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Comparison of two coniferous plantations in central Japan with respect to forest productivity, growth phenology and soil nitrogen dynamics

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Abstract

Japanese cypress (*Chamaecyparis obtusa* Endl.) and Japanese cedar (*Cryptomeria japonica* D. Don) are common species for plantation forestry in Japan. Cypress is conventionally planted on sites of low fertility whereas for cedar high fertility sites are used. Objectives of this study were to compare the productivities of cypress and cedar plantations grown on adjacent sites where common properties of soils, such as pH values and C and N contents, were similar, and to relate the N cycling at their site with productivities. The stem diameter of trees, aboveground litter production and fine root biomass were measured as indices of forest productivity. Parameters of N cycling included pools of total N and mineral N (ammonium + nitrate), annual N leaching, and potentially mineralizable N. The radial stem increment of the two tree species was similar. However, cedar site had higher total basal area and annual basal increment than cypress site reflecting higher tree density on the cedar site. Aboveground litter, fine root biomass, soil organic matter, and N turnover were higher on the cedar site than on the cypress site. However, litter production and fine root biomass per unit basal area was greater at the cypress site. Phenological pattern of stem growth and periodical litter production were similar for both species during the study period (1992–2000), but showed distinct annual variations caused by the fluctuation in the ambient temperature and precipitation. Mineral N content and the N mineralization potential were greater on the cedar site, indicating greater N availability and higher total tree productivity at the cedar site than those at the cypress site. When provided with more space in the canopy to expand more needles and in the soil to develop more fine roots to exploit sufficient resources, the individual cypress trees have the potential to grow faster. On fertile site and at lower tree density, thicker logs of cypress might be yielded.

Keywords: Forest productivity; Growth phenology; Japan; Nitrogen dynamics; Plantation forestry; Soil fertility

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1. Introduction

In temperate areas of Japan, Japanese cypress (*Chamaecyparis obtusa* Endl.) and Japanese cedar (*Cryptomeria japonica* D. Don) have been traditionally planted on different sites. Cypress is planted on low fertility sites and cedar on high fertility sites. Due to the steep topography of forestland in Japan, sites on the upper slopes or hilly areas are poor in fertility where cypress is grown whereas on the richer middle slopes or plains cedar is grown (Sasaki et al., 1994).

Productivity of cedar plantations is considered to be higher than that of cypress. Nitrogen (N) is one of the most important nutrients in regulating the forest productivity on many sites (Reich et al., 1997) and its interaction with soil water may be an important factor of higher productivity of cedar, similar to that observed for pines by Enoki et al. (1996). On a long slope with Japanese cedar uniformly planted from upper to lower slope, soils from an upper slope mineralized less N with low rates of nitrification when compared with soils from the lower part of the slope (Kutsuna et al., 1988; Hirobe et al., 1998). Litter decomposition rate was faster and the N release from decomposing litter was greater on pine plantations at the lower slope than those at the upper slope (Enoki and Kawaguchi, 2000). Similar differences in N dynamics would cause high productivity in cedar plantations at the lower slope when compared to cypress growing on the higher slope. It is, however, not known how they would differ in their productivities if grown on similar and adjacent areas. Moreover an understanding of the role of N dynamics in affecting productivities of cypress and cedar growing on similar and adjacent sites will provide additional useful options for future forest management.

In this study, the growth rate of stems, aboveground litterfall and fine root biomass were used as indices for the forest productivity of cedar and cypress forests growing on adjacent areas with similar soil conditions and related indices of N cycling, so that the forest managers have additional information to make site specific selection of planting different species.

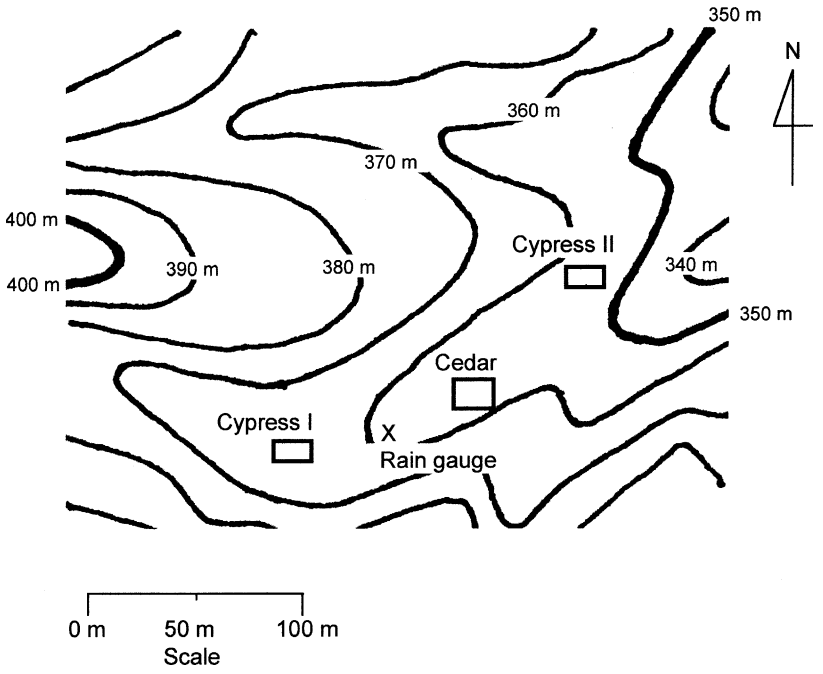

Fig. 1. Location of three study sites (white boxes) and rain gauge (X).