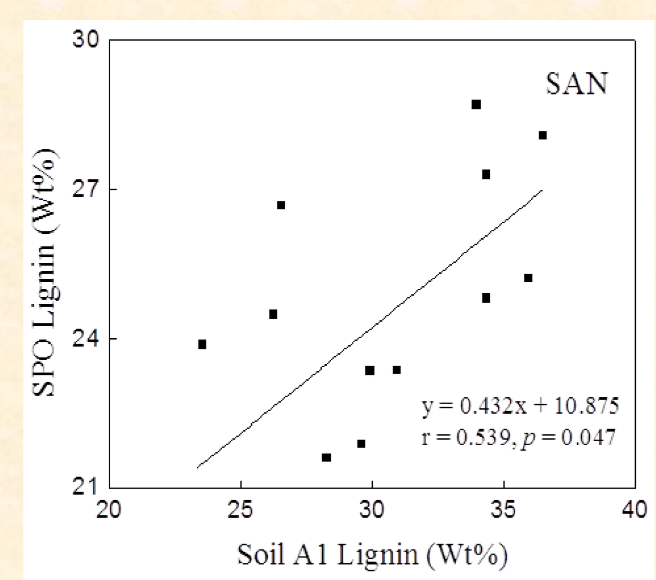

Fig. 11 Correlation of lignin between spodic light fraction and A1 horizon light fraction in SAN.

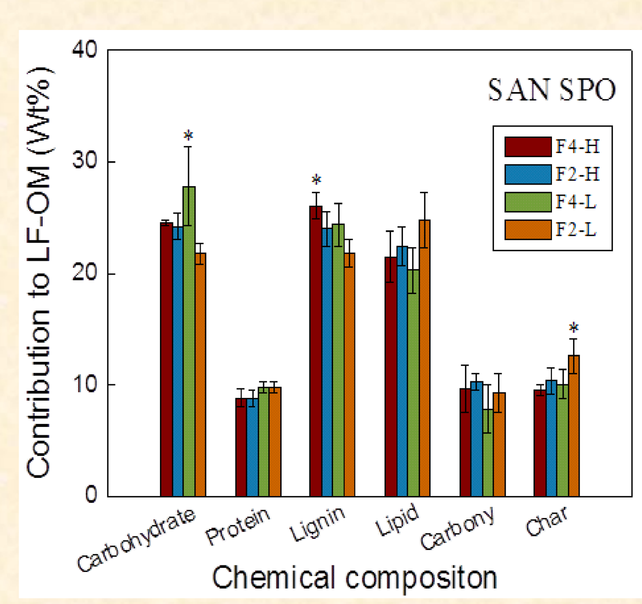

Fig. 9 Chemical composition of SOM of spodic horizon in SAN (p < 0.1).

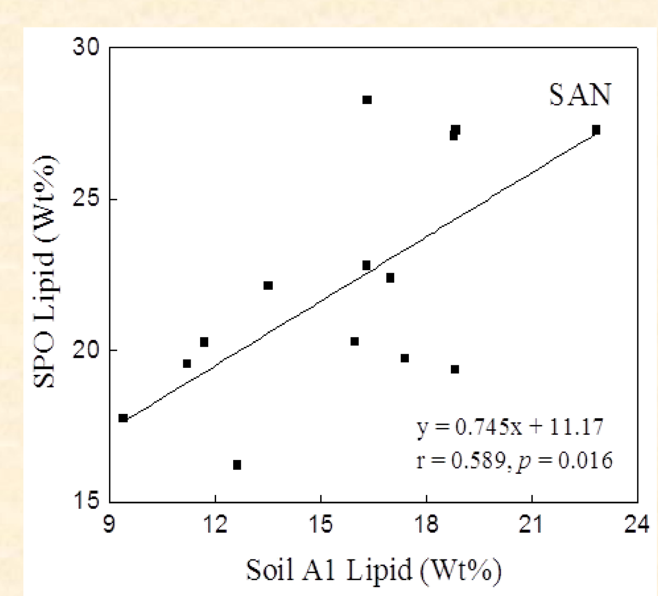

Fig. 12 Correlation of Lipid between spodic light fraction and soil A1 horizon light fraction in SAN.

Lab Measurements

Fig. 4 Separation of components in light fraction

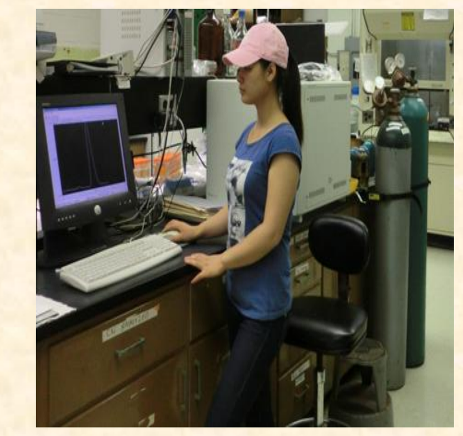

Fig. 5 C and N analysis

Fig. 6 ^{13}C NMR Bruker

Conclusions

(1) Both labile and stable fractions were significantly affected by genotype.

(2) Recalcitrant SOM fractions could be leached from upper layer and deposited into deeper soil layer.

(3) Treatment intensity influenced the stable fractions (carbonyl) of A1 horizon.

(4) Forest management could affect the dynamics of SOM by influencing it's chemical composition.

Reference

Baldock, J.A., Masiello, C.A., Gélinas, Y., Hedges, J.I., 2004. Cycling and composition of organic matter in terrestrial and marine ecosystems. Marine Chemistry 92, 39-64.

Nelson, P.N., Baldock, J.A.. 2005. Estimating the molecular composition of a diverse range of nature organic materials from solid-state ^{13}C NMR and elemental analyses. Biogeochemistry 72, 1-34.

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