Morphological, Physical, and Chemical Soil Properties Affecting Longleaf Pine (*Pinus palustris*) in East Texas

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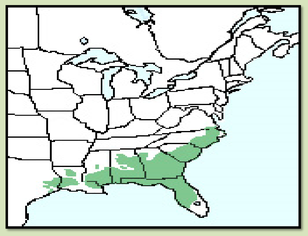
Abstract

Longleaf pine (*Pinus palustris*), a southern yellow pine native to the southeastern United States, once dominated 30 million ha. Logging, land conversion, and fire exclusion has reduced area occupied by longleaf pine to less than 1.2 million hectares, or 4% of its original area. Interest has developed for re-establishment of this species. However, little work has been done on soil/site relationships with longleaf pine. This study focused on coarse textured soils of east Texas that currently and historically support longleaf pine. Soil physical, chemical and morphological properties were evaluated for three soil series: Letney (Arenic Paleudults), Stringtown (Typic Hapludults), and Tehran (Grossarenic Paleudults). Site index for longleaf pine was measured on 10 sites for each soil series. Analysis of variation, ordination, and regression techniques were used in the comparison of soil properties for these soils and related to site index. Site index appears to be influenced by concentration of nutrients in the B horizon as well as texture and thickness of the B horizon within 150cm soil profiles.



Longleaf pine range map.

A typical longleaf pine stand located in the southeastern United States.

Objectives

The purpose of this study was to develop understanding of soil/site relationships for longleaf pine on coarse textured soils in east Texas.

Specific objectives of this study were to:

1. Determine select soil morphological, physical and chemical properties within relatively pure soil map units of three soils supporting longleaf pine.

2. Determine longleaf pine site index in natural stands on three relatively pure soil map units.

3. Test for relationships between longleaf pine site index and select soil properties.

Profile assessment using a three inch bucket auger to verify soil map unit.

Aging tree cores obtained using an increment borer.

Methods

Location

30 study sites, 50m radius, were located in the Sabine National Forest and Angelina National Forest. Care was taken to locate relatively pure soil map units of Stringtown, Letney and Tehran.

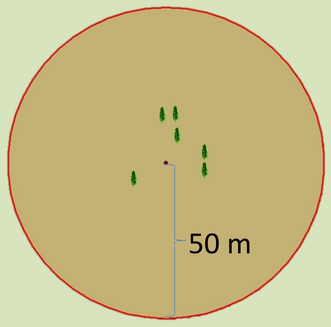
Soil Parameters

Soil profiles were examined to determine depths to A, E, and Bt1 horizons. Soil samples were taken by horizon and study site. Soil physical properties measured were: texture, including sand separates; field capacity; wilting coefficient; and organic matter content. Chemical properties measured for each horizon were: Total C, total N, NH_4^+, extractable P, exchangeable K, Ca, and Mg, soluble S and B.

Longleaf Pine Site Index

Six dominant/co-dominant trees were selected using a 10 factor BAF prism at each plot center and measured for height and age, from which site index was determined.

Figure 1. Boykin Springs and Fox Hunter Hill study areas located in Angelina, Jasper, and Sabine counties.



Circular plot displaying site index trees that fall within the relatively pure soil map units.

Results and Discussion

Longleaf pine site index among the three series varied significantly. Stringtown and Letney soils had site indicies of 22.2 and 22.6m, respectively. Tehran had a site index of 20.0m. As depth to B horizon increased, clay content in the B horizon decreased. Total N, NH_4^+, K, Ca, Mg, S and C was greatest in the B Horizon of the Stringtown soils than that of Tehran soils. Six regression equations were developed using variables created from principal component analysis and the driving variables of the significant principle components. These equations were created by evaluating chemical and physical variables separately and combined creating the following six equations:

Site Index =
= 21.61416 – (Principle Component 1 * 0.758884) - (Principle Component 5 * -1.12095)

PC1= Texture of each horizon and Depth to each horizon
=21.61416 + (Principal Component 1 * 0.79316)

PC1= Nutrients within the B horizon
=21.61416 - (Principle Component 1 * 0.95211) – (Principle Component 5 * 1.12095)

PC1= B horizon texture and chemical properties
PC5= E horizon chemical properties
=66.93652 + (Total Ca in the Profile * 0.05947)
= 88.71063 – (Depth to the B horizon * 0.19074) – (Total B horizon wilting potential * 0.26955)
=64.98+ (Total N in the B * 0.05119) + (Total Mg in the Profile * 1.66002) + (Total S in the B horizon * 5.87648) – (concentration of Mg in the B horizon * 0.22445) – (Total S in the profile * 5.25599) – (Total B horizon wilting potential * 0.53062)

Table 1. Means, standard deviations, and coefficient of variations for site index (base age 50) for natural longleaf pine stands (n=30) on three soil series (p=0.0079) located in the Angelina and Sabine National Forests in Texas. Same letters in a column indicate no significant difference (α=0.05).

Soil Series	n	Site Index (m)	Standard Deviation	Coefficient of Variation
Stringtown	10	22.2 a	2.3	10.4
Letney	10	22.6 a	1.33	5.89
Tehran	10	20.0 b	1.6	7.98

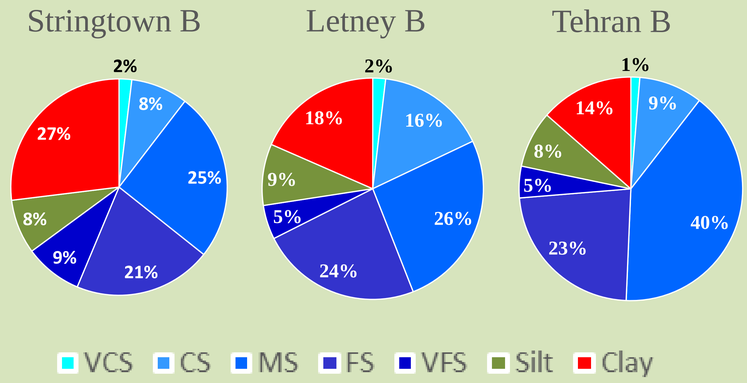


Table 2. Physical and chemical properties determined to be significant and were determined through regression to effect site index for longleaf pine on Stringtown, Letney and Tehran soil series in east Texas. Same letters in a column indicate no significant difference (α=0.05).

Horizon	Variable	Stringtown	Letney	Tehran	P-Value	Unit
B	Wilt. Coeff.	26.70a	12.13b	2.99b	<0.001	g cm-3
B	Mg	21.21a	15.04ab	2.55b	0.006	mg/Kg
B	S	2.62a	1.54ab	0.50b	0.025	mg/Kg
Profile	Mg	23.62a	18.01ab	5.53b	<0.001	g
Profile	S	3.11a	1.86ab	0.88b	0.017	g
Profile	Ca	79.85a	86.93a	32.90b	0.004	g

Conclusions

B horizon parameters appeared to be most significant in determining site index on Stringtown, Letney and Tehran soils in east Texas. Ultimately, depth to B horizon, texture of B horizon, and concentration of nutrients within the B horizon appear to be the driving force for site index on these three coarse textured soils. The 150cm rooting depth is an arbitrary depth that is not necessarily consistent with rooting depth of longleaf pine. Further research should be done to determine rooting depth of longleaf pine on these three soil series.

Soil texture determination using the Bouyoucos method.

Boring a longleaf pine to get age.

Acknowledgements

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