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Opinion

Bacillus Thuringiensis Berliner: A Key Biological Agent for Sustainable Agriculture

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Abstract

The increasing population and the resulted problems necessitate the application of ecofriendly and economically acceptable methods in sustainable agriculture. Integrated management of plant diseases and pests is an important part of such a system. Superior strains of the bacterial species, *Bacillus thuringiensis* Berliner can play multiple roles in biological control of plant diseases and pests and promote plant growth and development. Other useful bioactivities of the species, such as bioremediation are not covered in this paper.

Keywords: Control; Disease; Pathogen; Pest; Yield

Introduction

The increasing population of the world means further demand for agricultural production while imposes decreased access to irrigation water and agricultural lands. In spite of the hazardous impact of the chemical pesticides announced at least since the publication of the noble-prize winning Silent Spring [1], unfortunately the current rate of water and soil pollution is enough high to testify for the undeniable mismanagement of these invaluable environmental resources. The situation has got more aggravated due to other pollutants from industrial and civil activities. Air pollution due to the increased application of fossil fuels and irresponsible annihilation/use of forests is believed to be the main reason of global warmth. So, finding eco-friendly agrobiologicals replacements for current agrochemicals may be helpful in the reduction of farmers' reliance on agrochemical products. Among the most appropriate agrobiologicals are those based on the bacterium *Bacillus thuringiensis* Berliner, accounting for more than 90% of the global biopesticide employment [2].

The bacterium, about 0.5-1.0 × 2-5µm in size [3], is a cultivable aerobic or anaerobic facultative [4] gram-positive, thick-walled peritrichous species able to chemotactically trace and swim toward plant root exudates or target (micro) organisms [5]. There are strains of the bacterium able to promote plant growth and development and increase its yield [6]. Its antagonistic activity against plant pathogenic fungi including the mycotoxigenic *Fusarium oxysporum* is well documented [7]. The bacterium produces and secrets a range of antibacterial (such as bacteriocins) and antifungal metabolites (such as Zwittermicin, fengycin, and hydrogen cyanide) [8,9]. However, the bacterium is more famous because of its capacity for the production of insecticidal crystal proteins and metabolites. Based on flagellar H antigens, host specificity and the presence of plasmids, the species is divided to more than 100 sub-species and varieties divided into 70 serotypes [3]. Also, there are various types of Cry proteins each effective against specific group of insect pests [5]. Some Cry proteins are nematicidal [5]. Other insecticidal proteins produced by *B. thuringiensis* are vegetative Insecticidal Proteins (VIPs), and cytotoxic proteins (Cyt proteins) [10]. Furthermore, *B. thuringiensis* produces several classes of other toxins such as alpha-exotoxins, beta-exotoxins, hemolysins, enterotoxins as well as enzymes such as phospholipases, chitinase [11] as well as proteases [12]. The bacterium incites all three hormonal signaling pathways involved in plant systemic resistance to a broad range of plant pathogens and pests [13]. All these characteristics make this species an ideal candidate for integrated plant disease and pest management programs. The endospores are known as the most persistent form of life [14]. It is expectable, that the bacteria will produce endospores receiving the signals of plant senescence at the end of growing season. This is important as more than 90% of world agricultural lands may be classified as conducive soils [15] and the annual increase of the persistent bacterial propagules can lead to a shift in the soil biology from conduciveness to suppression.

The application of a bacterial strain of a sum of above-mentioned bioactivities is superior to the chemical treatments that even if they are not pollutant, only affect either plant pathogens or pests. Additionally, the use of the bacterium is preferred to the pre-treatment of plants with plant resistance inducing chemicals (such as salicylic acid, jasmonic acid, etc.) because such chemical treatments applied prior to the beginning of plant diseases or pest contamination can lead to reduced crop yields due to consumed material and energy for the activation of unnecessary defense pathways in the absence of the disease or pest [16]. The suitable *B. thuringiensis* can increase plant growth, development, and yield in the absence of the harmful (micro) organisms [6]. Considering the widespread use of *cry* genes in the biotechnological generation of genetically transformed crops [17], the pretreatment of plants with an appropriate stain(s) of *B. thuringiensis* does not need economically expensive and technically difficult procedures of genetic engineering, genetic transformation, and tissue culture followed by time-consuming and labor-requiring transformed plant propagation. From the medicinal point of view, *B. thuringiensis* is a species closely relative to *Bacillus spp*. (*B. cereus*, and *B. anthracis*) pathogenic in human [18]. This means that *B. thuringiensis* may compete with pathogenic *Bacillus spp*. And help into hygiene and health in rural environments. However, the carriage of Cry toxin plasmids substantially reduces *B. thuringiensis* competitive potential in soil [19]. The bacterium can be easily formulated thanks to its constitutive ability to produce persistent endospores [20]. The endospore-based formulations are of prolong shelf-life [21]. The resistant endospores can guarantee the persistence of the soil biology improvement despite of global warmth and harsh changes in the local climate. *B. thuringiensis* and autochthonous arbuscular mycorrhizal fungi can be applied to improve the physiological traits as well as performance of agronomical crops under drought conditions [22].

Conclusion

Bacillus thuringiensis can be useful in the ecofriendly development of global agriculture and improve the ecology and economy of the developing as well as developed countries affected with agrochemicals and the harmful impact of global warmth.

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