Stress tolerance marker or protective substance? Proline as a tool in the fight against drought in forests

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Keywords: proline metabolism, drought stress, tree seedlings, oxidative changes

Proline accumulation is a biochemical response of plants to water deficit. Stress associated with climate change, including drought stress, induces excessive accumulation of reactive oxygen species (ROS) in plant cells. Tree seeds are particularly susceptible to oxidative damage of cellular structures caused by these molecules.

Proline biosynthesis is enhanced to scavenge ROS and prevent the disturbances they cause. Proline stabilizes cell membrane structures and is an important component of many proteins, thereby improving their integrity. This amino acid also exhibits osmoprotective properties, limiting water loss from cells, which is critical under drought conditions.

Proline levels vary depending on temperature and moisture conditions, especially in seeds sensitive to desiccation (*recalcitrant* category). Its accumulation is also influenced by the duration of drought and the mass of the seeds from which seedlings developed. Moreover, seedlings of deciduous species and species producing recalcitrant seeds accumulate proline more intensively than seedlings of coniferous species and species producing seeds resistant to desiccation (*orthodox* category). Activation of drought defense mechanisms is also reflected in changes in the activity of enzymes involved in proline biosynthesis (pyrroline-5-carboxylate synthetase – P5CS) and catabolism (proline dehydrogenase – ProDH).

These observations suggest that proline and enzymes involved in proline metabolism are promising biochemical markers, potentially useful for selecting high-quality forest reproductive material. This could help mitigate losses in commercial forests resulting from the impacts of climate change.

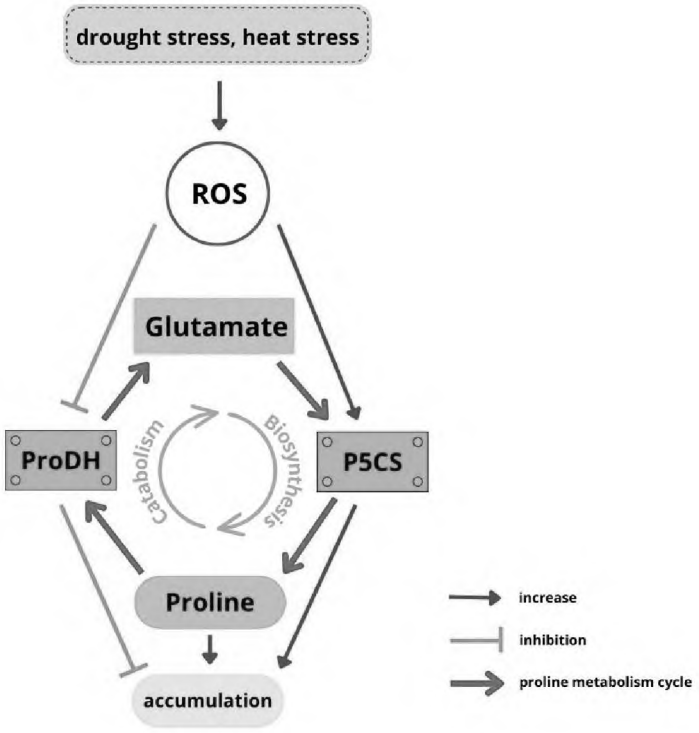

Fig. 1. The relationships between environmental stressors and the proline metabolism cycle