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How soil health-promoting Streptomyces adapt to soil stresses

Inhalt

Actinobacteria of the genus Streptomyces play a crucial role in supporting a fertile and biologically active soil ecosystem due to their unique biological and ecological functions1. They secrete a broad array of hydrolases which break down complex organic compounds like cellulose and chitin needed for recycling of nutrients and enrichment of the soil. They also produce many different antibiotics that suppress soil-borne pathogens, promoting a healthier microbial balance. However, in their natural habitat soil, streptomycetes and other microorganisms are often exposed to rapid changes in their environment such as variations in osmolality due to rainfall or drought. How they adapt to different types of stresses they face in soil is not well understood.

Many strategies that bacteria evolved for the adaptation to stress involve complex second messenger signalling cascades2. Nucleotide-based second messengers are small, diffusible molecules which can be monomeric, such as 3´,5´-cyclic adenosine monophosphate (cAMP) or dimeric for example bis-(3´-5´)-cyclic dimeric adenosine monophosphate (c-di-AMP). Streptomyces use five different nucleotide-based second messengers for signal transduction with dedicated and to some extent overlapping functions3. c-di-AMP is produced out of two molecules of ATP by the deadenylate cyclase DisA and is hydrolysed to the linear pApA and further to AMP by the phosphodiesterase AtaC. Increased levels of the signalling molecule interfere with the formation of stress-resistant spores, while deletion of the deadenylate cyclase makes Streptomyces highly susceptible to osmotic stress4. The molecular mechanisms causing failures in cell functioning upon modulation of c-di-AMP are not yet fully understood. In our recent studies, we found that c-di-AMP affects a range of physiological functions at the cell-environment interface, such as transport and cell wall architecture, and thus fulfils a crucial role for stress adaptation in streptomycetes.

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