Annals of Warsaw University of Life Sciences – SGGW
Forestry and Wood Technology No 74, 2011: 166-169
(Ann. WULS-SGGW, Forestry and Wood Technology 74, 2011

Genetic correlations between wood density components and tracheid length in European larch

MARCIN KLISZ

Forest Research Institute, Department of Silviculture and Genetics, 3 Braci Leśnej Street, Sekocin Stary, 05-090 Raszyn, Poland

Abstract: *Genetic correlations between wood density components and tracheid length in European Larch.* Genetic correlation between wood density components and tracheid length were estimated in 25-year-old trees of 161 full-sib families of European larch growing in seed orchard from northern Poland. The ring width and wood density traits of individual rings were determined by X-ray densitometry. The tracheid length for juvenile-wood increment core were obtained from optical fibre-analyser. The results shows moderate negative correlation between tracheid length and annual ring traits and positive correlations with wood density components and latewood percent. The contrary result was found for earlywood density.

Keywords: European Larch, wood density, tracheid length, genetic correlations

INTRODUCTION

The wood density is the complex trait of earlywood and latewood density, earlywood and latewood percent [2]. Wood density could be determined by the tracheid biometric traits [18]. Wood with shorter tracheid have a higher proportion of tracheid ends what resulted higher wood density [8]. The genetic background for the relationships of wood density components and tracheid length were reported in the literature [4, 17]. Genetic investigation of coniferous properties have focused on fast growing species [11]. European larch are one of the most promising fast growing species [16].

MATERIAL AND METHODS

Measurements were put over on larch wood samples (*Larix decidua* Mill.), coming from seed orchard established in 1985 in the Forest Ranges Młynary in northern Poland. The wood density traits and tracheid length were estimated in 161 trees of full-sib families. Two five-millimeter bark-to-pitch increment cores and one juvenile-wood increment core from each sample-tree were collected at 1,3 height. The increment samples were cut using twin blade circular saw to results two parallel cuts along the bore core with uniform thickness [12]. Resins was then extracted from cores with distilled water for 24 hours [6]. Samples were dried to moisture content of approximately 5-15%. Intra-ring density and width information was obtained using an X-ray densitometry technique [3]. For each annual rings in the samples, wood density components were obtained based on densitometric profiles: ring width, earlywood width, latewood width, earlywood percent, latewood percent, overall ring density, earlywood density, latewood density, maximum wood density, minimum wood density. Tracheid length samples were soften in 1:1 solution of hydrogen peroxide (H_2O_2) diluted to 25% and acetic acid (CH_3COOH) at 90-100°C for about 20-24 hours [5]. Thereafter samples were manually squeezed in a tube until a homogenous tracheid was formed. The fibre parameters were measured using a Kajaani FiberLab 3.5 optical fibre-analyser with three runs per sample [10]. All tracheid shorter than 0.5mm were excluded from the data because of a high potential error in correct definition at this size. Variance components for each traits were estimated using method of the SAS 9.2 Pl VARCOMP procedure, and estimated of the covariance between different traits were obtained from the MANOVA statement [13]. The genetic correlation was calculated as follows [15]:

$$r_{gxy} = Cov_{Fxy}/(\sigma_{Fx}^{2}\,\sigma_{Fy}^{2})^{1/2}$$

where:
σ_{Fx}^{2} – family variance components for traits X and Y, respectively,
Cov_{Fxy} – family covariance components for traits X and Y,

RESULTS

The genetic correlation between wood density components and tracheid length were calculated (Fig. 1). Ring width, earlywood and latewood width, and earlywood percent negatively correlated with tracheid length (respectively: -0,31; -0,33; -0,13; -0,42), only correlation between latewood percent and tracheid length were slightly positive (0,28). Genetic correlation obtained for wood density traits and tracheid length were moderate and positive, only coefficient of correlation estimated for earlywood traits were slightly negative (-0,28; -0,10).

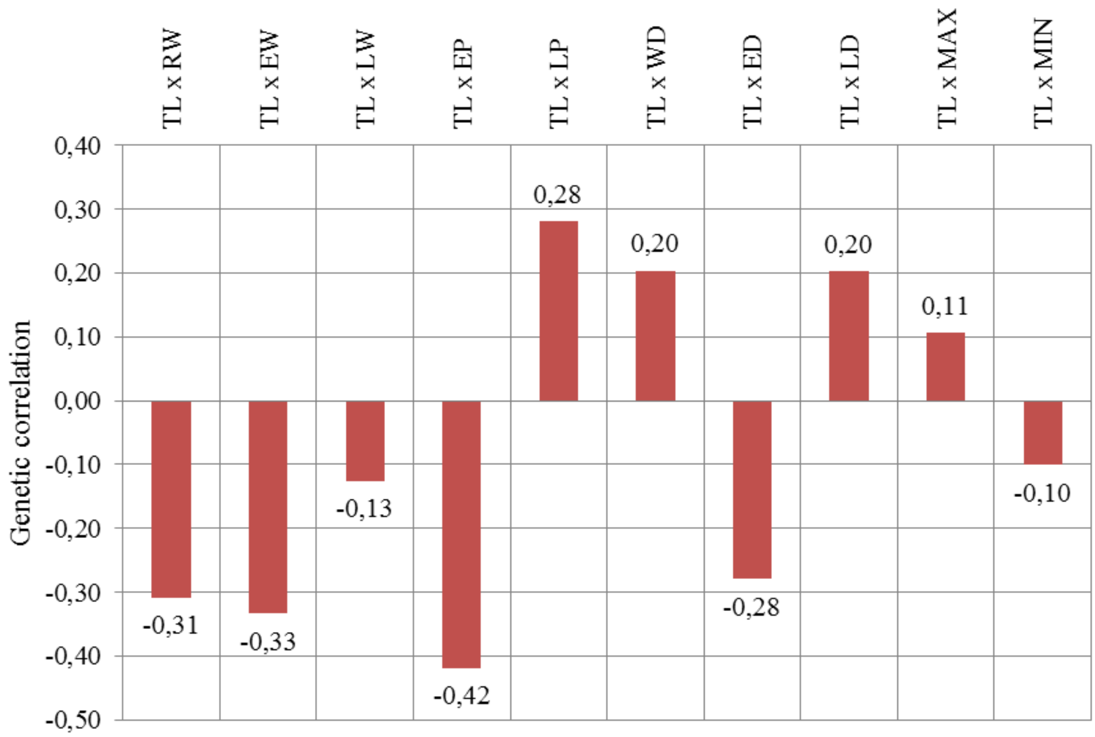

Fig 1 Genetic correlation between wood density components ant tracheid length.
Ring width (RW), earlywood width (EW), latewood width (LW), earlywood percent (EP), latewood percent (LP), overall ring density (RD), earlywood density (ED), latewood density (LD), maximum wood density (MAX), minimum wood density (MIN).

CONCLUSIONS

The genetic relationships between tracheid length and ring traits were inverse. With increasing tracheid length the annual ring traits: ring width, earlywood and latewood width decreased. Different trends were found in 28 years-old Scots pine growing in south-eastern Sweden, where tracheid length showed moderate positive genetic correlations with ring width in juvenile and mature wood (0,18 – 0,32) [9]. The differences in relationships obtained for Scots pine and European larch could be explain by the differences in species-specific ring width and a number of anticlinal cells divisions [1]. The moderate positive correlation between tracheid length and wood density components are consistent with results from studies in Norway spruce and Loblolly pine [7, 14]. Only earlywood density negatively correlated with tracheid length (-0,28). This is in contrast to the medium relationship reported for Norway spruce (0,48). These results confirmed that tracheid length was moderate inversely correlated with annual ring traits and positively correlated with wood density traits.

REFERENCES

1. M. W. BANNNAN Sequential changes in rate of anticlinal division, cambial cell length, and ring width in the growth of coniferous trees. Can. J. Bot. 45 (1967) 1359–1369,
2. J. R. BARNETT, G. JRONIMIDIS, Wood quality and its biological basis. Blackwell Publishing (2003),
3. U. BERGSTEN, J. LINDEBERG, A. RINDBY, R. EVANS, Batch measurements of wood density on intact or prepared drill cores using x-ray microdensitometry. Wood Sci. Tech. 35 (2001) 435–452,
4. P. DUTILLEUL, M. HERMAN, T. AVELLA-SHAW, Growth rate effects on correlations among ring width, wood density, and mean tracheid length in Norway spruce (*Picea abies*). Can. J. For. Res., 28 (1998) 56–68,
5. G. L. FRANKLIN Preparation of thin section of synthetic resins and wood-resin composites, and a new macerating method for wood. Nature 3924 (1945) 51,
6. M. GRABNER, R. WIMMER, N. GIERLINGER, R.EVANS, G. DOWNES, Heartwood extractives in larch and effects on X-ray densitometry. Can. J. For. Res., 35 (2005) 2781–2786,
7. B. HANNRUP, C. CAHALAN, G. CHANTRE, M. GRABNER, B. KARLSSON, I. LE BAYON, G. L. JONES, U. MÜLLER, H. PEREIRA, J. C. RODRIGUES, S. ROSNER, P. ROZENBERG, L. WILHELMSSON, R. WIMMER, Genetic parameters of growth and wood quality traits in *Picea abies*. Scand. J. For. Res. 19 (2004) 14–29,
8. B. HANNRUP, Ö. DANELL, I. EKBERG, M. MOËLL, Relationships between wood density and tracheid dimensions in *Pinus Sylvestris* L. Wood Fiber Sci. 33 (2001) 173-181,
9. B. HANNRUP, I. EKBERG, A. PERSSON, Genetic correlations among wood, growth capacity and stem traits in *Pinus sylvestris*. Scand. J. For. Res. 15 (2000) 161–170,
10. M. KLISZ, Automatyczna metoda określania rozkładu parametrów cewek w oparciu o nie destrukcyjne metody pobierania prób z drzew. Leśne Prace Badawcze 69 (2008) 270–273,
11. S. KUMAR, H. S. DUNGEY, A. C. MATHESON, Genetic parameters and strategies for genetic improvement of stiffness in Radiata pine. Silvae Genet. 55 (2006) 77-84,
12. B. LARSSON, K. PERNESTǺL, B. JONSSON, A wood sample preparation method for direct scanning x-ray microdensotometry. Umeå, Swedish University of Agricultural Sciences, Report 29 (1994) 1-19,
13. SAS/STAT User’s guide, version 9.2 2002 SAS Institute, Cary NC online,
14. R. SYKES, F. ISIK, B. LI, J. KADLA, H-M. CHANG, Genetic variation of juvenile wood properties in a loblolly pine progeny test. Tappi Journal 86 (2003) 3-8,
15. J. W. VRIGHT, Introduction to forest genetics. Academic Press, New York San Francisco London (1976),

16. K. ZAJĄCZKOWSKI, A. ZAŁĘSKI, Produkcyjność szybko rosnących gatunków drzew leśnych w doświadczalnych i gospodarczych uprawach plantacyjnych. Sprawozdanie końcowe. (2007) 1-42,
17. J. B. ZOBEL, B. J. JETT, Genetics of wood production. Springer-Verlag, N. York-Berlin (1995),
18. ZUBIZARRETA GERENDIAIN, H. PELTOLA, P. PULKKINEN, R. JAATINEN, A. PAPPINEN, Differences in fibre properties in cloned Norway spruce (*Picea abies*). Can. J. For. Res., 38 (2008) 1071–1082,

Streszczenie: *Korelacje genetyczne pomiędzy gęstością drewna a długością cewek modrzewia europejskiego.* Dla 25-letnich pół-rodów modrzewia europejskiego z plantacyjnej uprawy nasiennej z północnej Polski obliczono współczynniki korelacji genetycznych pomiędzy cechami składowymi gęstości drewna długością cewek. Cechy gęstości drewna i słoja rocznego określono z wykorzystaniem rentgenograficznej metody obrazowania struktury drewna. Długość cewek określono z wykorzystaniem optycznego analizatora włókien. Współczynniki korelacji genetycznych cech słoja rocznego i długości cewek były umiarkowanie negatywne, natomiast korelacje z cechami gęstości drewna były pozytywne. Jedynie dla gęstości drewna wczesnego otrzymano przeciwstawne wyniki.

Corresponding author:

Marcin Klisz
Forest Research Institute,
Department of Silviculture and Genetics,
3 Braci Leśnej Street,
Sękocin Stary, 05-090 Raszyn, Poland
E-mail address: kliszm@ibles.waw.pl