«Сейфуллин оқулары – 18: « Жастар және ғылым – болашаққа көзқарас» халықаралық ғылыми -практикалық конференция материалдары = Материалы международной научно-практической конференции «Сейфуллинские чтения – 18: « Молодежь и наука – взгляд в будущее» - 2022.- Т.I, Ч.VI. – P.88-92

A TOOL FOR DETERMINING GENOTYPES AND POPULATIONS OF FOREST TREE RESISTANT TO CLIMATE CHANGE: BIOCHEMICAL ANALYSIS

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Abstract

The twenty-first century is a century in which climate change and its effects are most felt and new strategies need to be developed. The positive or negative effects of abiotic and biotic stress factors on climate change and its induced effects on different ecosystems are being monitored more and more intensively every day. In particular, global warming not only triggers abiotic stress factors, but also increases insect damage, which has an important place among biotic stress factors, and can cause an increase in insect populations and epidemic damage. This situation is expected to increase the severity of the damage caused by forest pests due to possible climate change in the future. Therefore in today's conditions, not only establishing forests, but also establishing forests resistant to changing conditions stands out as a very important goal. In parallel with classical breeding studies, biochemical analyzes (SOD, POD, CAT, APX, Prolin etc.) to be performed on forest trees and the detection of individuals and populations resistant to biotic and abiotic stress factors can provide a practical prediction in a much shorter time compared to long-term classical breeding studies. In this way ıt will be possible to establish forests that are resistant to the effects of climate change and to achieve higher plantation success.

Keywords: Abiotic, biotic stress, resistant forest, tree breeding.

Introduction

As a result of uncontrolled destruction of forests, global climate change and global warming in parallel, the threat level of biotic and abiotic stress factors on forest areas has increased. This negative impact of climate change in the last century, intensification of human influence, and movement changes of herbivorous insects between regions are among the main reasons for the current pressure on forests (Vertui and Tagliaferro, 1998; Fedorov, 2000; Hogg and Brandt, Kochtubajda, 2002; Woodward, 2006; Storozhenko, 2001; Hopper and Sivasithamparam, 2005).

Large quantities of leafy and coniferous tree seeds are needed for the reforestation of forest areas all over the world that have been degraded due to the destruction of forest areas (Çanakçıoğlu, 1963). For this reason, the need for seeds and saplings have an importance in artificial regeneration and silviculture treatments (Özek and Avcı, 2017). Regeneration and silvicultural practices are faced with a number of disruptions caused by both biotic and abiotic stress factors. These difficulties negatively affect the success of silvicultural treatments. Errors in origin selection and inappropriate seed selection negatively affect the success of silvicultural treatments like many other factors (Bat-Erdene and Dashzeveg 1995).

For this purpose, it is important to combine the results of long-term classical breeding studies and the information using biochemical parameters with classical breeding studies in order to increase the success rate in silvicultural studies that are resistant to abiotic and biotic stress factors in changing climatic conditions. Thus, in order to develop plantations resistant to multiple abiotic and biotic stress conditions in nature, the success rate will be increased in silvicultural studies together with classical breeding studies.

Bioactive Components and Antioxidant Systems

Plants produce a wide variety of secondary metabolites that are not involved in primary metabolisms necessary for survival and survival. In a number of studies, including Feeny's (1970) pioneering work on the ecological roles of plant tannins, many of the plant secondary metabolites have been identified as playing important roles in plant defense activities against herbivores, including insects, mammals, and snails. By the 1980s, information on the main groups of defense chemicals such as alkaloids, non-protein amino acids, cyanogenic glycosides, glucosinolates, terpenoids, coumarins, cardenolides, iridoid glycosides, tannins, phenolics, flavonoids and phytoecdysteroids increased and their defense roles against insects began to be better understood (Rosenthal and Berenbaum, 1991; Harborne, 1993).

The defenses caused by herbivorous insects in plants are divided into two as direct and indirect defenses. Direct defenses are used by plants as plant secondary metabolites or bioactive components, while indirect defenses include extrafloral nectars (Kaplan et al., 2016; Aljbory and Chen, 2018) or predators of herbivorous insects and It can also be in the form of volatile compounds (terpenes) that attract parasitoids (Dicke et al., 2003).

There are many defense mechanisms that protect plants against the effects of biotic and abiotic stress factors. It is known that these protection mechanisms act in the defense of the plant against a wide variety of stress factors (Pereira and Filipe, 1998). Flavonoids and isoflavonoids are biosynthesized via the phenylpropanoid pathway and contribute to plant defense against oxidative stress factors (Dakora and Phillips, 1996) such as pathogens, herbivores or abiotic factors. Plant injury induces these compounds (Hagerman and Butler, 1991). In addition to all these, phenolic compounds, which are plant secondary metabolites known to be effective in preventing pathogen invasions as well as providing mechanical support in plants, should be considered (Table 1).

Table 1. Plant Biochemical components and functions in plants

THE ANALYSIS	**WHY ARE THESE ANALYZES REQUIRED?**

THAT NEEDS TO BE DONE	
Chlorophyll amount analysis (Chlorophyll a, chlorophyll b, Total chlorophyll, carotenoid)	Chlorophyll; *a* and *b* are the most important biological molecules involved in photosynthesis. The amount of sunlight absorbed in photosynthesis is related to the pigment concentration in the leaf. The decrease in the amount of chlorophyll limits photosynthesis and primary production. Leaf nitrogen is associated with chlorophyll, which can be an indirect way of measuring the nutrient status of the plant. Molecules such as chlorophyll a, chlorophyll b, and carotenoid are also related to stress biology.
Total flavonoid analysis Determination of total phenolic content	Phenolic compounds; It is found in plant, fruit, seed, flower, leaf and branch. They are used in the growth and development of plants, plant defense, color and taste properties of fruits and vegetables. Phenolics also; It acts as a preventative, antioxidant, anti-mutagenic, anti-viral, anti-bacterial, algicidal, anti-fungal, insecticidal against ROS, herbivores and pathogens in UV protection.
Analysis of certain phenolic compounds subject to research by HPLC	Analysis with the standard to be determined in line with the parameter to be investigated
Determination of enzymatic antioxidant enzymes (SOD, POD, CAT, APX)	In a tissue damaged by insects, there are many biochemical processes that disrupt the normal functioning of plant cells. The rapid increase in the formation of reactive oxygen species (ROS), such as superoxide anion (O_2^-) and hydrogen peroxide (H_2O_2), is an early response of plant cells to tissue damage. The increase in the activity of enzymatic antioxidants directly involved in the metabolism of plants is the result of intense and additional production of ROS. SOD is the first enzyme of the organism to fight against oxidants and has high antioxidant activity. They carry out the dismutation of the superoxide radical to H_2O_2. SOD is an enzyme that catalyzes the dismutation between O_2^- to H_2O_2 and O_2. The most important function of the CAT enzyme is to minimize irreversible damage to cell and organelle membranes. CAT; It catalyzes the conversion of H2O2 to molecular oxygen. Ascorbate peroxidase (APX); It catalyzes the conversion of H_2O_2 to water and

	monodehydroascorbate. POD has many tasks in relation to defense occurring in plants. Such as lignification, suberization, embryogenesis, auxin metabolism. Another important enzyme that breaks down H_2O_2 is APX. In addition, plants; Thanks to their antioxidant systems, they can fight against the negative effects of environmental stress (abiotic stress factors).
Proline analysis	Proline; It acts as an adaptation mechanism against various stress factors. It shows an important regulatory activity especially in drought and salinity. Proline; It is used as a backup source for C, N and ATP during the stress recovery process. Protects thyloid membranes against free radicals promoted by mild damage. It acts as a protection against ROS and singlet oxygen. It stabilizes membranes as well as protein and DNA. It is an effective scavenger of ROS formed under salt, metal and dehydration stress conditions.
Polifenol oksidaz (PPO)	PPO has important functions in plants. One of them is to increase the resistance of the plant when exposed to a viral or microbial infection. For example; Tissues with viral infection have higher levels of PPO enzyme than healthy tissues. In addition, PPO provides a defense against insects after insect injuries.
Phenylalanine ammonium lyase (PAL)	Since PAL plays a key role in the synthesis of phenylpropanoids, it removes the amine group from phenylalanine, an amino acid that plays an important role in defense against herbivorous insects, and converts it to cinnamic acid, which is also effective in the synthesis of secondary metabolites such as suberin, lignin, flavonoid and phytoalexin.

Conclusion and Recommendations

Global climate change, characterized by increasing temperatures, decreasing precipitation and temporal variability of precipitation, will cause drought events to occur with greater frequency and intensity (Hoerling et al., 2012). This situation may cause the existing forest assets to be more affected by the negative situation caused by biotic and abiotic stress factors. In this context, the effect of climate change and the resulting global warming on plants and insects should be well understood. The increase in temperature values may cause herbivorous insects, which could not find a habitat before, to use new places as habitat in forest areas. Because global warming may also encourage the expansion of some herbivorous species whose distribution is mostly limited to low temperatures (Shaver et al., 2000; Logan et al., 2003; Björkman et al., 2011). In addition, climate change and global warming may cause more extreme abiotic stress factors. Therefore; The effect on plant secondary chemistry and biotic-abiotic stress factors should be well researched and should be used effectively within the scope of short-term studies in parallel with the breeding studies in forestry activities.

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