NANOPARTICLES IN AGRICULTURE: DEVELOPMENT OF SMART DELIVERY SYSTEMS FOR PLANT RESEARCH

A. Pérez-de-Luque[1,], D. Rubiales[1], C.I. Marquina[2], M.R. Ibarra[2,3], J. M. de la Fuente[3]*
[1]CSIC, Instituto de Agricultura Sostenible, Alameda del Obispo s/n, Apdo. 4084, E-14080 Córdoba, Spain; [2]CSIC-Unversidad de Zaragoza, Instituto de Ciencia de Materiales de Aragón-Departamento de Física de la Materia Condensada, Pedro Cerbuna 12, 50009-Zaragoza, Spain; [3]Instituto de Nanociencia de Aragón, Universidad de Zaragoza, Edificio Interfacultativo II, Pedro Cerbuna 12, 50009-Zaragoza Spain
[*]Corresponding author: bb2pelua@uco.es

One of the most interesting biological applications of nanotechnology is the development of smart delivery systems for local drug delivery. It can be done through the use of nanoparticles incorporated into the blood which travel to specific sites to deliver their chemical load. In this way, it is possible to avoid collateral damage in patients and reduce the amount of active substance for treatments [1].

These techniques have a great potential for application in agriculture. For example, they can be used for the development of insecticides, fungicides, herbicides or fertilizers. In fact, this is really being done by the most important corporations in this field like BASF and Syngenta, and countries like USA and Israel [2]. A more in depth study of these technologies in agronomical sciences would allow their use in crop protection and/or studies of plant-pathogen interactions, opening new gates to face researches still under speculation or belonging to science fiction. The idea presented in this work is to give a step forward to adapt the technology of nanoparticles for systemic translocation in plants [3], allowing the transportation of substances to specific sites, studying the movement of solutes through the plant and the study of the plant-pathogen interaction. The application of this technology for treatment of plants with chemicals acting by contact (fungicides, insecticides, herbicides, etc.) seems to be immediate, but it is more complex for substances which must be translocated whithin the plant to reach the action point. If it is possible to get a distribution of the nanoparticles through the plant vascular system, and guide them to specific areas, they could be used for phytosanitary treatments with a minimum active substance amount, reducing the risks for environmental contamination and the presence of chemicals in the plant for further commercialization. In addition, this system could be used to unload chemicals or substances (plant hormones, elicitors, nucleic acids, etc.) into localized areas of the plant tissues, to carry on several studies at the physiological, biochemical and genetic levels.

For example, nanoparticles could be designed to target specific phytopathogens like fungi, viruses, bacteria or parasitic plants. In some cases, phytopathogens develop inside plant tissues (vascular pathogens [4, 5]) or under earth in the roots (root parasitic plants [6]), and fighting against them is very difficult because they remain undetected until the first disease symptoms appear. And then it is too late to treat the crops. But if nanoparticles can travel through the plant and target those phytopathogens releasing their chemical load at such point, many crops and trees diseases would be easier to control.

In addition, nanoparticles can be used to genetically transform plants in a more controlled way compared to the biolistic method. Following this approach, some works are being developed by USA research groups, as recently reported in Nature Nanotechnology [7].

References:

[1] Fernández-Pacheco R, Marquina C, Valdivia JG, Gutiérrez M, Romero MS, Cornudella R, Laborda A, Vitoria A, Higuera T, García A, García de Jalón JA, Ibarra MR, Journal of Magnetism and Magnetic Materials **311** (2007) 318-322.
[2] BASF, Nanotechnology at BASF. A great future for tiny particles, (2004), URL: http://www.corporate.basf.com/en/innovationen/felder/nanotechnologie/nanotech.htm?id=V00-EnACn72xfbcp2l1
[3] González-Melendi P, Fernández-Pacheco R, Coronado MJ, Corredor E, Testillano PS, Risueño MC, Marquina C, Ibarra MR, Rubiales D, Pérez-de-Luque A, Annals of Botany, **101** (2008) 187-195.
[4] Beckman CH, Roberts EM, Advances in Botanical Research, **21** (1995) 35-76.
[5] European and Mediterranean Plant Protection Organization, EPPO Bulletin, **34** (2004) 201-207.
[6] Joel DM, Hershenhorn J, Eizenberg H, Aly R, Ejeta G, Rich PJ, Ransom JK, Sauerborn J, Rubiales, Horticultural Reviews, **33** (2007) 267-349.
[7] Torney F, Trewyn BG, Lin VSY, Wang K, Nature Nanotechnology, **2** (2007) 295-300.