Silver Banksia plants excel at phosphate saving

December 10 2013

Proteaceae are used to a lack of phosphorous. Their efficient management of phosphorous could be of interest for the optimisation of crop plants. Credit: MPI of Molecular Plant Physiology

Plants in the leached soils of Western Australia have developed a special strategy for coping with the scarcity of phosphorus. Together with colleagues from the University of Western Australia, Perth, scientists from the Max Planck Institute of Molecular Plant Physiology in Golm near Potsdam have discovered that plants from the Banksia genus of the Proteaceae family make severe cutbacks, in particular to the RNA found in the ribosomes (rRNA). The cell's protein factories are the biggest consumers of phosphorus; in this way, the plants save on both phosphorus and water. As global phosphorous reserves are in severe decline, the strategies of the Proteaceae could be of interest from the perspective of optimising crop plants through breeding.

Plants in Western Australia have to be very tough to survive. The heat is oppressive there, rain is extremely rare, and phosphorous in the form of phosphate is virtually nowhere to be found in the soil. However, this element is crucial to the survival of plants. It attaches itself to sugar and proteins and is a component of DNA, the cell membrane and the energy currency ATP. When phosphorous is scarce, photosynthesis declines and plants hardly grow.

This is not, however, the case with some of the plants from the Banksia genus of the Proteaceae family. "These plants grow on soils which contain a hundred times less phosphate than unfertilised soils in Europe," explains Mark Stitt, one of the authors of the study. This is due to their roots, on the one hand, which resemble toilet brushes and suck every phosphorous atom from the soil with their fine hairs. On the other hand, the plants are extremely prudent in their use of the little phosphorous available to them.

They save most in the nucleic acids, which combine between 30 and 50 percent of the cell's total phosphorous. Cutbacks are applied in particular to ribosomal RNA, a component of the cell's protein factories. Compared to Proteaceae, the model plant *Arabidopsis thaliana* has two to four times more ribosomes in its fully-grown leaves and, in the case of young leaves, it has 10 to 40 times more. Fewer ribosomes produce fewer proteins and enzymes. The plant grows more slowly as a result, but does not present any symptoms of phosphorous deficiency. In fact, only too much phosphorus could prove dangerous for them.

"The plants can be fertilised to death, as they cannot halt the absorption of phosphate," explains Mark Stitt. Other plants simply close down when over-fertilised. "Up to now, we did not know why the Proteaceae, which have adapted to phosphorous deficiency, are no longer able to do this." Presumably, they have simply never been in such a situation, as the soils of Western Australia are very old and weathered and did not acquire additional phosphate in the past from volcanic eruptions, people or animals.

The plants are also extremely economic when they form new leaves. Instead of investing simultaneously in the growth and formation of the photosynthesis equipment, which would bind huge volumes of ribosomes and, thus phosphorous, they focus first on the formation of the leaf and later on the production of the green chlorophyll.

In the next phase of their study, the researchers would like to establish whether humans could implement the strategies of the Proteaceae for the efficient use of phosphorous in crop plants, or whether this approach could be associated with disadvantageous characteristics, for example lower yields.

Phosphorous is very rarely found on the Earth and deposits are concentrated in very small geographical areas: almost 75 percent of the world's total phosphate rock is found in Morocco and the Western Sahara and a further 15 percent is distributed between China, Algeria, Syria, South Africa and Jordan.

More information: Ronan Sulpice, Hirofumi Ishihara, Armin Schlereth, Gregory R. Cawthray, Beatrice Encke, Patrick Giavalisco, Alexander Ivakov, Stéphanie Arrivault, Ricarda Jost, Nicole Krohn, John

Kuo, Etienne Laliberté, Stuart J. Pearse, John A. Raven, Wolf-Rüdiger Scheible, François Teste, Erik J. Veneklaas, Mark Stitt, Hans Lambers, Low levels of ribosomal RNA partly account for the very high photosynthetic phosphorus-use efficiency of Proteaceae species, *Plant Cell Environment*, Online Pub DOI: 10.1111/pce.12240

Provided by Max Planck Society