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ORIGINAL ARTICLE

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Long-term variation in Scots pine seed crop size and quality in northern Finland

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Abstract

Quantitatively and qualitatively good Scots pine (*Pinus sylvestris* L.) seed years are rare in northern areas because of the short growing seasons. The seed crop size was studied in four natural pine forests in northern Finland during 1960–2004. Data on seed crop quality were collected during 1986–2004 and quality was determined by X-ray radiography. The long-term average annual seed crop of pine was 77 seeds m⁻², varying from 5 to 225 seeds m⁻². The expected average annual germination percentage of the seed crop was 61%, varying from 7 to 81%. General linear models were used to analyse the size and quality of the seed crop. Independent variables explained 52% of the variation in annual seed crop quality, and no proper model was found for determining the size of the seed crop; the coefficient of determination was only 5%. A combination of more than 100 seeds m⁻² and an expected germination percentage of over 50% was observed once during the years 1986–2004. In most years, natural regeneration in northern Finland is difficult and often limited by the seed crop's quality as well as quantity. These results confirm the importance of seed tree cutting in abundant seed crop years to enable the natural regeneration of pine.

Keywords: *Expected germination percentage, regeneration, Scots pine, seed crop.*

Introduction

Seed production and seed crop quality in Scots pine forests (*Pinus sylvestris* L.) vary from year to year (Heikinheimo, 1937; Sarvas, 1962; Hagner, 1965; Koski & Tallqvist, 1978; Béland et al., 2000; Hokkanen, 2000, Karlsson & Örlander, 2000; Hannerz et al., 2002). The reproductive cycle of pine consists of several phases, each of which determines the size and quality of the seed crop. The most important phases are the formation of regenerative buds, flowering, pollination and seed maturation. Weather conditions during the growing seasons of the reproductive cycle are crucial factors determining the size and quality of the seed crop. Summertime temperature is the most important factor when the buds are initiated and again during the seed-ripening process in the third year. The wind conditions and amount of precipitation also have an effect on the seed crop (Sarvas, 1962, 1970; Kohh, 1968; Kardell et al., 1973; Leikola et al., 1982; Almqvist et al., 1998). The annual heat sum in the third year of the reproductive cycle is especially

important for pine seed maturation. According to Sarvas (1970), 845 degree days (d.d.) are needed for 50% of the seeds to mature anatomically, and even higher annual heat sum requirements have been reported (Henttonen et al., 1986). Most of the seeds are mature if a temperature sum of 900–1100 d.d. is reached (Sarvas, 1970; Henttonen et al., 1986). Environmental factors other than the annual heat sum also have an influence on the observed variation in seed crop maturity. In previous studies it has also been reported that the length of the photoperiod has an effect on seed maturation (Sahlén & Bergsten, 1994) and that the chemical maturation of the surface structure of pine seeds is connected to the photoperiod (Tillman-Sutela et al., 1998).

Pine produces seeds almost every year in the northern part of Finland, but good seed years occur rarely and the germination capacity of the seed lots seldom exceeds 70% in northern areas (Renvall, 1912; Heikinheimo, 1937; Asplund et al., 1973; Ryyänen, 1982). The poor quality of the northern seed crop is caused by the incomplete maturity of the