Bacterial emboli – new biofilm-like structures, the formation of which requires the interaction of plants and microbes

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The population dynamics of pathogenic bacteria *Pectobacterium atrosepticum* SCRI1043 (*Pba*), and structure of microbe cells was examined within tobacco plants from the inoculation until preservation of microorganisms in the remnants of dead plants. We found and characterised peculiar structures that totally occlude xylem vessels, which we have named bacterial emboli. Bacterial emboli represent a new type of the three-dimensional structures, which consist of tightly packed, oriented bacterial cells that contact with each other. These structures are functionally designed for the xylem vessels blockage, which provides downstream flow of bacteria and causes the bacterial wilt symptoms. The bacterial emboli differ from previously described biofilms in their genesis and the composition of extracellular matrix. Besides exopolysaccharides, the matrix includes the plant cell wall-derived polysaccharides, which are spliced into complex network by the phenolic compounds and peroxidates. Whereas biofilm development begins with cell attachment to the substrate surface, formation of bacterial emboli starts with the gelation of the xylem sap. The resulting gel serves as a niche for the multiple bacterial cells and cell-to-cell contacts strengthen the structure of bacterial emboli. The formation of bacterial emboli coincides with partial hydrolysis of cell wall polysaccharides, which provide structural elements for emboli. Vessels blockage provides downward migration of bacteria through the xylem that facilitates diffusion of microorganisms in the rhizosphere.

The infection of tobacco often causes the death of the plant. However, 30% of inoculations lead to reproduction and dispersal of microorganisms without disease symptoms. Asymptomatic infection is associated with a predominance of salicylate response over the jasmonate-dependent response. After the death of the host-plant, bacterial emboli were dispersed gradually and viable but non-culturable (VBN) *Pba* cells were identified in the remnants of dead plants. The conditions for resuscitation of these VBN cells were established.

Our study shows that bacterial population within the plant is a structured developing system, integrated into the life cycle of macroorganism, which uses the immune reaction of plants to achieve their own physiological purposes.

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