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Algae for Soil Regeneration

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Abstract:
Algae are a large and diverse group of organisms that carry out photosynthesis by capturing energy from sunlight. Algae plays an important role in agriculture where they are used as biofertilizers and soil stabilisers. Algae can be grown in arid and semi-arid regions with minimum fresh water demand. With problems such as desertification of soil around the world(especially in agricultural regions) and climate change becoming very prominent, algae can be used for soil regeneration to efficiently combat these critical problems.

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I. Introduction:

Algae are a diverse group of aquatic organisms that have the ability to conduct photosynthesis. Certain algae are familiar to most people; for instance, seaweeds (such as kelp or phytoplankton), pond scum or the algal blooms in lakes. However, there exists a vast and varied world of algae that are not only helpful to us, but are also critical to our existence.

The term "algae" covers many different organisms capable of producing oxygen through photosynthesis (the process of harvesting light energy from the sun to generate carbohydrates). These organisms are not necessarily closely related. However, certain features unite them, while distinguishing them from the other major group of photosynthetic organisms: the land plants.

Primarily, algae are not highly differentiated in the way that plants are. That is to say, they lack true roots, stems and leaves, and a vascular system to circulate water and nutrients throughout their bodies. Second, many algae are unicellular. They also occur in a variety of forms and sizes. They can exist as single, microscopic cells; they can be macroscopic and multicellular; live in colonies; or take on a leafy appearance as in the case of seaweeds such as giant kelp. Picoplankton are between 0.2 to 2 micrometers in diameter, while the fronds of giant kelp are as large as 60 meters in length. Lastly, algae are found in a range of aquatic habitats, both freshwater and saltwater. By virtue of these characteristics, the general term "algae" includes prokaryotic organisms — cyanobacteria, also known as blue-green algae — as well as eukaryotic organisms (all other algal species).

Algae are an integral part of many ecosystems, and can be used to combat many environmental problems we face today. The presence of algae in soil can lead to reduced erosion by regulating water flow into soils. They also play a role in soil fertility, soil erosion, soil reclamation, and formation of microbiological crust. Overall, algae plays a major role in soil regeneration.

Need for Soil Regeneration:

1. **Problem of Desertification in the World:**

- Desertification refers to the persistent degradation of dryland ecosystems by climatic variations and human activities. It occurs on all continents (except Antarctica) and affects the livelihoods of millions of people, including a large proportion of the poor in drylands.
- The problem of desertification is a major problem throughout the world, especially in the agricultural regions.
- If something is not done about this, we may end up losing a large portion of our agricultural land which will result in a major catastrophe.
- The use of chemical fertilisers in agriculture to compensate for the lack of nutrients in soil due to desertification leads to ecological disruption and severe environmental pollution.

2. **Issue of Climate Change:**

- The problem of Climate Change due to the increase in the GreenHouse Gases in the atmosphere is a problem which threatens our way of life.
- 33% of the world's land surface area is covered by deserts.
- This land area covered by deserts consists of nutrient devoid soil with very little agricultural potential.

- However, this land can be regenerated in such a manner so that it can temporarily serve as agricultural land, and ultimately become a carbon sink like the Amazon Rainforests to help combat the problem of Climate Change.

Both these problems can be combated together by using eco friendly methods for large scale soil regeneration.

Soil Regeneration using Algae:

1. Uptake of Nitrogen and Phosphorus:

Nitrogen and Phosphorus are the two most important macronutrients and the two most frequent limiting macronutrients for plant growth. Nitrogen is primarily responsible for vegetative growth. Nitrogen assimilated into amino acids are the building blocks for proteins in plants. Phosphorus is a major component of plants in DNA and RNA. Phosphorus is also critical in root development, crop maturity, and seed production. Algae are able to reduce atmospheric nitrogen to ammonia, a process by which oxygen evolved as a result of the photosynthetic activity is detrimental to nitrogen fixation. Heterocysts are specialised cells whose interiors become anaerobic for the oxygen sensitive nitrogen fixing process to carry on. Algae when added to soil can fix atmospheric nitrogen to ammonia for the plants to use to build protein which is essential for their growth. Most aquatic systems are resource limited, especially in Nitrogen and Phosphorus. To ensure survival, an organism must be able to maintain net population growth at resource levels lower than that required for other species. Algae are adapted to scavenge their environments for resources through structural changes, storage or increased resource utilisation efficiency. Internal adaptations by algae have resulted in adjustments with which they can also excrete substances to enhance nutrient availability. Algae excrete phosphates almost immediately on the onset of Phosphorus limited conditions. Algae can also excrete other pH altering secretions which in turn can render absorbed Phosphorus available. Algae also storces resources like Phosphorus in excess of their immediate needs. This 'luxury' uptake is excreted in times of a Phosphorus deficient environment. Algae when a part of the soil can help increase the phosphorus content in times of phosphorus deficient conditions without the addition of artificial fertilisers and can help sustain plant life over a large period of time.

2. Source of Organic Matter:

Algae is an important source of organic matter in soils. The organic matter from the decay of dead algae in soil increases the humus content of soil making it more habitable for other plants. Humus accumulation is also responsible for increased moisture content of the soil. In the USSR algae was found to be an important part of soil formation. The incorporation of organic carbon and nitrogen via photosynthesis and nitrogen fixation respectively is the most important contribution of algae in soil fertility. They also act as a storehouse of inorganic nutrients.

3. Soil Reclamation:

The main problem in reclamation of land in arid and semi-arid regions is the salinity conditions over large soil areas. Regular plants are not tolerant towards this high salt concentration, and even though with the addition of growth regulators such as gibberellic acid(GA3) improve the salt tolerance of plants, they are very expensive and impractical for large scale applications. However, marine algae is tolerant to high concentrations of salt and can easily grow in these conditions. Over time, algae can not only increase the soil fertility of these regions, but can also reduce the salinity levels thus making the land suitable for plant growth.

4. Excretion of Extracellular Substances:

Certain algae(like cyanobacteria or BGA) excrete a large number of substances that benefit plant growth. They benefit plants by producing growth promoting regulators(the nature of which resembles auxins and gibberellins), vitamins, amino acids, phosphates, polypeptides, antibacterial and antifungal substances that exert phytopathogen biocontrol and polymers, especially exopolysaccharides, that promote improvement of soil structure and exoenzyme activities.

5. Treatment of Heavy Metals:

The recalcitrant nature of heavy metals plays an integral role in the degradation of soil. Microalgae have emerged as a potential sink for the removal of toxic heavy metals from soils(and the environment in general) using biosorption. Algae sequester, adsorb, or metabolise these noxious elements into substantial levels. Algae also require certain heavy metals for their functioning like iron for photosynthesis and chromium for metabolism. Algae also absorb heavy metals from soil for intracellular protective mechanisms, in which the ion exchange occurs in the outer cell wall. Ion exchange for heavy metals also occurs in mucilaginous sheaths that behave as an 'external vacuole'. The metal binding property of algae is mainly due to a high density of anionic charge(negative charge), especially carboxyl, identified in the capsular polymer. Algae could have a higher

efficiency in biosorption during its growth in a polluted environment. The use of algae for bioremediation is highly advantageous as the process occurs in light conditions, and does not need oxygen, instead heavy metals are removed, oxygen is released and carbon dioxide is absorbed from the atmosphere. Algae has emerged as a suitable low cost vector for detoxification of soil which also helps in other environmental issues. Algae placed in contaminated land not only reduces the concentration of metal ions and helps in the reclamation of land, but also removes carbon dioxide from the atmosphere and adds oxygen to it.

6. Soil Crust Formation:

Structural soil crusts are relatively thin, dense, somewhat continuous layers of non-aggregated soil particles on the surface of tilled and exposed soils. Structural crusts develop when a sealed-over soil surface dries out after rainfall or irrigation.. It can also indicate that a soil has a high sodium content that increases soil dispersion when it is wetted by rainfall or irrigation. Soil microorganisms typically aggregate soil particles in regions where vascular vegetation is patchy and water is limited to form a biological soil crust. Crusts alter soil factors like water availability, nutrient content, aeration, and erosion susceptibility and thus affects plant life directly or indirectly. Algae stabilizes the soil by binding smaller particles together into larger particles. This binding can be achieved by binding of soil particles in the entanglement of algae filaments, or adhesion to mucilaginous sheaths. This binding increases the organic content in the crust, improving the resistance of soil to both air and water erosion. Wind and water erosion is a major problem faced in desert areas, and if we introduce algae in those arid regions, after the formation of soil crust the land won't be susceptible to erosion and can easily be reclaimed for agriculture, and after time can be fertile enough to support a major carbon sink.

7. Stabilisation of Soil Aggregate:

Soil conditioning is any procedure or product that improves not only the physical properties of soil for agriculture, but also the soil structure by genesis and/or stabilisation of soil aggregates. Soil Aggregate formation is a complex process and is primarily due to adsorption and binding of particles by polysaccharides or microbial origins together with environment by microbial filaments. When inoculated onto irrigated sandy soils by center pivot sprinklers, mass cultured algae has been shown to dramatically improve the integrity of soil aggregates in the face of disruption by wind and slaking in water.

II. Conclusion:

In this paper, a review was carried out about the beneficial roles algae plays soil regeneration. Algae are an important component of arid and semi-arid ecosystems. Their distribution can indicate the health of the environment. In this paper we saw the possibility of using algae as a conditioner for soil instead of using chemical or artificial conditioners, where the use of algae reduces the pollution to soil and plant while improving both soil and plant health.

Algae are ubiquitous to the world of soils. Although they are primarily photosynthetic agents of the soil, their ecological role is still not fully defined. In this study, we examined the beneficial properties of algae to plant and soil ecosystems and how it can be used to increase the fertility of soil and in soil reclamation. Some of the beneficial properties of algae for both plant and soil ecosystems which can be useful for soil regeneration are:

1. Excretions that increase both the availability and uptake of Phosphorus.
2. Provision of nitrogen by nitrogen fixation.
3. Increased soil organic matter.
4. Excretion of substances which promote plant growth.
5. Concentration of heavy metal ions present in the environment.
6. Crust formation.
7. Stabilisation of soil aggregate by extracellular polysaccharides.

References:

[1]. Vidyasagar, Aparna. "What Are Algae?" Live Science, 4 June 2016, www.livescience.com/54979-what-are-algae.html.
[2]. "Desertification." Green Facts, www.greenfacts.org/en/desertification/l-2/1-define-desertification.htm. Accessed 28 Sept. 2020.
[3]. Ball, Jeff. "Back to Basics: The Roles of N, P, K and Their Sources." Noble Research Institute, 3 Jan. 2007, www.noble.org/news/publications/ag-news-and-views/2007/january/back-to-basics-the-roles-of-n-p-k-and-their-sources/.
[4]. Priya, Madhu, et al. "Microalgae in Removal of Heavy Metal and Organic Pollutants from Soil." Microbial Biodegradation and Bioremediation, Elsevier, 11 July 2014, www.sciencedirect.com/science/article/pii/B9780128000212000236.
[5]. "Soil Crust." Soil Crust - an Overview | ScienceDirect Topics, www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-crust.
[6]. Abdel-Raouf, Neveen & Al-Homaidan, Ali & Ibraheem, Ibraheem. (2012). Agricultural importance of algae. AFRICAN JOURNAL OF BIOTECHNOLOGY. 11. 11648-11658.