Influence of ginseng cultivation under larch plantations on plant diversity and soil properties in Liaoning Province, Northeast China

LIU Wei-wei1,a, LIU Mou-cheng1*, LI Wen-hua1, ZENG Fan-shun3 and QU Yi3

1 Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China
2 University of Chinese Academy of Sciences, Beijing 100049, China
3 Liaoning Academy of Forestry, Shenyang 110032, China


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Abstract: Currently, transforming the mode of forest management and developing multiple forest management practices are actively encouraged in China. As one forest management type, ginseng cultivation under larch plantations has been developed significantly in the east of Liaoning Province. However, research on the influence of the ecological environment for this mode of production is still deficient. Based on this, our study compares the plant diversity and soil properties in the ginseng cultivation under larch plantations (LG) with larch plantations (LP) and natural secondary forests (SF). First, we randomly selected three plots for each of the three stand types which have similar stand characteristics; then, we carried out a plant diversity survey and soil sampling in each of the nine plots. The results show that no significant difference was found in plant diversity between LG and LP, but the evenness of herbs was significantly lower in LG than LP. No obvious changes in soil physical properties were found in LG, but a significant decrease in most of the soil nutrient content was presented in LG. Furthermore, we found a correlation between plant diversity (H’) and soil properties in the three kinds of stand types, especially between herbaceous plant diversity and soil properties. We conclude that ginseng cultivation under larch plantations has no obvious effect on plant diversity, except the herbaceous evenness. Soil fertility can be depleted significantly in LG, but physical structures are not affected. Moreover, maintaining the diversity of herbaceous plants and controlling the density of ginseng cultivation in LG by farmers are important for the ecological environment. Based on this study and its good comprehensive benefits and with the support of policy, we think this forest management type should be promoted moderately in the region.

Keywords: Forest management; Ginseng cultivation;
Larch plantations; Secondary forests; Plant diversity; Soil properties; Changbai Mountain

Introduction

Ginseng (Panax ginseng C. A. Mey.) belonging to Araliaceae family, is one of the most valuable traditional Chinese herbal medicines, which is distributed mainly in the mountain areas of northeast China, typically in cool wet climates (Li et al. 2012; Ying et al. 2012). Due to the good reputation of ginseng for promoting health and general body vigor, and even prolonging life (Jennifer and Prabashni 2002; Coleman et al. 2003), the economic value of ginseng is relatively high. Naturally grown ginseng in the mountains is regarded as having precious value as a medicine; however, the supply of wild ginseng is far from meeting the demand (Beon et al. 2013). Ginseng is now mainly being planted on mountain sites in the northeast of China, called semi-wide ginseng, where conditions mimic those of naturally grown plants.

The terrain of northeast China is mainly composed of mountains and plains. In the east of Liaoning Province, the average forest coverage rate can reach more than 75%, where the stand types are mainly natural secondary forests and plantations. In this mountainous region, most of the subsistence and economic income can only be acquired from the forests. The Chinese government attaches great importance to the economic development of forests. In 2008, the government carried out the collective forest tenure system reforms, thus allowing farmers to obtain forest management rights and tree ownership. In recent years, the government has actively encouraged the development of a variety of forest management types, especially the under-forestry economy (Chang 2009). The Kuandian ShíZhu Ginseng Cultivation System was approved as the first batch of China Nationally Important Agricultural Heritage Systems (China-NIAHS) in 2013, which will actively promote the region’s development of ginseng. Globally Important Agricultural Heritage Systems (GIAHS) is sponsored by the Food and Agriculture Organization of the United Nations (FAO) and defined as “remarkable land use systems and landscapes which are rich in biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development” (FAO 2008). And China was the first country to carry out the protection of Nationally Important Agricultural Heritage Systems in 2013.

Plant diversity plays a vital role in sustaining human life and the health of our planet. While growing ginseng, one should consider community species composition and structure, including species, density, coverage, etc. In addition, farmers need to clear a certain degree of herbaceous cover to meet the growing space needs of ginseng, which directly influences the diversity of herbaceous plants. On the other hand, the requirement of ginseng cultivation on soil quality is very high, including physical and chemical properties (Li and Nai 1994). Ginseng absorbs a large amount of soil nutrients during its growth. Meanwhile, it influences soil properties severely through root exudate profile (Cheng et al. 2011). Plants and soil are interdependent, and each can be affected by alterations in the other (Silva and Batalha 2008; Tang et al. 2015). Plant communities with different composition and diversity can influence the physical and chemical characteristics of soil, and soil properties can also vary vegetation distribution and diversity (Fu et al. 2004; Dybzinski et al. 2008; Eskelinen et al. 2009).

As one forest management type, ginseng cultivation under larch plantations has been widely implemented in the east of Liaoning Province. However, research on the ecological environment influences of this type is still scarce. In order to better implement and promote this valuable plantation type, we try to elucidate the influence of ginseng cultivation under larch plantations on plant diversity and soil properties by comparing the differences among ginseng-larch agroforestry systems (LG), larch plantations (LP) and secondary forests (SF). In addition, we explore the relationship between plant diversity and soil properties based on the three stand types. The objectives are (1) to survey and compare the plant diversity among the three kinds of stand types, (2) to measure and contrast the physical and chemical properties of the soil among the three kinds of stand types, and (3) to quantify the relationships between plant diversity and soil properties in the three kinds of stand types.