2. Abstract

Yellow lupin (*Lupinus luteus* L.), an agriculturally important species, is characterized by a high correlation between drought stress and yielding. Water deficit in the soil leads to premature and excessive flower abscission, which prevents the development of pods with high-protein seeds. The process of flower abscission occurs in specialized layers of cells located at the base of pedicels, which forms the abscission zone (AZ). Drought activates the AZ and causes molecular and biochemical transformations in this tiny piece of tissue, leading to a loosening of the cell wall structure, a break in tissue continuity, and, consequently, the organ separation. Among the elements coordinating the changes taking place in the AZ are phytohormones, which, by influencing specific gene expression and hydrolytic enzyme activity, determine the rearrangement of cell wall components.

The doctoral thesis aimed to investigate hormonal changes and modifications related to the cell wall structure in the AZ of *L. luteus* flowers in response to soil water deficit. As a first step, the effectiveness of the stress stimulus was verified by histological changes of flower AZ and the determination of stress markers. It was shown that soil drought induces a loss of cell integrity and increases the level of proline, which exhibits osmoprotective properties. Moreover, the stressor increases malondialdehyde, a breakdown product of polyunsaturated fatty acids, and causes the accumulation of phospholipase D, which, by hydrolyzing cell membrane components, determines the formation of, e.g. α-linolenic acid, a precursor of jasmonates - the hormonal stimulators of flower abscission in *L. luteus*. Drought stimulates the expression of the gene encoding lipoxygenase (*LlLOX2*) involved in jasmonate biosynthesis and accelerates LOX activity and accumulation of jasmonic acid, the main representative of the jasmonate group. Soil water deficit activates also the enzymes responsible for the signaling pathway of these phytohormones in AZ. Other hormonal factors regulating AZ flower function are auxins and the maintenance of their basipetal transport guarantees the detachment of organs on the plant. Soil drought increases the level of indole-3-acetic acid and activates AZ by disrupting the gradient of this phytohormone on both sides of this structure.

Biochemical and immunocytochemical analyses indicate that drought caused cell wall rearrangement, which includes an increase in pectin content in the AZ of *L. luteus* flowers and changes in the degree of homogalacturonan (HG) esterification. This stressor altered the tissue and cellular localization of enzymes catalyzing the demethylation reaction (pectin methylesterase) and polygalacturonase, which hydrolyses the bonds linking

unesterified pectin. The water deficit induced in the AZ of *L. luteus* flowers changes the localization of galactans and arabinans, which can regulate interactions between HG chains, also modified the distribution of xylogalacturonans, and reduced the level of other cell wall polysaccharides – hemicelluloses. Drought modifies the cellular and tissue localization of one of the predominant groups of cell wall hemicelluloses (xyloglucans) and extensins, key cell wall glycoproteins that enable cell wall growth in stress conditions. The results of transcriptomic analyses confirmed that drought is a factor that differentiates the expression of genes related to cell wall remodeling in the AZ of *L. luteus* flowers. In turn, proteomic analyses enabled the identification of proteins that appear in flower AZ in response to drought. These include proteins involved in transcription and translation regulation, phytohormone biosynthesis and signal transduction pathways, those regulating cell metabolism and signaling and associated with the plant's response to stress, those involved in the degradation of other proteins, and proteins related to AZ functioning.