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Opinion

Bacillus thuringiensis and their Endophytic Capabilities

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The main characteristic of *Bacillus thuringiensis* is that during sporulation produces a parasporal inclusion formed by one or more proteinaceous bodies that exhibit insecticidal activity upon ingestion by susceptible larvae of different orders of insects. In addition, the crystals are composed of insecticidal proteins (Cry/Cyt) and constitute the active ingredient of the most widely used biological insecticide [9].

Since the first commercial *B. thuringiensis*-based bioinsecticide (Sporeine®) was introduced into the market, this bacterium has demonstrated a proud and successfully history in insect pest management for almost 80 years [4]. More recently, genes encoding their insecticidal proteins have been transformed into plants and other organisms [9]. Since then, the spectrum of its applications has increased and is no longer limited to its initial function. It has become clear that the potential of *B. thuringiensis* would transcend biological control of insect pests. Recent studies analyzed novel properties for this bacterium, such as plant growth promoter [8].

From the environmental point of view, *B. thuringiensis* has been shown to be a multifaceted bacterium that may occupy various niches [9]. Notwithstanding the large amount of research on this bacterium, its true ecology is until now a matter of discussion. Some hold that *B. thuringiensis* is a specialized pathogen that, by colonizing and killing its hosts, and proliferating in their cadavers, is then deposited in soil and on phylloplane of plants, which thereby become natural reservoirs. Besides, some *B. thuringiensis* strains have shown the ability to colonize interior of plants without damaging their morphology or physiological processes [7].

In an endophytic relationship, *B. thuringiensis* would take up nutrients from the plant to survive, but would compensate such activity by protecting them against pest attacks. Some studies in cabbage, cotton, legumes (soybean, rice bean, French bean, gahat, lentil and pea), and medicinal plants (Indian Ginseng and greater celandine) have reported that *B. thuringiensis* was successful in endophytic colonization, even with production of insecticidal toxins [1,2,5-7,10]. The efficient *B. thuringiensis* colonization of cabbage seedlings roots suggests this might be in fact the main route of its penetration in the plant. Subsequently, vegetative cells, spores and crystals were found in diverse parts of the seedlings, achieving a complete colonization [8]. Comparably, *B. thuringiensis* was able to colonize the roots of determined legumes, which resulted in an increment of nodulation and growth of the plants [5,10]. Even in its vegetative stage, *B. thuringiensis* secretes toxins that can decrease pests or diseases attacks [8,9]. *B. thuringiensis* might enter the host plant root by penetration, through a natural opening (stomata) or via a wound, or through the action of hydrolytic enzymes [7]. It is widely known that Cry toxins are degraded by UV radiation and can be washed out from the phylloplane by irrigation or rain; when *B. thuringiensis* grows endophytically, these unfavorable conditions do not occur. Other reports, nevertheless, have showed that biological control tactics using the endophytic capabilities of *B. thuringiensis* have been less studied than transformation of other endophytic bacteria to express *B. thuringiensis* toxins [3,10].

Endophytic capabilities of *B. thuringiensis* in plants, accompanied by the production of Cry proteins, are of special interest because it might be used for the development of a new kind of pest-resistant crops. Future studies that go deeper into the exposed properties along this manuscript will be decisive in this regard.

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