Agropol Transcriptomics

Transcriptional profiling of maize genes in response to a growth-promoting agropolymer

ABSTRACT

The use of polymers in agriculture is gaining popularity. Superabsorbant polymers potentially influence soil permeability, density, texture, evaporation and water infiltration rates. Functionalized (or “smart”) polymers are used to deliver various substances including pesticides and herbicides, thus lowering the doses applied to the cultures. Today a myriad of applications of these polymers exist (for a review see Puoci et al., 2008).

The Solvay-Rhodia company has identified the guar gum, a natural polymer produced by the legume Cyamopsis tetragonolobus, as a plant growth-promoting compound. The guar gum is a galactomannan, i.e. a polysaccharide consisting of a mannose backbone with galactose side groups, which is used to increase viscosity in food and pharmaceutical industries. Its beneficial effect on plant growth has been shown with maize and wheat, whether spread in the soil or used as a seed-coating agent. In addition to the simple guar gum (Pol0), 3 derivatives have been produced in which galactose units have been modified with either an amine group (PolA), or a propyle group (PolB), or both (PolAB).

It is unclear why the guar gum and its derivatives positively impact plant growth and yield. Within the frame of two successive collaborative projects involving Solvay-Rhodia and the Agropolis Foundation (NUTRIPOL1) and Solvay-Rhodia alone (NUTRIPOL2), our group in BPMP has investigated the impact of the 4 agropolymers on the plant biology. NUTRIPOL1 explored the response of the model plant Arabidopsis thaliana to the agropolymers in terms of growth and water/mineral assimilation in various culture systems. Although supplementation of the growth medium with either one of Pol0, PolA, PolB or PolAB affected profoundly the development of roots, we failed to observe a significant and reproducible effect on water and mineral nutrition. In order to try and tackle the metabolic or developmental process(es) targeted by the agropolymers, NUTRIPOL2 scrutinized the global changes in gene expression in response to PolA, the most effective polymer, using transcriptomic analysis. The study was conducted in Arabidopsis but also in maize in order to include an agronomically relevant plant. Short-term responses to PolA, within hours of exposure, were monitored. In maize, PolA induces a large number of genes involved in membrane and plastid biosynthesis/structure, and inhibits expression of genes related to protein trafficking. Hierarchical clustering of Arabidopsis genes response to PolA revealed 27 clusters with a rather blurred take-home message. Comparison of the transcriptomic response between the two species is under way.

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GOAL

Over the last few years, experimentations with maize grains coated with the guar gum-derivatives, in particular PolAB, have recurrently demonstrated improved growth in the field (data communicated by Solvay). On the contrary, the supply of polymers in laboratory conditions, even when attempting to mimic seed coating, often resulted in growth inhibition. A major drawback of the two previously funded projects was therefore to work with plant samples for which improved growth by the polymer treatments had not been satisfactorily achieved. The situation has recently changed since a positive effect of PolAB treatment, namely an increase of root growth, is now routinely observed with maize in the germination laboratory of Solvay (Clara Vernay, personal communication). We therefore propose to resume the transcriptomic study of polymer-treated plants using plant material obtained following Solvay’s optimal growth conditions.