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Short Communication

Blue green algae: A potential biofertilizer for paddy crop

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The present world population is predicted to cross 10 billion by the end of year 2050. So, the annual production of cereals needs a jump of about 50% to provide food to all by those times. A huge pressure on agriculture sector is created to achieve the sufficient food security and this can be achieved either to cultivate more land or by enhancing the productivity of land or soil available for cultivation. The primary choice remains a distant dream in the light of restricted or limited land and growing population. The choice of increasing soil fertility and agricultural productivity with the application of better eco-friendly management tools, guarantees a successful food security. Indiscriminate use of chemical fertilizer contributed in loss of soil productivity beside addition of salts to the soil. Concept of biofertilizer came forward to revive the soil health because an alternate source for chemical fertilizers has become essential. The term biofertilizers includes selective microorganism includes bacteria, fungi and algae which are capable of providing nutrient to the soil into forms which are available to the plants on application. Biofertilizer is a cost effective, eco-friendly and renewable supply of soil nutrient which play a vital role in maintaining a long term sustainability and fertility of soil. The biofertilizer maintain the soil fertility cost by using in the yield is assured with biofertilizer and continuos use of biofertilizer makes the soil very fertile for significant yield. The biofertilizer can be manufacture in solid or in liquid form. Biofertilizer is important part of modern agriculture since demand of safe and residue free food is increasing. Therefore, to fulfill the need, it is necessary to promote the production of biofertilizers.

Blue green algae in sustainable management

As a beneficial microorganism, blue green algae (BGA) may play a potential role in the enhancement of agriculture productivity. Currently, it has been proposed that blue green algae could be the vital bioagents in ecological restoration of less fertile lands. Nitrogen-fixing BGA grow tremendously in tropical regions specifically in paddy fields (Singh, 2016). Blue green algae or Cyanobacteria are a diverse group of prokaryotes which form complex associations with same or other bacteria and green algae in structures known as cyanobacterial mats. They are the main nitrogen fixers in freshwater and marine systems. The most vigorous nitrogen-fixing Cyanobacteria have been tested to use as green fertilizer in paddy fields and desirable effects have been reported in Asian countries (Brempong, 2014). Application of Cyanobacteria in the rice fields promotes both rice growth and yield. Application of BGA inoculum along with N:P:K in ratio of 30:20:20 kg ha^{-1} was found to be the foremost effective treatment for paddy field productivity(Paudel *et al.*, 2012).

Through nitrogen fixation process they fulfill their own nitrogen requirement and turnout some bioactive compounds that improve the soil nutrient status, promote the plant growth, and protect them from pathogens. Blue green algae is also useful for wastewater treatment, and have the ability to degrade the different toxic compounds even the pesticides (Shah, 2014). This article highlights the role of blue green algae in agriculture, environmental sustainability and used as a biofertilizer.

BGA or Cyanobacteria are one of the main components of the nitrogen fixing biomass in paddy fields. In rice cultivation, the agricultural importance of blue green algae is directly related with their ability to fix nitrogen and other positive effects for both plants and soil health. After water, nitrogen is the second limiting element for plant growth and productivity in many fields and efficiency of this element is completed by fertilizer. Blue green algae play an crucial role in maintenance, build up and enhancement of soil fertility, consequently

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increasing paddy growth and yield as a biofertilizer. Blue green algae are free living photosynthetic nitrogen fixers. These are capable of reducing various types of pollutants and have benefits as potential biodegrading organisms. Excretion of growth-promoting substances like amino acids, hormones and vitamins. Their jelly like structure increase their water-holding capacity. Increase in soil biomass when their death and decomposition occur. Preventing weeds growth and soil phosphate is increased by excretion of some organic acids.

It has been reported that deficiency of nitrogen affects paddy crop productivity in several ways including retarded growth and development, dwarf plants, yellowing of leaves and lower yield. Most of the cropping system have less than 50% recovery efficiency (Fageria, 2013) Moreover, a large quantity of applied nitrogen is lost due to various processes like volatilization, leaching, denitrification, and soil erosion (Rakshit *et al.*, 2015). Algae with ubiquitous nature in almost all environments and are one of the unique characteristic organism on this planet, having potential application in nutrition as food supplements, in agriculture sector as biofertilizers and improvement of sodic soils, in waste water treatment, and as a source of biofuel. These are filamentous, heterocystous, nitrogen fixer, photosynthetic cyanobacteria (BGA) are part of tropical paddy field ecosystem and they assumed as an excellent source of global nitrogen economy of rice fields and also embraced as a good alternative to agrochemicals with significant economic and environmental edges. Such cyanobacterial strains differentiate heterocyst beneath nitrogen-deprived condition and therefore use both photoautotrophy and diazotrophy, thus requiring only water, carbon dioxide, light and mineral nutrients for their survival. Apart from BGA, red algae and brown algae have additionally been used as a potential biofertilizer.

Table 1: Important genera of nitrogen fixing blue green algae

Cyanobacterial form	Cyanobacterial Genera
Unicellular	*Dermocapsa, Synechococcus, Myxosarcina, Pleurocapsa, Xenococcus*
Non-heterocystous	*Myxosarcina, Oscillatoria, Plectonema, Schizothrix, Trichodesmium*
Heterocystous	*Calothrix, Camptylonema, Anabaena, Anabaenopsis,Aulosira, Mastigocladus, Nodularia, Nostoc*

Blue green algae as biofertilizers

BGA fix atmospherical nitrogen either as free-living or in symbiotic associations with partners such as water fern *Azolla, cycads* etc. and a list of different form of nitrogen fixing blue green algae has been presented in Table 1. Some cyanobacterial members are endowed with the modified with thick-walled specialized cells known as heterocyst, which are considered main site of nitrogen fixation by enzyme nitrogenase. The enzyme is a complex that catalyzes the conversion of the molecular nitrogen into reduced form (ammonia). The fixed nitrogen is released in the form of polypeptides, vitamins, ammonia, free amino acids, and phytohormones like substances either by microbial degradation or secretion process (Singh *et al.*, 2011). The ability of nitrogen-fixation has not only been shown by BGA having heterocystous but also by several non-heterocystous group of BGA (Table 1). BGA can contribute upto 30 kg N ha^{-1} along with organic matter to the soil which is significant for the economically weak farmers unable to invest for costly synthetic nitrogen fertilizer. Several BGA belongs to group *Anabaena, Nostoc, Aulosira, and Tolypothrix* found to be effective biofertilizers. Alternative to nitrogen fertilizers many Asian countries have been utilizing BGA in paddy cultivation. It has been reported that application of cyanobacteria in agriculture ecosystems, particularly the paddy fields available nitrogen to plants is increased (Singh *et al.*, 2016). Several researchers have reported that inoculation of cyanobacteria in wheat crops, could enhance the plant length, weight as well as yield under in vitro (Karthikeyan *et al.,* 2007).

Biofertilizers facilitate to solve the problem of feeding, an increasing global population at a time when agriculture is facing numerous environmental stresses. Blue green algal biofertilizers are recommended to be used as renewable nitrogen sources for many crops in agriculture. In depth research on different basic

and applied aspects of algae have been published that biomass of algae can be used for variety of application like soil improver and sustainable production. To improve or enhance their utility in agriculture and associated sectors requires serious attention. Thus there is an urgent need to address certain key problems of exploiting cyanobacteria or blue green algae, the better way.

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