CO2 increase in the atmosphere augments tolerance of barley to salinity

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In future, climate change will bring an increase in salty surfaces on the Earth and in the concentration of CO_2 in the atmosphere. However, this higher CO_2 has some positive effects on the physiology of barley plants and increases its tolerance to salinity. This is the conclusion of the PhD thesis of Ms Usue Pérez-López, defended at the University of the Basque Country (UPV/EHU).

Barley is one of the most important crops in the world. In fact 56 million hectares are under barley crops, making it the fourth most grown cereal worldwide. It is widespread over all the Continents, given that it adapts very well in different habitats. As with other plants, the correct development of barley depends on a suitable balance between the availability of water, nutrients and CO_2. Nevertheless, it is predicted that there will be an increase in salinity in the soil in future, causing various imbalances which will result in a reduction in the growth of barley.

According to a number of authors, an increase in the CO_2 level in the atmosphere may mitigate this growth decrease of the plants caused by high concentration of salts. However, research to date differs as regards results, and it is not known if the increased levels of CO_2 can mitigate the negative effects of salinity on barley. This question was addressed by UPV/EHU teacher, Usue Pérez-López, in her PhD, presented at the University's Faculty of Science and Technology: *Physiological responses of barley to the interaction of salinity and increased CO_2. Prospects with climate change*. Ms Pérez-López, a graduate in Biological Sciences with an Extraordinary Degree Award, carried out her work under the

direction of doctors Alberto Muñoz-Rueda and Amaia Mena-Petite, from the Department of Plant Biology and Ecology. Dr. Pérez-López developed part of her research at the Department of Chemistry and Agricultural Biotechnology of the University of Pisa (Italy).

Greater rates of salinity and CO_2

According to data supplied by the Food and Agriculture Organization of the United Nations (FAO), some 20% of irrigated arable surface area is subject to some level or other of salinisation, thus being hostile terrain for agriculture. Moreover, it is predicted that, in the near future, salinity will increase due to factors such as the expansion of irrigated zones, inefficient irrigation systems, the use of poor quality water and the increase in soil water loss due to greater evaporation as a consequence of high temperatures.

As a result of this increase in salinity the hydric state of barley plants will deteriorate and imbalances in their nutrition will occur due to excess sodium and chlorine (components of salt) and due to lack of potassium, calcium and nitrogen. In essence, the plant will produce less carbohydrates and proteins, which means a reduction in its growth.

The Intergovernmental Panel on Climate Change (IPCC) predicts that the CO_2 concentration in the atmosphere at the end of the XXI century will double current levels. An increase contributed to by human activity through the combustion of fossil fuels and the destruction of forests. However, Dr. Pérez-López believes that barley could benefit from this increase, at least as regards mitigating the negative consequences of high salinity. Her research was based on the hypothesis that the greater the concentration of CO_2, the higher the rate of photosynthesis, the hydric state of the plant is enhanced due to its lower transpiration (losing less water) and absorbs less toxic ions and is better protected against oxidation.

Dr. Pérez-López selected two varieties of barley (*Hordeum vulgare cv Alpha* and *Hordeum vulgare cv Iranis*) and studied their development, their nutritional and hydric states, their antioxidant system and carbon and nitrogen metabolisms, under high salinity and CO_2 conditions, both separately and together.

Positive effects of CO_2

One of the goals of Dr. Pérez-López's thesis was to see if the increased CO_2 levels would enable less chlorine and sodium to be accumulated in the tissues of the barley plant. After undertaking a study of the various plant organs, she concluded that CO_2 does not mitigate the accumulation of sodium in the tissues, despite the plant showing greater growth and less transpiration.

This lower transpiration, cause by the presence of high concentrations of CO_2, does attenuate the loss of water through the plant leaves, due to the fact that the stomas are kept closed and the plant tissues are dehydrated to a lesser degree. Moreover, Dr. Pérez-López observed that plants growing under these conditions show greater root development, which augments the surface for water absorption. As a consequence, deducing from Ms Pérez-López's thesis, high levels of CO_2 considerably enhances the hydric state of barley.

Dr. Pérez-López also asked herself if higher concentrations of CO_2 in the atmosphere mitigate the reduction in growth caused by salinity. According to her PhD thesis, high concentrations of CO_2 have a positive influence on the photosynthesis of the plant because, despite the fact that the plant keeps its stomas shut, the diffusion of CO_2 between the exterior and the interior of the leaf is greater.

Finally, Dr. Pérez-López determined the oxidative stress level of the barley (the oxidation suffered by a plant due to high salinity), studied its

antioxidant capacity, that is its defence mechanisms. Her conclusion was that high concentrations of CO_2 alleviate this stress.

In short, Dr. Pérez-López's research concludes that the increase in CO_2 enables greater growth of barley plants subject to saline conditions, thanks to the improvement in their hydric state and turgescence, but, above all, to the increase in photosynthesis.

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