Drought is one of the most common environmental stresses affecting the growth, development, and mortality of plants. The decline in trees productivity that results from growing under drought conditions for long periods of time, representing a significant challenge to forest management. Therefore, the management practices used in tree nurseries should be designed to minimize the adverse impact of drought on trees, after they are transplanted into forest stands. For example, cultivated seedlings should have a root system that can tolerate long periods of water scarcity. Indeed, the ability of trees to exhibit greater levels of drought tolerance is significantly linked to the water-acquisition potential conferred by its root system architecture.

Pedunculate oak grown from seeds sown directly in the soil are able to overcome periods of water shortage by drawing water from deeper layers of the soil due to the presence of a taproot system. Therefore, deep rooting greatly improves the water balance of a plant, compensating for the water scarcity in subsurface layers of the soil due to a lack of rainfall. The agrotechnical techniques used in forest nurseries during the cultivation of oak seedlings in containers, however, damage the taproot by the practice of "root pruning", thus limiting the ability of trees to access water under drought conditions. Therefore, it is essential to determine if and how trees sense changes in environmental conditions, such as drought, and transduce a signal to the root system that allows it to respond to water limitations. More specifically, we need to better understand how taproot growth and development is controlled by the integration of external (water shortage) and internal (genes and other regulatory molecules) factors. Gene expression can be regulated by controlling transcription through the activity of transcription factors (TFs) and/or by inhibiting the translation and cleavage of target messenger RNA (mRNA) by small, microRNAs (miRNAs). The interaction between genes, TFs, mRNAs, and miRNAs contributes to the control of gene expression at the tissue and developmental level. Thus, regulating the balance between these components plays a crucial role in root growth, especially under water stress conditions.

The key objectives of the proposed project are: 1) determine if container-grown oak seedlings with altered root system architecture (lack a taproot), can regrow their taproots and activate the same regulatory pathway in those taproots and lateral roots that are activated in oak seedling where the original taproot was not damaged; 2) determine the regulatory factors (genes, TFs, and miRNAs) that induce and regulate taproot growth and development; and 3) determine if there is a correlation between drought tolerance and enhanced taproot elongation brought about by the activation of growth-promoting genes. Elucidating the molecular mechanisms regulating the growth taproots and lateral roots will provide a better understanding of the role of these mechanisms in the response of root systems to drought. More broadly, the obtained information can be used to develop tree cultivation practices in nurseries that enhance the ability of containerized oaks to access water during sustained periods of drought.