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Timing for the planting method using deciduous forest topsoil in suburban Tokyo, Japan

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Abstract

The suitable time for planting using the topsoil of a warm temperate deciduous forest is discussed based on the germination characteristics of the soil seed bank. Forest topsoil was collected regularly over a 1-year period from a deciduous forest in suburban Tokyo, and seedling emergence in the outdoors was recorded immediately after collection. Many seedlings were observed from February to May, indicating that this is the best time for planting because this is when most buried seeds germinate. Additionally, it was inferred that buried seeds germinate immediately after planting during the period from February to October, although the quantity of seed germination varies according to the season. The method of evaluating the forest topsoil as a planting material is also discussed. The simple and preferred method of evaluation is to examine outdoor seedling emergence from February to May. Accurate evaluation during the summer and autumn months proved problematic, especially when counting tree seeds, and it was necessary to continue the evaluation into the following spring. A practical understanding of the timing of planting and the method of evaluating forest topsoil as a planting material is possible in warm temperate areas.

Keywords: Deciduous forest; Emergence; Germination; Pioneer species; Planting; Revegetation; Seed bank; Topsoil

1. Introduction

We tested the planting method of using forest topsoil as a planting material. This planting method is an efficient restoration technique used in Japan (Hosogi et al., 2000, 2001, 2002, 2004, 2005; Jimmon et al., 2000; Nakamura et al., 2002; Koh et al., 2004) and is frequently used for planting on man-made slopes. The main material used in this planting method is the seed contained in forest topsoil. The viable seeds that compose the soil seed bank have species-specific germination times (Washitani, 1989; Hamada and Kuramoto, 1994; Iwamura and Kameyama, 1996; Probert, 2000). Therefore, we predict that there will be differences in germination time, depending on the time of planting. It is necessary to know the germination characteristics of the forest soil seed bank to determine

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the germination periods and to estimate the best times for planting. However, this knowledge alone is insufficient. It is also necessary to perform the planting during the best times to prevent erosion in susceptible areas. Thus, knowledge of the best times for planting is important for the success of the planting.

Knowledge about the germination characteristics of the forest soil seed bank can also be used to assess the planting material. In fact, it is necessary to examine the quality of the soil seed bank as a planting material before planting (Van der Valk and Penderson, 1989; Daby, 2002). Planting methods using forest topsoil will be more efficient and commonly used if a simple method of evaluating the soil seed bank as a planting material is established.

The objectives of this study were to determine the optimal planting time for the method using the topsoil of warm temperate deciduous forest, and to determine a method for evaluating forest topsoil as a planting material. Forest topsoil was collected throughout 1 year and maintained in external environmental conditions. Germinated seedlings were counted after collection to ascertain the germination characteristics of the forest soil seed bank. The optimal time for establishing plantings using forest topsoil was determined based on these results. The most efficient method of assessing the soil seed bank for planting is also discussed.

2. Methods

2.1. Topsoil collection site

Topsoil was collected in a deciduous coppice forest in Oyamadairi Park in Tama-shi, Tokyo, Japan. It is located on a hill 180 m above sea level, at 35°36′N and 139°22′E. The mean annual temperature is 14.3 °C, and the annual precipitation is 1537 mm. This area is classified as a temperate deciduous forest.

2.2. Topsoil collection method

Buried viable seeds are generally distributed heterogeneously in soil (Silvertown, 1987; Hamada and Kuramoto, 1994; Albrecht and Forster, 1996; Olano et al., 2002), and are concentrated in irregular patches (Nakagoshi, 1981, 1984; Nakagoshi et al., 1982). Therefore, many small samples should be collected rather than a few large ones when the soil seed bank

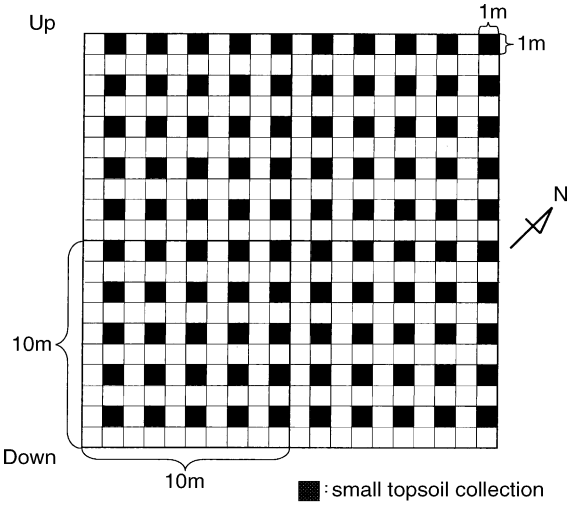

Fig. 1. Diagram of the soil collection site.

composition is to be examined (Silvertown, 1987; Simpson et al., 1989). We set up a 20 m × 20 m quadrat divided into 1 m × 1 m (small) quadrats, and selected 100 small quadrats for the collection of topsoil (Fig. 1). We collected topsoil in early January, April, July, and October 2001. Hereafter, the topsoil collection times are referred to by the month of the collection.

A soil sampling cylinder (100 mL volume: 19.6 cm^2 × 5.1 cm) was used to collect topsoil. Four samples were collected from each small quadrat, for a total of 400 mL of topsoil. In total, 40 L of topsoil was collected during each collection time. When topsoil was collected, large items of litter were removed; however, some litter remained with the topsoil. The holes that resulted from topsoil collection were filled with a mixture of small lumps of red loam and vermiculite, and colored steel pipes were inserted into the ground to avert further collecting at the same point. Soil samples were transported in separate polyethylene bags at room temperature, and were processed within 1 week of collection.

Topsoil temperature at 2 cm below the surface was continuously measured using a thermometer with a data logger (Ondotori TR-71, T&D Co.).

2.3. Examination of the timing of germination of the soil seed bank

To examine the timing of germination of the forest soil seed bank, seedlings that germinated from the