

Age–age correlations and early selection for growth traits in 40 half-sib families of *Larix principis-rupprechtii*

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Abstract *Larix principis-rupprechtii* Mayr is a dominant species in coniferous forests of North China. However, early selection of *L. principis-rupprechtii* for growth traits is poorly characterised. To explore the optimal selection age for this species, heights (HT) and diameters at breast (DBH) of 40 half-sib families were measured at ages 3, 12, 22, and 28 years in a progeny test population established in the town of Kangjiahui, Shanxi Province. Age trends in heritability, age–age genetic correlations, and early selection efficiency for height and DBH were analysed. The

individual heritability of these growth traits varied over time, and maximized at different ages (0.55 at age 12 for HT and 0.48 at age 28 for DBH). The age–age genetic correlations were always positive, and the majority were high (0.790–0.953) between the juvenile and mature ages for HT and DBH. For the same pairs of measurements, HT demonstrated higher age–age genetic correlations than DBH, and both age–age genetic correlation data sets were described well by the linear relationship with the logarithm of the age ratio ($r^2 > 0.90$). The regression slope for DBH was lower than that for HT. Based on the early selection efficiency estimates, the optimal selection age could be as early as age 6 for DBH and 8–9 years for HT. The results of this study provide information that can be used to assist early selection practices in *L. principis-rupprechtii* improvement programs in Shanxi Province.

Keywords Age–age correlations · Early selection · Heritability · *Larix principis-rupprechtii* · Selection efficiency

Mingliang Dong and Yingming Fan contributed equally to this work.

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Introduction

Larix principis-rupprechtii Mayr is one of the most valuable native coniferous species in North China, and is mainly distributed in montane areas at altitudes of 1400–2800 m in Shanxi and Hebei Provinces (Wang et al. 1992; Di et al. 2014). It plays an important role in reforestation programs and commercial enterprises, given its rapid juvenile growth, wide ecological adaptability, and desirable wood products (Lelu-Walter and Pâques 2009; Zhao et al. 2015). Because the planting area of *L. principis-rupprechtii* is increasing, a large volume of genetically improved seed is urgently needed for reforestation.