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BIOCHEMICAL PARAMETERS IN AGING DETECTION OF SEEDS AND COATING MATERIALS IN PRESERVATION OF QUALITY PROPERTIES

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The effects of changes in the global climate in the last century have been observed more intensely. These changes occur as a change in precipitation regime as well as changes such as gradual or extreme temperature increase in the climate and may pose a threat to forest ecosystems. At the beginning of these threats, drought, which occurs as a result of extreme temperature increase, which is one of the main indicators of global climate change, appears as an abiotic stress factor in forest trees. This situation, which is caused by climatic changes, has important effects on the quantity and quality of the seed, which is the key and basic production material in the natural regeneration of forests and artificial plantation facility. While the aging effect increases in recalcitrant seeds, which are sensitive to drying and can be stored for short periods, especially in forest trees, it may lead to decreases in seed germination parameters.. In this context, besides the temperature increase, the change of precipitation regime and sudden air movements may negatively affect the effective fertilization and healthy seed formation in the seed pollination phase. For these reasons, it is becoming more and more important to extend the storage life of the quality seeds obtained in abundant seed years and to keep them alive for a longer period of time. Basic biochemical parameters can be used to determine the aging effects of forest tree seeds and coating materials can be used to extend the storage life. As a result; It is aimed to determine the mentioned parameters and to preserve the quality of the seeds by ensuring the viability of the seeds for a longer period of time.

Introductıon. Forests cover approximately 30% of the world’s total land mass (FAO, 2010) and are an integral part of life on earth, providing a range of services at local, national and global levels. Projected changes in climate, both gradual and extreme events, pose a serious threat to forestry (IPCC, 2011). The direct pressures of climate change on forest gene resources and indirect effects caused by changes in biotic (eg insects and disease) and abiotic (eg fire, flood) disturbances affecting forests are known. It is an inevitable result of global warming caused by the increase in temperature of the sun's rays that cannot escape

from the earth, due to the increase in the densities of greenhouse gases such as carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4) and nitrogen dioxide (N_2O) in the atmosphere. As a result of this, "climate change" has become a factor that negatively affects natural life today. Climate change may result in high variability in temperature and precipitation, with an increase in incidence of extreme events, such as flooding, late frosts and intensive summer droughts, among other events (IPCC, 2011).

The effects of elevated CO_2 and temperature on seed quality have been recently reviewed. Therefore, the effects of climate change on the seed are revealed by the decrease in seed weight, germination and viability characteristics (Hampton et al., 2013). The seed crop is also affected by climate change regarding the change in crop phenology, reproduction, flowering, anthesis/pollen viability, pollination/fertilization, length of seed-filling duration, seed set, seed size, seed dormancy, seed yield, and ultimately seed quality (Singh et al., 2013). Climate change, which affects the reproduction of trees, may have long-term consequences by reducing species dispersal and by the acquisition of new habitats (Dyderski et al., 2018). Therefore, there is an indisputable need to store forest reproduction material to guarantee the continuity of regeneration of species in farm forests. Trees produce more flowers at higher temperatures but the flowers are not effectively pollinated and numerous seeds are infertile as a result (Pearse et al., 2016).

Most species have clearly recalcitrant or orthodox seeds. However some species with recalcitrant seeds can significantly change their position on the desiccation tolerance scale depending on climate (Daws et al., 2006). Climate changes occur at a rate that is too fast to enable genetic adaptation of such species, and thus these plants may have a considerable influence on the ability of their seeds to germinate (St Clair and Lynch, 2005). Orthodox seeds acquire desiccation tolerance, therefore they are prepared for survival in unfavorable environmental conditions even during development. However, recalcitrant seeds cells do not contain those components and the lack of them leads to membrane damage and, as a consequence, to viability loss due to environmental stress (Berjak et al., 2007; Kijowska-Oberc et al., 2021).

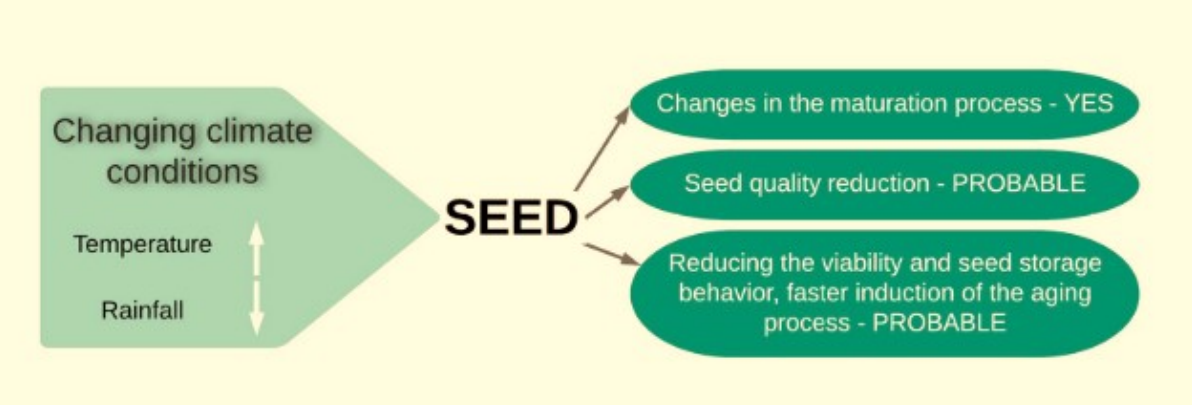

Figure 1. Impact of changing climatic conditions on the quality and viability of forest reproductive material, current knowledge and perspectives

As a result of high temperature effects caused by climate change, stress factors become active in the seed. This situation causes aging in the seed. In this context, the effects of abiotic stress factors on the seed can be delayed with some applications and seed pre-treatment.

Seed priming is the known methods for rapid germination and sustained establishment of the plant in stress condition that the most influential factors on agricultural production (Bewley et al., 2013). Different priming methods include hydro-priming, osmo-priming, halo-priming, thermo-priming and hormone-priming that different reports on different plants this priming are presented by researchers (Rehman et al., 2012). One of the newest priming methods, using micro or macro nutrients for the seed treatment before sowing is called nutri-priming (Mirshekari, 2015).

There are various defense mechanisms in seeds to eliminate the effects of free radical derivatives, and the most important of these is antioxidant enzymes. These enzymes, primarily catalase (CAT), superoxide dismutase (SOD), various peroxidases (POX, APOX, etc.) and glutathione reductase (GR), play an important role in the conversion or elimination of free radicals formed as a result of aging into harmless compounds (Gill and Tuteja, 2010).

As a result of all these evaluations; High and extreme temperatures caused by climate change increase the aging process in seeds and adversely affect seed quality. Therefore, the protection of seed gene resources has become more and more important. In this context, it is aimed to increase the germination capacity and preserve their vitality with different priming applications of seeds that have decreased germination and vitality characteristics.

Clımate change, seed and seed agıng. Climate change creates a big problem especially for endemic species and their seeds (Turkes, 2008). Each plant maximizes its growth and development performance at optimum temperatures with a lower and upper limit. If the temperature approaches the lower and upper limits, the growth slows down, if it rises above these limits, the growth stops completely (Kubilay, 1999). It is known that global warming also affects the flowering times of plants. Oaks normally wait for late spring temperatures to open buds. It has been observed that oaks in the Netherlands open their buds earlier due to the 2˚C increase in temperature since 1980 (Erman, 2009).

Throughout their long lives, trees are exposed to various kinds of stress. It may be caused by unfavorable external conditions, such as water shortage, extreme temperatures, strong salinity or too high levels of toxic metals. Depending on the inducing factor, stress may restrain plant development to a different degree at the various phases of its life. One of the main responses of plants to stress is an excessive production of reactive oxygen species (ROS), such as $O2^{-\bullet}$, H_2O_2 and •OH (Kurek et al. 2019). Trees produce more flowers at higher temperatures but the flowers are not effectively pollinated and numerous seeds are infertile as a result. Observations conduced in the recent decades revealed a relationship

between the increase in average temperatures and higher frequency of seeding years in European beech (*Fagus sylvatica* L.) (Kijowska-Oberc et al., 2021).

The indirect effect of global warming on seeds is con- nected with their long-term storage. desynchronization of massive seed yields for trees exhibiting cyclic yields results in a lower number of seeds with a living embryo (Bogdziewicz et al., 2020). Under the circumstances, it becomes indispensable to secure the seeding material by storing it after harvesting for the purpose of forest regeneration in the future (Kijowska-Oberc et al., 2021). By minimizing the effects of seed aging caused by climate change, seed quality and vitality will be preserved. For this purpose, especially in long-term storage, applications that ensure the viability and germination properties of seeds for a long time come to the fore.

Coatıng materıals to preserve seed vitality. Seed aging reduces the biological value of the seed, reducing its resistance to stress conditions and the germination rate. However, priming also alleviates these negative effects of aging on the seed. As a matter of fact, priming increases the respiratory activity of seeds when priming is applied to old seeds, the activity of superoxide dismutase, catalase and glutathione reductase enzymes improves. On the other hand, priming application increases the activity of various antioxidant enzymes and in addition to this, the level of various antioxidants such as glutathione and ascorbate (Elkoca, 2007).

It has been determined that priming applications with polymers such as chitosan and putrescine, α-tocopherol, glutation increase the seed germination capacity, especially in order to increase the germination capacity of the seed. Afzal et al. (2009) determined that priming with polyamines improved seed germination, seedling viability and anti-oxidative activity in tomato seeds. Castro et al. (2016), the germination of chitosan-treated tomato (*Solanum lycopersicum*) and coriander (*Coriandrum sativum*) seeds increased significantly compared to the control group. In another study, priming with glutathione was applied to increase the quality of forage seeds and it was determined that the quality of seed lots was increased by priming (Prasath et al., 2020). The effect of antioxidant solution priming on the vigor of sunflower seeds exposed to the cold test was significantly more pronounced than that on seeds exposed to accelerated ageing.

Conclusıon. Global climate change refers to the increase in the average surface temperature of the earth and the changes in the climate as a result of the increase in the natural greenhouse effect of the greenhouse gases released into the atmosphere as a result of human activities. In other words, it is the gradual or excessive increase in the earth's temperature. The negative effect of this temperature increase on plants and seed gene resources is manifested as loss of vitality and low germination capacity. Therefore, the importance of seed gene resources in maintaining genetic diversity and preserving seed quality is an indisputable fact. Especially in forest tree seeds, the effects of global warming were determined as the prolongation of the period between the years of abundant seed and the decrease in seed quality in this process. In this context, the seeds obtained in abundant seed years lose their vitality during storage due to effects such as aging. Viability and germination properties of these aging processes are

improved by pre-treatment of seeds with substances containing different polyamines or antioxidant properties.

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