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Cyanobacteria in Plant Biotechnology

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Introduction

Cyanobacteria are prokaryotes undergoing oxygenic photosynthesis partaking relationship with plastids of eukaryotic autotrophs and prokaryotes. Cyanobacteria have a wide range of pigments including chlorophyll, carotenoids and phycobiliproteins having distinct colors. There are large number of physiologically active chemicals having antiviral, antibacterial, antifungal and anticancer properties. Polyhydroxyalkanoates, exploited as a substitute for nonbiodegradable petrochemical-based plastics, have been discovered in several strains of cyanobacteria.

Role of Cyanobacteria

- **Increase soil porosity: By production adhesive substances**
- **Excretion of growth promoting substances**
- **Increase water holding capacity: Through its jelly structure**
- **Increase soil phosphate: By excretion of organic acids**
- **Increase soil biomass: After death and decomposition**
- **Decrease soil salinity: By absorbing soluble Na+ from the soil**

Current Biotechnological Tactic

Plant plastids and cyanobacteria have a shared evolutionary connection. *Synchocystis* sp. PCC 6803 cyanobacteria is the first having a full genome sequencing and then about 200 full genome sequences of various cyanobacterial species are accessible in the public domain. In an 'omics', transcriptomics and proteomics can be employed. Ability to adapt to a variety of environments, minimal growing requirements and synthesis of high-value chemicals and pigments. Bioethanol, hydrogen, and biodiesel are all examples of chemicals that can be produced.

Transgenic Cyanobacteria in Crop Advance

Many genetically distinguishable organisms have a revolutionary impact on the agriculture commerce and GM organisms are precisely produced for fetching valuable assets not found in their wild equivalents. In cyanobacteria, several genes have been cloned which catalyzes formation of chloramphenicol, acetyl transferase, B-galactosidase and luciferase with involvement of cat, lacZ, luxA and B genes. hetR is a principal regulator of heterocyst differentiation encoding a serine-type protease. The recombinant strain AnFPN hetR produced more continuous heterocyst and nitrogen fixation, as well as providing more nitrogen to rice seedlings throughout time.

Role in Stress Management

The Hsp60 and Hsp10 chaperonins are encoded by the bicistronic groESL operon in *Anabaena* PCC7120 with Hsp60 chaperonins expression in heat stress, leading enhanced thermotolerance. Chaurasia and Apte (2009) inserted the groESL operon into the genome of *Anabaena* sp. strain PCC7120 without affecting the native groESL operon's stress-responsive expression. At ambient circumstances, transgenic strain with net expression of the two groESL operons enhanced growth, nitrogen fixation, photosynthesis and boosted the recombinant *Anabaena* strain's resistance to heat and salt stressors.

Gene Pool for Evolving Transgenic Crops

Oscillatoria, *Phormidium* and *Nostoc* are most common phototrophic cyanobacteria in Antarctica. Cyanobacteria may thrive in hypersaline, alkaline, high metal concentrations, and xerophilic environments (Wynn-Williams, 2000). They can withstand nutritional shortage, heat dessication or drought, salt, UV-B, heavy metals and metalloids, among other environmental challenges. Chroococcidiopsis is one of several cyanobacterial species tolerate high CO_2 levels.

Antifungal and Antibacterial Action

Fischerella sp., *Lyngbya* sp., and *Microcystis lacustris* owns antibacterial action against gram-positive and negative bacteria. To suppress damping-off, *Fusarium* sp., *Pythium* sp., and *Rhizoctonia solani*, *Anabaena* sp., *Scytonema* sp., and *Nostoc* sp. were effective. The growth of *Sclerotinia sclerotiorum* was significantly suppressed by *N. muscorum* algal culture filtrates. *O. agardhii* evidenced successful in integrated disease control of barley against foliar pathogens such as net blotch, spot disease, powdery mildew and rust (Haggag *et al.*,2015). It also improved grain yield, kernel weight, and other quality metrics by increasing antioxidant enzymes like catalase, peroxidase and superoxide dismutase.

Conclusion and Future Path

There is an urgent need to produce transgenic crops employing cyanobacterial genes to fulfil the growing need for food, as they are adapted to flourish in severe and stressed environments. Postgenomic analysis for this key group has been hastening as a result of the rising number of finished cyanobacterial genome projects, which will offer a large number of useful cyanobacterial genes. Despite fact that there are a huge number of cyanobacterial genes known to give various stress tolerance, only a small number of them have been defined and only a small number of them have been exploited to generate transgenic crops. As a consequence, it is anticipated that we will need to essence on this prospectus in order to fulfil our growing demand.

Reference

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