Cyanobacteria: A Potential Adaptability to Improvise the Soil Ecology Enhancing Soil Health

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Introduction

Blue green algae (cyanobacteria) are considered as the most primitive photosynthetic prokaryotes, they are supposed to have appeared on this planet during the Precambrian period which is possibly the are first photosynthetic microorganisms persisted over a period of two to three billion years can performing an important role in evolution of higher form. They are very susceptible to sudden physical and chemical alterations of light, salinity, temperature and nutrient composition

Important features of cyanobacteria

- Photosynthetic gram-negative prokaryotes
- It is commonly known as blue green algae conferred the capability to fix atmospheric nitrogen, phosphate solubilisation detoxifies heavy metals
- It decomposes the organic residue and terminate the growth phase of microorganisms in environment to mitigate the biotic and abiotic stress in plants
- It is also improve nutrient uptake and bioavailability to the plants
- These organisms also produce some bio-active compound that function as elicitor molecules which is beneficiaries for plant health and soil fertility by improving physico-chemical conditions of soil to maintain the complexity and diversity of ecosystem
- Enhance the soil methanotrophic diversity and methane sink strength in long term to protect the nature and natural resources
- It is also produce exopolysaccharide which is present in cyanobacterial biomass, can aggregate soil and accumulate organic component which can promote survival and growth

Plant growth promoting and nutrient use efficiency

Cyanobacteria are known to liberate a wide array of extracellular substances, Although, considered as obligate photoautotrophs e.g. plant growth regulators, vitamins, amino acids, sugars and other metabolites that have direct or indirect impact on plant growth and yields also there were a well-established role as nitrogen supplements and tolerance to desiccation that can be key players in carbon sequestration and improving nutrient use efficiency with higher crop yields (Mandal et al., 1999; Prasanna et al., 2008). A number of cyanobacteria that promote plant growth by IAA production which help in colonising the rhizosphere or the root and shoot systems and providing nutrients effectively but some of them mainly which are phototrophic that grown as biofilms and produce exopolysaccharides which make them environmentally conducive for the growth of not only plants but also other beneficial microfauna and flora that maintain the soil ecology and provide the best fertility sources with higher range of productivity a longer periods.

Bioremediation

Cyanobacteria have been used efficiently as a low-cost method for remediating in various wastewaters by converting the dissolved nutrients into biomass (Lincoln et al., 1996) and for biotreatment (removal) of dissolved inorganic nutrients to allow them to be used as economic and low-maintenance remediation technology for contaminated systems. The beneficial application of cyanobacteria in remediation of contaminated waters in natural aquatic environments or industrial effluents, is still not optimally manipulated whereas like cyanobacterial specie such as *Oscillatoria salina, Plectonema terebrans, Aphanocapsa* sp. and *Synechococcus* sp, have been successfully used in bioremediation of oil spills in different parts of the world (Raghukumar et al., 2001; Radwan and Al-Hasan, 2001; Cohen, 2002). Blue green algae have been shown to be highly effective as accumulators and degraders of different kinds of environmental pollutants including pesticides, crude oil naphthalene, phenol, catechol in effective way to natural system.

Bio-fertilizers

Cyanobacteria fix atmospheric N_2 by forms of free-living and symbiotic associations with partner such as water fern *Azolla, cycads*, *Gunnera*, which are endowed with the specialized cells known as heterocyst–thick-walled modified cells which is considered site of nitrogen fixation by nitrogenise enzyme that is a complex which catalyses the conversion of the molecular N_2 into reduced form like ammonia.

Carbon recycling to improving CO_2 fixation by sequestration strategies

CO_2 from the industries are today's demand in order to reduce the impact of CO_2 on global warming so sequestration strategies adopted so far can be broadly divided into physical and biological mean where the physical means of CO_2 sequestration has disadvantages which having high costs associated with it thereby need to develop the suitable technologies for capturing, transporting and storing CO_2 are also very expensive processes so there for biological method of CO_2 sequestration is an alternative to physical method where the use of algae for CO_2 sequestration has several advantage to mitigating CO_2, the major source of global warming as well as producing biofuels and other interesting secondary metabolite where the one kilogram of algal dry cell weight utilizes around 1.83 kg of CO_2 . Annually around 54.9– 67.7 tonnes of CO_2 can be sequestered from raceway ponds corresponding to annual dry weight biomass production rate of 30–37 tonnes per hectare (Brennan and Owende, 2010). The main mechanism which is a multistep process of photosynthesis plants and algae (green algae and cyanobacteria) fix CO_2 into sugar using light and water as energy and electron source however the metabolic engineering has proven to be effective in rerouting fixed CO_2 from the CB cycle into a desired metabolic pathway, the incorporation of inorganic carbon is still heavily restricted at the initial steps of fixing CO_2 in the CB cycle. Where the availability of inorganic carbon is promoted by the spatial confinement of CO_2 in the CCM which consists of three key components that hydrates and reduces atmospheric carbon into the CB cycle: RuBisCO, carbonic anhydrase (CA) and the carboxysome.

Soil enzymes activity control towards the soil fertility improvement

Soil enzymes are thought to be largely of microbial origin which are obviously associated with viable cells remain catalytic in cell debris in soil solution or completed with clay or organic colloids whereas the ecological role of cell debris and extracellular complexes enzymes is yet to be completely explored but hypothesized that humic–enzyme complexes may benefit some organisms by hydrolysing substrates are too large or insoluble for microbial uptake. Soils that have been managed to promote soil should have higher biological activity than intensively used soils that is reflected in greater enzyme production and possibly greater potential to stabilize and protect extracellular enzymes to forming soil enzyme complexes. Cyanobacteria, such as *Nostoc muscorum* and *Tolypothrix tenuis* that produce the extracellular enzymes which decompose organic residues (Hussein et al., 1989) are also used as inoculants to increase the polysaccharide content and microbial activity of soil.

Conclusion

It has great potential in soil ecology and fertility improvement strategy that can be modern tools in modern farming system in coming generation to overcome the food security and maintain the soil fertility over longer periods of time and some potential research should be need to conducted to greater applicability of the methods and its mechanism process to increase its efficiency.

References:

- Brennan, L., Owende, P., 2010. Biofuels from microalgae-a review of technologies for production, processing, and extractions of biofuels and co-products. Renew. Sustain. Energ. Rev. 14, 557–577
- Hussein, Y.A., Abb-El-Wahab, S.M., Hassan, M.E., Shalan, S.N., 1989.
- Mandal B, Vlek PLG, Mandal LN (1999) Beneficial effects of bluegreen algae and Azolla, excluding supplying nitrogen, on wetland rice fields: a review. Biol Fertil Soils 28:329–342
- Prasanna R, Jaiswal P, Singh YV, Singh PK (2008) Influence of biofertilizers and organic amendments on nitrogenase activity and phototrophic biomass of soil under wheat. Acta Agron Hung 56(2):149–159
- The specific degradation of lignin by blue-green alga. International Journal of Experimental Botany (Phyton) 49, 13–15.