Effet de bio-stimulant en agriculture

Impacts of agropolymers on germination and root development in plants (Arabidopsis t., Zea m., Casuarina g.)

ABSTRACT

Stimulated by the International Group "Rhodia-Operations-Solvay", a collaborative research project was created on the Agropolis Fondation plateform (Montpellier) in 2012 with the following topic: Use of plant biostimulants for agriculture. This project is supported by both the International Group and the Labex Agro in 2013 then managed by the University of Montpellier 2 (period 2013-2017). Today, it integrates several teams from diffrents research units (UMR DIADE, BPMB, IATE) belonging to the AgroBio Sciences Pôle which is emerging at Montpellier and combining complementary competences in sciences, technologies and agronomy. A real consortium has been organized with 3 professors (University, SupAgro school), 6 scientists (IRD, INRA, CNRS), 1 ingineer (University), 1 post-doctoral position during 9 months, 2 technicians (IRD, INRA) from which is added 1 external member (Prof University Lyon) from the thesis commitee, the scientific Head of the International Group including other chemists from his team.

On the basis of plant phenotype analyses when plants are submitted or not to differents polymers (Pol0, A, B, AB), contrasted root developments were observed whatever the culture system used. While PolB promotes growth of primary roots in Arabidopsis thaliana, PolA reduces it drastically but promotes the development of lateral roots which are relatively short and thick. These developmental patterns were also observed in Casuarina glauca with reliable consequences on the formation of symbiotic structures with Frankia (actinorhize). Interestingly, PolAB induces root architectures well-balanced combining a good growth of primary root with the emergence of numerous well-elongated lateral roots. In Zea growing in hydroponic system, PolAB seems to incerase both root and arial part biomasses, as previously observed in Arabidospis.

Following to these first data, a work thesis was engaged on the understanding of physiological mechanisms induced by the polymers, with a special attention to the root development in Arabidopsis, Zea, Casuarina and on the actinorhize formation in Casuarina. Different hypotheses were postulated concerning the roles of polymers on plants which depend on their physico-chemical properties, themselves linked to chemical changes of PolA, PolB and PolAB. Are polymers able to modify the hydro-mineral conditions in which the roots are developing when polymers are caoted on grains or added in nutritive solutions ? Can polymers induce directly physiological responses of plant tissues when they are in contact with roots ? Are they degradated by means of enzymes liberating therfore oligomers that could act as bioactivators or toxic molecules according to their chemical structures and concentration at root level?

Priliminary molecular approaches were investigated at 2 levels: 1- Using Arabidopsis plants that have integrated in their genome the fluorescent protein GFP under-controlled by the promoter DR5, itself regulated by auxin. Thus, the variations of fluxes and amounts of auxin in roots can be studied by microscopy (epi-fluorescence or confocal) through the green fluorescence localization. An increase of fluorescence was shown in root tips when PolB was added; PolB was previously shown to promote the primary root growth as compared to the control (Pol0). 2- By detection with a fluorescent probe (DAF-D2) indicating the level of NO in roots submitted or not to different polymers. NO is known to be a cellular signal involved in regulation of various physiological processes such as oxidative stress. The roots treated by PolA et PolAB show high level of fluorescence lindicating a high production of NO that could be responsible for the changes in root architecture mentionned above.

The work thesis is now focusing on the identification of polysaccharides able to modulate these root architectures including the formation of the symbiotic structures such as actinorhize. The next experiments are aimed to purify the polymers provided by "Rhodia-Operations-Solvay" and determine their active part that could induce the contrasted phenotypes previously observed. Then, it will be

necessary not only to purify them but also to obtain fragments by enzymatic way and to prove that roots can degrade the polymers. Finally, the monomers and oligomers will be isolated and then tested to better understand their functions by comparison to the whole polymers.

Furthermore, a new approach will be developed by the UMR BPMP (end of 2014-2015) in order to explore the effects of these polymers on the availability of hydromineral solution components at the root level. A phenotyping approach in Arabidopsis will be conducted in order to determine whether the mineral assimilation by roots is changed when the different polymers are added in the nutritive solution. A transcriptomic study will be then performed in order to identify the first molecular targets that could be involved and then deeply studied.

Keywords : Developing the plant of the future, Plant, Operation, Arabidopsis, Arabidopsis (species), root

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