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Phosphate concentration alters the effective bacterial quorum in the symbiosis of *Medicago truncatula-Sinorhizobium meliloti*

Pakdaman, Najmeh, Akbar Mostajeran, and Zohreh Hojati

Department of Biology, University of Isfahan, Isfahan, Iran
LOEWE Center for Synthetic Microbiology, Philipps University of Marburg, Marburg, Germany
Najmeh Pakdaman

Abstract

The symbiosis *of Medicago truncatula-Sinorhizobium meliloti* is affected by phosphate (P) deficiency in the environment. Quorum sensing (QS) is a regulatory pathway in *S. meliloti* that controls various functions of free-living and symbiotic bacteria in response to phosphate availability and regulation is mediated by a periplasmic protein PstS, and also bacterial density. The quorum sensing pathway of *S. meliloti*, involves three genes named *sinI, sinR* and *expR* and also some bacterial auto-inducers such as N-acyl homoserine lactones (AHLs). In the current study, the expression of the different genes of quorum sensing and *pstS* were evaluated under 0.1, 0.5 and 2 mM P. The qRT-PCR results showed an increased expression of *pstS* and also the quorum sensing genes *sinI* and *sinR* but not *expR*, following phosphate starvation. Indeed, the enhanced level of *sinR* induces the expression of *sinI* that is responsible for the N-acyl homoserine lactones (AHL) production in *S. meliloti*. The different response of *expR* may be due to its negative control on *sinR* expression. In the symbiosis of *M. truncatula-S. meliloti*, it was shown that the concentration of phosphate in the medium alters the effective inoculating bacterial quorum (density). By increasing the phosphate concentration in the medium from 0.1 to 0.5 and 2 mM, considering the optimal plant growth and pink nodule (nitrogen-fixing) formation, the effective inoculating bacterial densities were 10^5, 10^7 and 10^9 CFU ml^{-1}, respectively. Therefore, low phosphate concentrations can compensate for a low bacterial density by inducing the quorum sensing pathway and establishing a symbiosis. Conversely, bacterial density plays the main role in the formation of symbiosis at high phosphate concentrations.