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Bacteria that Promotes Plant Growth: Mechanisms and Applications

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Abstract

The terrible outcome of increased environmental harm and population pressure around the world is that there may soon not be enough food being produced to feed everyone. Therefore, it is imperative that agricultural productivity rise dramatically over the next few decades. In order to achieve this, agricultural practises are changing in favour of a strategy that is more environmentally friendly and sustainable. This includes the expanding use of genetically modified organisms, such as bacteria and plants, in conventional agricultural methods. Here, several ways that bacteria encourage plant growth will be discussed and taken into account. Plant growth-promoting bacteria are anticipated to start taking the place of pesticides in agricultural, horticultural, forestry, and environmental cleaning methods in the not too distant future. Although there may not be a single strategy that can effectively promote the growth of all crops under all conditions, some of the strategies discussed have shown great promise.

Keywords: Environmental; Agricultural; Plant Growth

Introduction

There are currently around 7 billion people in the world and this number is expected to grow to around 8 billion around 2020. When considering both the expected increase in world population and the increasing environmental damage. As a outcome of increasing levels of industrialization, it is clear that in the next ten to twenty years, feeding the entire world population will be an uphill challenge, a problem that will only get worse as time goes on.There is absolutely no time to waste; to feed this growing population, the world must begin to significantly increase agricultural productivity in a sustainable and environmentally friendly way. In order to feed the developing world, it is necessary to rethink many existing agricultural methods including the use of chemical fertilizers, herbicides, fungicides and pesticides. Instead, sustainable agriculture is likely to use more than two types of transgenic crops. It is estimated that about "40% of all deaths worldwide are due to pollution of water, air and soil" and that "environmental degradation, related to the growth of the world's population, is the main cause of major cause of the rapid increase in human diseases [1,2]. In other words, due to population growth and industrialization, the Earth's atmospheric, soil and water systems are no longer capable of absorbing and decomposing the increasing amount of waste we generate. As a outcome, the environment is increasingly polluted by a wide range of toxic metals and organic compounds. Recognizing the nature and extent of the problem is an important first step. However, even if all pollution ceases tomorrow, it is still essential that all contaminated soil and water be cleaned up. One way to address this is to use phytoremediation, the deliberate use of plants to absorb and concentrate or degrade a wide variety of environmental pollutants. In addition, adding PGPB to the plants used in phytoremediation processes often makes the entire process much more efficient [3-5].

Plant growth

Soil is full of microscopic life forms including bacteria, fungi, actinomycetes, protozoa and algae. It has long been known that soil contains a large number of bacteria, and that the number of culturable bacterial cells in the soil usually represents only about 1% of the total number of cells present. However, in soils under environmental stress, the number of culturable bacteria can be as low as 104 cells per gram of soil. The amount and type of bacteria present in different soils is affected by soil conditions, including temperature, humidity, and the presence of salts and other chemicals. In addition, bacteria are often not evenly distributed in the soil. In other words, the concentration of bacteria found around plant roots is often much higher than in the rest of the soil. This is due to the presence of nutrients including sugars, amino acids, organic acids and other small molecules from plant root secretions, which can account for up to a third of the carbon fixed by the plant. However, the effect of a particular bacterium on a plant can change as conditions change [6,7]. For example, a bacterium that aids plant growth by providing fixed nitrogen or phosphorus, compounds that are usually present in limited amounts in many soils, is unlikely to benefit plants. Crops when significant amounts of chemical fertilizers are added to the soil. Furthermore, a particular bacterium can affect different plants in different ways. On the other hand, with cherry cuttings, the level of IAA was optimal before the addition of bacteria and the additional amount of IAA provided by the bacteria became inhibited. Despite these caveats, deciding whether a bacterium promotes or inhibits plant growth is often straightforward [8].

Nitrogen fixation

Also has the ability to fix nitrogen and provide it to plants. However, free-living bacteria are generally thought to provide only a small amount of the fixed nitrogen needed for the host plant to bind to the bacteria. Nitrogenase genes required for nitrogen fixation include structural genes, genes involved in Fe protein activation, iron-molybdenum cofactor biosynthesis, electron donor, and regulatory genes required for function function and enzyme synthesis. In diazotrophic bacteria, nif genes are usually found in a cluster about 20-24 kb in size with seven operons encoding 20 different proteins. Due to the complexity of this system, genetic strategies to enhance nitrogen fixation have been elusive. At one time, some scientists believed that once the nif genes were isolated and characterized, they could be genetically engineered to enhance nitrogen fixation. And, some individuals have argued that it is

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possible to genetically engineer plants to fix their own nitrogen. These ideas seem a bit naive these days. Since nitrogen fixation requires a large amount of energy in the form of ATP, it is advantageous if the bacterial carbon source is directed towards oxidative phosphorylation, which promotes ATP synthesis, rather than glycogen synthesis, leading to the storage process [9]. In one experiment, a strain of Rhizobium tropical was created by knocking out the glycogen synthesis gene. Treatment of bean plants with this modified bacteria outcome in a significant increase in the number of nodules formed and an increase in dry weight of the plants compared with treatment with the wild-type strain. This is one of the very few examples of scientists genetically engineering the nitrogen fixation machinery of bacteria and achieving increased levels of nitrogen fixation

Oxygen is both a Nitrogenase enzyme inhibitor and a negative regulator of nif gene expression; however, it is required for Rhizobium spp. bacterial respiration. In order to prevent oxygen from inhibiting nitrogen fixation, and at the same time provide enough oxygen for the respiratory nodule bacteria, it can introduce bacterial hemoglobin, which binds to free oxygen. After transfecting Rhizobium etli with Vitreoscilla sp. hemoglobin gene, at low dissolved oxygen levels, rhizobial cells had a respiration rate two to three times higher than that of the unconverted line. In the greenhouse, after inoculation of R. etli containing hemoglobin in the legume plants, the legume plants had a nitrogenase activity 68% higher than that of the wild R. etli inoculated plants. Etli [10]. A mild, localized increase in plant ethylene levels is usually produced after legume plants are infected with Rhizobium spp. Some strains of rhizobia are able to increase the number of nodules formed on the roots of host legume plants by limiting ethylene rise by synthesizing a small molecule called rhizobitoxin, which is chemically inhibited. activity of the enzyme ACC synthase, an enzyme that biosynthesizes ethylene. In addition, some strains of rhizobium produce the enzyme ACC deaminase that removes some of the ACC before it can be converted to ethylene.

Discussion

In addition, in cold and temperate climates, many plant fungal pathogens are most destructive when soil temperatures are low. In these environments, cold tolerant biocontrol PGPBs are likely to be more effective in the field than thermophilic biocontrol strains. Nearly twenty years ago, several researchers first reported that several thermophilic and thermophilic bacteria, including PGPB, secreted anticoagulant proteins into the surrounding medium when the bacteria were cultured at room temperature. Bacterial anticoagulant proteins, some of which may also have ice-nucleating activity, appear to regulate the formation of ice crystals outside of bacteria, thereby protecting bacterial cell walls and membranes from life-threatening damage caused by the formation of large ice crystals that would otherwise have occurred. Since the initial reports of bacterial anticoagulant proteins, there have been a number of additional reports documenting the isolation and characterization of bacterial anticoagulant proteins.

Conclusion

The use of PGPB as an integral part of agricultural practice is a technology that is timed. These bacteria have been used successfully in a number of countries in the developing world, and the method is expected to grow. In more developed countries, where agrochemicals are still relatively cheap, the use of PGPB occupies a small but increasing place in the development of organic agriculture. Furthermore, it is reasonable to expect an increasing use of PGPB in different vegetation remediation strategies. However, wider use of the PGPB will require addressing a number of issues. In the first case, the transition from laboratory and greenhouse experiments to field trials to large-scale commercial use will require some new methods of growing, storing, transporting, formulation and application of these bacteria. Second, there is a need to raise public awareness about the use of PGPB in large-scale agriculture. Much of the popular myth is that bacteria are the only pathogens that cause disease. This misconception needs to be corrected before the public accepts the intentional release of beneficial bacteria into the environment on a large scale.

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