1. INTRODUCTION

Regeneration is one of the fundamental processes during the forest's life, through which it is ensured the forest maintaining in space and time. The regeneration and extension of forest areas is an obligation and a priority for the national forestry sector (Romanian Forestry Code 2018). In the last period, the annual country-wide regenerated area has been approximately 28,000 ha, of which the artificially regenerated area represents 38%. Concerning artificial regeneration, coniferous seedlings occupy the majority share (57% of the total planted seedlings), Norway spruce being in the first place with 27%, followed by European silver fir with 5% (National Statistics Institute 2018). In our opinion, taking into consideration the ecological requirements of silver fir and the site conditions in the ecosystems of Romania, and also the economic value of this species, it would be required to use it to a greater extent than it has been used by now.

At an international level, one of the objectives of the Agenda UNO 2030 on sustainable development is to increase the forest areas and to reduce their fragmentation to ensure soil protection and the supply of forest products. In the context of climate change, maintaining forest productivity and increasing wood quality has become lately a major problem for the forestry domain. Climate change is leading to radical changes in the species geographical distribution, wood production and reproductive capacity (Hoffmann & Sgro 2011). EU regulations and policies regarding forest regeneration and carbon sequestration promote afforestation and reforestation with native species and local provenances as being one of the basic measures that can contribute to adapting and mitigating the effects of climate change on forest ecosystems.

Romania is under the influence of the temperate-continental climate and scenarios upon the effects of climate changes foreshadow the possibility of recording periods of excessive drought during the vegetation season, which cannot remain without consequences on the vitality and regeneration of the forest. Productivity and adaptability of tree populations are closely related to the genetic and qualitative characteristics of the forest reproductive material. Therefore, the production and use in reforestation of forest reproductive material with superior genetic traits will ensure the success of reforestation work and the capacity of the forest's ecosystems to adapt to environmental changes.

In this context, in addition to the aspects regarding the production of forest reproductive material with superior qualitative characteristics, the conservation

of high-quality seeds is extremely important. Seeds conservation is necessary both in the short and long-term, given that most forest tree species do not have fructification yearly.

The European silver fir (*Abies alba* Mill.) is one of the most important species of the mountain ecosystems in Romania with multiple functions, including ecological, economic and soil protection. The periodicity of abundant fructifications of silver fir is between 4 to 5 years in seed stands and 2 to 3 years in seed orchards (Mihai, 2015). In Romania, there are 10 silver fir seed orchards with a total area of 85 ha and 3,344 ha seed stands in the selected category (Pârnuță et al., 2012). The seed production of silver fir seed orchards, in good fructification years, is approximately 300-400 kg/ha, and the viability percentage is on average 60%. Due to the very good fructification of silver fir seed orchards in Romania, the easiness of cones harvesting and the high quality of seeds, the forest reproductive material currently used in the reforestation works mostly comes from seed orchards. At the same time, given the high quality of silver fir seeds harvested from the seed orchards in our country, since 2010 the export of seeds from seed orchards managed by the National Forest Administration - Romsilva has increased.

Therefore, it is necessary to preserve the surplus of silver fir seeds in the good fructification years, at least until the next fructification. In Romania, a method for silver fir seeds conservation has not been established, and losses due to seed storage until the next spring can reach up to 50%. Because of this, literature in the country and existent technical guidelines recommend sowing the silver fir seeds in autumn, immediately after harvesting, to prevent the decrease in the percentage of germination (Haralamb 1967, Rubţov 1971).

The conservation conditions must ensure that the qualitative characteristics of the seed lot are maintained and that they will not be subject to depreciation during the storage period. The success of forest species seeds conservation depends on the knowledge of the factors that influence conservation, namely both genetic and initial qualitative characteristics of the seed lot (germination/ viability, purity, moisture content, presence of pests, etc.), as well as of the storage conditions (temperature, type of packaging etc.) (Holmes & Buszewicz 1958, Barton 1961, Harrington & Jonnson 1970, Wang 1974). At the same time, in order to optimize the technical conservation procedures and prolong the longevity of seed preservation, it is important to determine and monitor the specific physiological processes that may occur in the mass of the seed lot.

Depending on these factors, forest species were classified as orthodox (Norway spruce, European larch, Scots pine), recalcitrant (sessile oak, common

oak, horse chestnut tree) and intermediate (European silver fir, European beech) (Gosling 2007). The "orthodox" and "recalcitrant" categories were first introduced by Roberts (1973). The author defined the orthodox species as being those for which the seeds' moisture content could be lowered till 2 to 5%, and for which the longevity increased proportionally with the decreasing of the storage temperature. Recalcitrant species require high moisture content to maintain seed viability (40%), and the storage temperature cannot be lowered below -3 °C (Suszka 1971, 1974). Characteristic for intermediate species is that, being more sensitive to drying than orthodox species, seeds' moisture must be maintained within certain limits (10 to 12%), which leads to a shorter period of conservation (Hong et al. 1996, Gosling 2007).

More than 90% of the forest species from the temperate zone are orthodox. The silver fir is considered to be an intermediate species, which requires a higher moisture content to maintain seeds' viability (Barner 1975b). Also, silver fir seeds contain oils and resin in a high percentage (approximately 20%), which besides the beneficial role of protecting seeds from excessive drying or early germination can determine the rapid depreciation of seeds by breaking of resin vesicles and embryos contamination (Bouvarel & Lemoine 1958, Cermak 1987). Therefore, the main problems for the conservation of silver fir seeds are the following: 1) which are the qualitative characteristics of the seed lot that influence seed conservation, 2) what conditions must the conservation environment meet, 3) which would be the suitable conservation method, and 4) what would be the conservation period?

The main objective of this paper was to study the main factors that influence the viability of silver fir seeds during the conservation period and to establish an adequate method for the conservation of the silver fir seeds over a period of at least 3 to 4 years, as that is the fructification periodicity of silver fir seed orchards and seed stands in Romania.

The book is structured in five chapters and it is completed with a working protocol for silver fir seeds conservation. The first chapter presents the material and research method by describing the silver fir seed lots used, the environments tested for the conservation of silver fir seeds, the laboratory and statistical analyses carried out and the determined parameters. Chapter 2 presents the results concerning the genetic variability of some morphological and qualitative characteristics of the silver fir cones and seeds harvested from seed orchards and natural populations in Romania. Chapter 3 shows the results obtained during the experiments carried out in the period 2010 - 2019, in order to determine the silver fir seeds conservation method, by testing various storage conditions.

This chapter also describes pre-treatments tested to stimulate the germination capacity of the stored seeds, emergence percentage of stored seeds in the nursery compared to fresh ones and characteristics of seedlings obtained from conserved seeds. Chapter 4 presents a series of recommendations concerning harvesting and processing of silver fir cones, extraction of seeds from cones, drying and processing of silver fir seeds. We consider that these recommendations are very useful for obtaining high-quality seeds both in terms of conservation and improving the technology for producing silver fir seedlings in nurseries. The final chapter presents the conclusions drawn from the analysis of the research outcomes.

The book is addressed to forest engineers who work in the field of forest regeneration, researchers and anyone interested in the breeding and culture of this species in nurseries.

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