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The Relationship Between Fiber Length and Cambial Age at Nonlinear Model Levels

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Abstract: In the present study, the relationship between wood fiber length and cambial age were determined by different nonlinear models in maple wood. In order to determine of fiber length, three normal trees were selected in Noshahr site. Disks were cut at beast height. Wood samples were prepared along radial position (cambial age) from the pith to the bark. For separation of fibers were used Jeffrey's solution methods. Then relationship between fiber length and cambial age were examined by linear (Y = ax+ b) and different nonlinear regression models. The nonlinear models are including polynomial, logarithmic, power, exponential models. The analysis of variance indicated that this relationship between fiber length-cambial age were significant in all of nonlinear models. There are positive correlation between fiber length and cambial age in all of models. Correlation coefficients (R^2) in polynomial models are more than other nonlinear models. The values of fiber length were increased along radial position from pith to the bark (increasing cambial age). The average of fiber length was determined 1.10 mm in maple wood.

Key words: Maplewood · Fiber length · Cambial age · Nonlinear models

INTRODUCTION

Cambium age and growth rate are main factors affecting wood properties, primarily cell dimensions and density in both coniferous and deciduous species. Reports on variation patterns of wood density and cell dimensions with age are associated with the process of cambium maturation and the assessment of the period of juvenile tree development. The majority of these studies refer chiefly to conifers while comparatively less attention has been paid to hardwoods, particularly ring-porous [1-4].

Fiber length is one of the quality parameters for pulpwood [5]. It has been extensively studied in relation to tree age and within tree position [6,7]. Fiber dimension are determined by the dimensions of the cambial fusiform cells from which they are derived and by the process that occurs during cell differentiation [8,9]. Fiber length and cell wall thickness have been reported to show gradual increase from pith to bark [10,11]. The increases in fiber length from pith to bark according to [11] are due to the increasing age of the tree with a resulting effect on cell wall development. Rulliaty and America [12] reported a decreasing trend in wood fiber length from the tree base to the top. This decreasing trend on wood fiber length is attributable to the influence of the growth promotion substances which are close to the growing tip. These growth promoting substances initiate rapid production of cells at this point with decreasing maturation time thereby resulting in the production of short cells at the tree top.

The main objective of the study was to examine the relationship between fiber length and age cambial with using different nonlinear regression models in maple wood (*Acer velutinum* Boiss).

MATERIALS AND METHODS

In this research, three normal trees (*Acer velutinum* Boiss) were selected from Noshahr site in the western part of Mazandaran province in Iran. Disks samples were cut at breast height. Study area was located at 51° 27' 45"-51° 23' 45" E longitude and 36° 37' 45"-36° 33' 15" N latitude. The altitude of sea level for this site was 100 m. The soil texture of this region was clay to clay-loam with a clay percentage of 30 to 35%. The annual rainfall and annual average temperature (1978-2005) was 1302 mm and 16°C, respectively. October (256 mm) and November (216 mm) are high-rain months and July (32.6 mm) is a low-rain month. The mean monthly

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temperature reaches its maximum level in August (25.4 °C) and July (25.2°C). The mean of monthly maximum temperature and monthly minimum temperature was 19.5 and 12.7 °C for Noshahr site.

A disk, 5 cm in thickness, was removed from each tree at breast height level for evaluation of fiber length properties. The fiber length of the early wood of every ring from the radial direction (from 1960-2009) were measured for each of the tree samples disks. After macerating them with Jeffrey's solution (10% nitric acid: 10% chromic acid: water, 1: 1: 18), the dimensions of 30 fibers of every ring were measured using the Leica Image Analysis System. Final, the relationship between fiber length and age cambial were determined by nonlinear regression (polynomial, linear, logarithmic, power, exponential).

RESULTS AND DISCUSSION

The variance analysis of regression results indicated that there are significant differences in relationships between fiber length and cambial age among studied nonlinear models (Table 1). Correlation coefficients (R^2) in

Table 1: Variance analysis of relationship between fiber length- cambial age in different models for maple wood

Models	R^2	F	Sig
Linear	0.699	107.41	0.000
Logarithmic	0.702	108.383	0.000
Polynomial	0.978	107.04	0.000
Power	0.677	96.543	0.000
Exponential	0.675	95.382	0.000

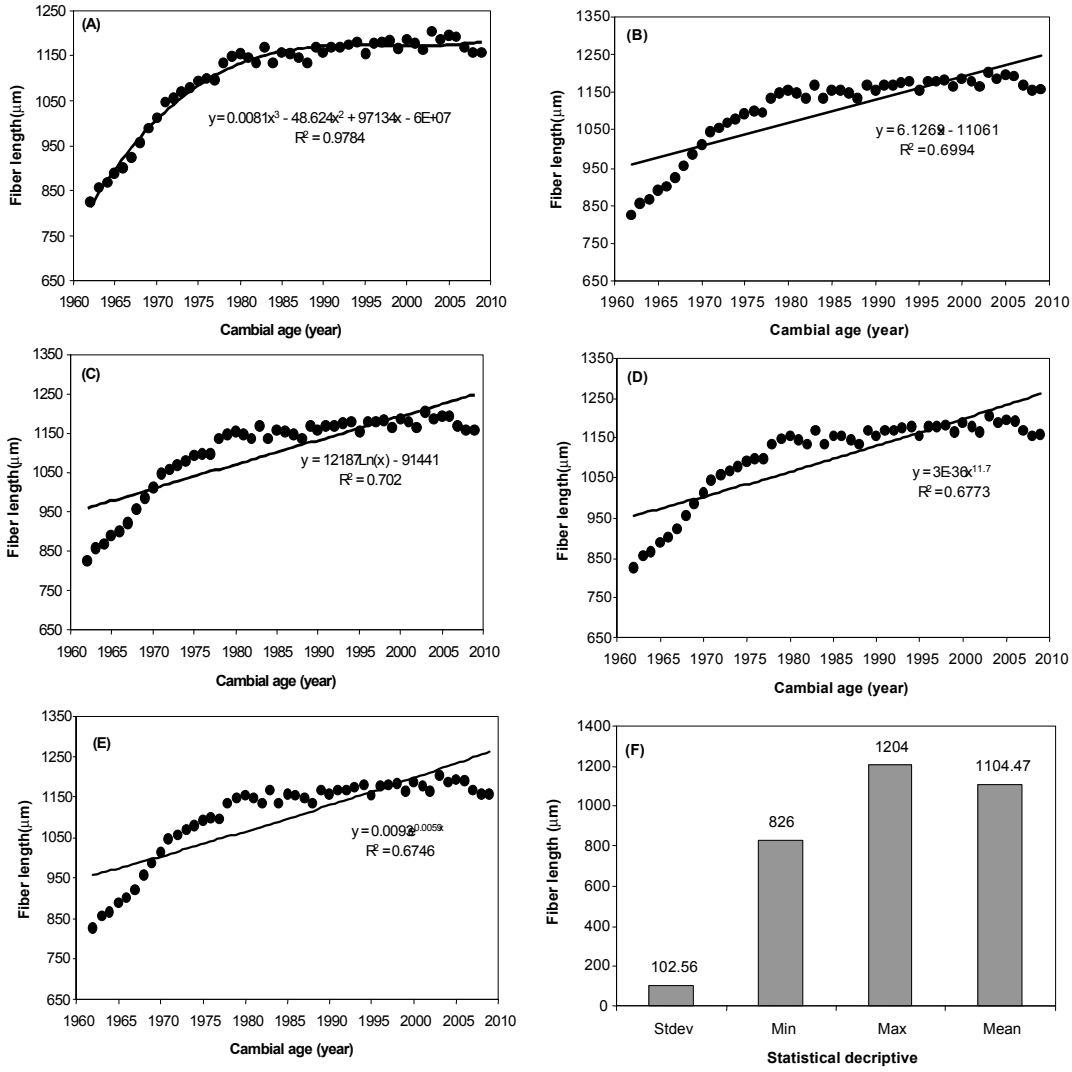

Fig. 1: The relationship between fiber length and cambial age in polynomial (A), linear (B), logarithmic (C), power (D), exponential (E) and statistical descriptive (F) in maple wood

polynomial model are more than other models in maple wood. The values of correlation coefficients in linear, logarithmic, polynomial, power and exponential models were determined 0.699, 0.702, 0.978, 0.677, 0.675, respectively. The equation of linear and nonlinear models for the relationship between fiber length and age cambial are presented in Figure 1.

The average, maximum and minimum of fiber length were determined 1104, 1207 and 826 μm in maple wood. The average of fiber length values were increased along radial position from the pith to the bark (or increasing cambial age), which were previously reported by Panshin and de Zeeuw 1980, Zobel and van Buijtenen 1989, Bakhshi *et al.* 2011, Kiaei 2011) [2,3,13,14].

CONCLUSIONS

In the present study, the relationship between fiber length and cambial age of maple wood in five different models were determined. The following conclusions were obtained from this research:

- The values of fiber length were increase with the increasing cambial age in maple wood.
- There are significant differences in relationship between fiber length-cambial age in all of studied models.
- The regression coefficient in polynomial models is more than other models.

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