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**EFFECT OF *Spirulina* BIOFERTILIZER SUSPENSION ON PLANT GROWTH AND
SEED GERMINATION: A REVIEW**

CHANDERA D AND SHRIVASTAV A*

Department of Microbiology, Parul Institute of Applied Sciences, Parul University,
Vadodara, 391760, Gujarat, India

*Corresponding Author: E Mail: anupama.shrivastav82045@paruluniversity.ac.in

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ABSTRACT

For highest yielding of the crop, the agriculture management is majorly dependent on the fertilizer, which contain inorganic matter and chemicals, which are hazardous to human health and the environment. Biofertilizer provides macronutrients as well as micronutrients during biological processes and provide favourable conditions for germination and initial growth. There are different Biofertilizers, which are available commercially. One of them is algal Biofertilizer which is the best alternative of the synthetic fertilizers, as they have the natural ability to fix the nitrogen into the soil. They are used as a biofertilizer in the cultivation of onion, rice and other cereals and pulses like (*Vignaradiata*, *Cicer Arietinum*, etc.). Some best microalgae biofertilizers are *Spirulina Platensis* and *Chlorella Vulgaris*. The growth parameters like plant height, leaf number, dry weight, biochemical composition, leaf area, neck thickness, bulb length, diameter and weight with the yield and growth found to higher when they are treated with these two algal biofertilizers. So this review article focuses on checking the effect of *spirulina* on the cultivation of onion.

Keyword: Biofertilizer, micronutrients, macronutrients, *Allium cepa*, *vignaradiata*, *Cicer Arietinum*, *Spirulina Platensis*, *Chlorella vulgaris*

INTRODUCTION

Biofertilizer is a living fertilizer compound of microbial inoculation or groups of microorganism. Microalgae are the major

part of aquatic biodiversity, growing in different environments like sea, freshwater and desert. Microalgae are found

in different forms like single cell, colonies or filaments. For enhancing the nutritional value of the food supplements, algae have been used nowadays. It is a good alternative food of natural antioxidant. *Chlorella*, *Arthrospira*, *Dunaliella Salina* these microalgae are edible strain. Nowadays *Spirulina* cyanobacterium (*arthrospira platensis*) becomes the best food for good health.

Spirulina is a cyanobacterium, blue, chlorophyte found in lakes, freshwater, in salt water, also as in brackish bodies of water and grown commercially [4]. *Spirulina Platensis* may be a gram negative, ubiquitous, spiral, twisted, unicellular, and long without mucilaginous sheath [4]. *Spirulina* is grown in highly alkaline medium pH 10-12 [4]. Various species of *Spirulina* are included *Spirulina Maxima*, *Spirulina Platensis*, *Spirulina Pacifica* (also known as *Arthrospira Platensis*, *Arthrospira Maxima*) [4]. *Arthrospira Platensis* is additionally referred to as *Spirulina Plantensis* and is that predominant species, and commercially cultivated worldwide through [4]. Their fixed nitrogen under anaerobic condition with the help of specialized cells called heterocyst, which comprises 5-10% of cells in a filament [13].

Spirulina is algal bio-fertilizer and is the best alternative source of nitrogenous chemical fertilizers and is the eco friendly,

fuel independent, cost effective and simply available in one. [13] Auxin, cytokinins and gibberelic acids, are present in the extraction of nitrogen fixing algae [13]. In this review article was aimed to analyze the impact of algal productivity under various dosages of algal (*Spirulina Platensis*) fertilizers and to determine the potentiality of bio-fertilizer application in order to have maximum yield as well as for ensuring a healthy environment [13].

Onion is one among the four most important vegetable crop and commercially grown worldwide. Quite (simply) 28% production of onion is produced by china as compared to India, Pakistan, Iran, Brazil, Egypt, Turkey, Russia, and Netherlands so china is a first rank on onion production [2]. Enhancement of onion production and productivity was related to different growth factors. The dry bulb production of onion depended on nutrient requirement, location of onion, nutritional requirement, location of onion production, soil type, agronomic practice, etc. [2].

According to market demand and preferable advantage from the production of pulses for the farmers, growing areas were extended than in the past. The current yield level of mung (*Vigna Radiata*) and chickpea is largely dependent upon the utilization of chemical fertilizer [15]. Mung (*Vigna Radiata*) and chickpea (*Cicer Arietinum*) both are

plant species and belongs to Fabaceae family and both involved more protein and fibers instead of others. There was a clear increase within the plant growth parameters, yield, production, seed quality, seed germination and physical, chemical parameters of rice and maize by the impact of algal biofertilizers but just some studies was carried out to harness the extended fertilizing effect of micro algae. [2].

In agriculture, farming more use of chemical fertilizer may affect the soil environment and grain quality. Therefore, the use of Biofertilizers in mung (*Vigna Radiata*) and chickpea (*Cicer Arietinum*) cultivation has the excellent opportunity which can become established for organic farming or sustainable agriculture [15].

Chickpea contain a good amount of carbohydrate and protein, this quality is better than other pulses. Mung is a nutritional powerhouse and also define as an excellent food. *Spirulina* is a photosynthetic organism and thought of as an important biofertilizers due to its present in high amount of vitamins, essential amino acids and fatty acids [2]. *S. Platensis* is an enhancer of plant growth in term of protein content.

During the last century the microalgae and macro algae was used as a biofertilizer in many countries. The blue, green algae, *spirulina platensis* were used as

biofertilizer in cultivation of mung (*Vigna Radiata*) and chickpea (*Cicer Arietinum*). Plant growth analysis of green gram is essential in the estimation and determination of growth and yield of the crop [15].



Figure 1: Microscopic image of spirulina

Spirulina nutrient value:

Spirulina contains a wide range of healthy/nutritional elements, more than 50 different amino acids, vitamins, protein, minerals, other nutritional elements, carbohydrate, fat, and moisture. *Spirulina* contains the very good amount of protein — six times more than tofu and five times more than meat, and also contain the very good amount of beta-carotene — twenty-eight times more than carrots. *Spirulina* contains one of the most important mineral elements is iron — thirty-nine times more than spinach. The constituents of *Spirulina* include protein (70%), including all essential amino acids, essential fatty acids, polysaccharides, B-vitamins, particularly vitamin B12, beta-carotene and minerals particularly iron [4]. *Spirulina* has

proved the excellent antioxidant properties because they contain beta-carotene, Tocopherol, and phenolic acids. *Spirulina* is an effective dietary source of vitamin A. An investigation in India of preschool children with vitamin A deficiency demonstrated that the bioavailability of carotenes from spirulina was comparable to that from other sources such as carrots and green leafy vegetables, thereby suggesting the potential use of *Spirulina* as a dietary source of vitamin A [1, 4].

Spirulina benefits:

Spirulina is almost 60 – 70% protein, and it's an excellent alternative to meat protein sources. Nutritionists say that its one of the very few plant source of vitamin B12. As you may know, vegetarians lack this vitamin in their in their diet. Spirulina contain ALA- alpha-linolic acid (omega-3), omega-6, GLA- gamma-linolic acid (reduce inflammation), and DHA- Docosahexaenoic acid (main components of brain). These healthy lipids carry many important roles [1, 4].

Nutrient profile of spirulina vs. other foods (Figure 2)

- 180% more calcium than whole milk

- 670% more protein than tofu
- 3100% more beta carotene (vitamin-A) than carrots
- 5100% more iron than spinach
- 280% more antioxidant than blue berries.

The blue green algae contains vitamins B1 (thiamine), B2 (riboflavin), B3 (nicotinamide), B6 (pyridoxine), B9 (folic acid), C, D, E [4].

It's an excellent source of potassium, calcium, chromium, copper, magnesium, manganese, phosphorus, selenium, sodium and zinc [4].

Comparing phytonutrients level, *Spirulina* is 31 times more potent than blueberries, 60 times more potent than spinach and 700 times more potent than apples [4].

What makes spirulina this special?

It's actually a cyanobacteria or blue green algae as expert explain. *Spirulina* got its name after its bright colour. Most of its pigments are bioavailable and healthy, especially beta – carotene and chlorophyll – a. Algae produce oxygen through photosynthesis, which makes it pretty similar to land- dwelling plant (Table 1, Figure 3).

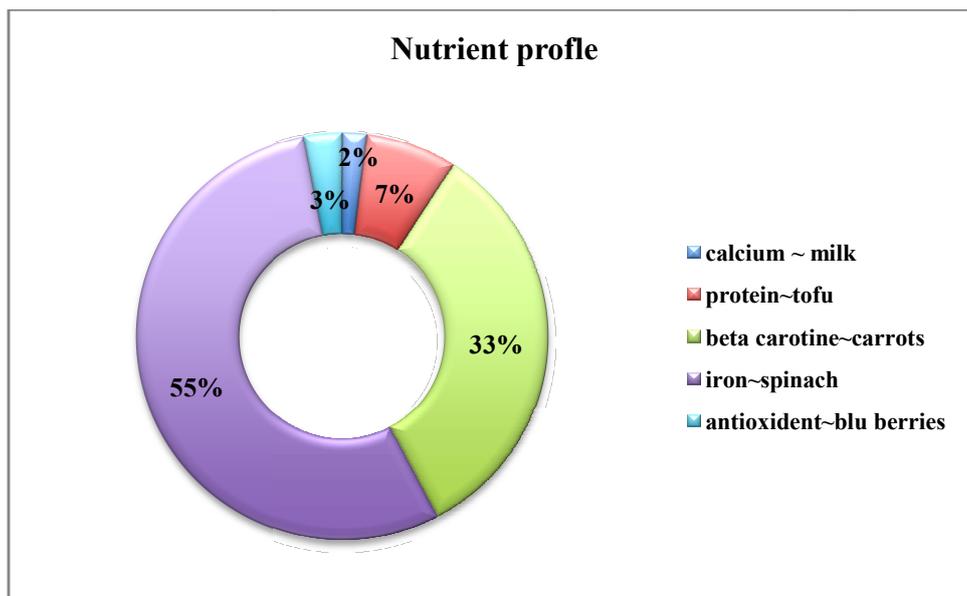


Figure 2: Nutrient Profile of *Spirulina*

Table: 1 General Composition of *Spirulina* [4]

General Composition of <i>Spirulina</i>	
Protein and Amino Acids	70%
Carbohydrates	20%
Lipids	6%
Minerals	8%
Moisture	3%
Dietary fibers	12%
Water	3%

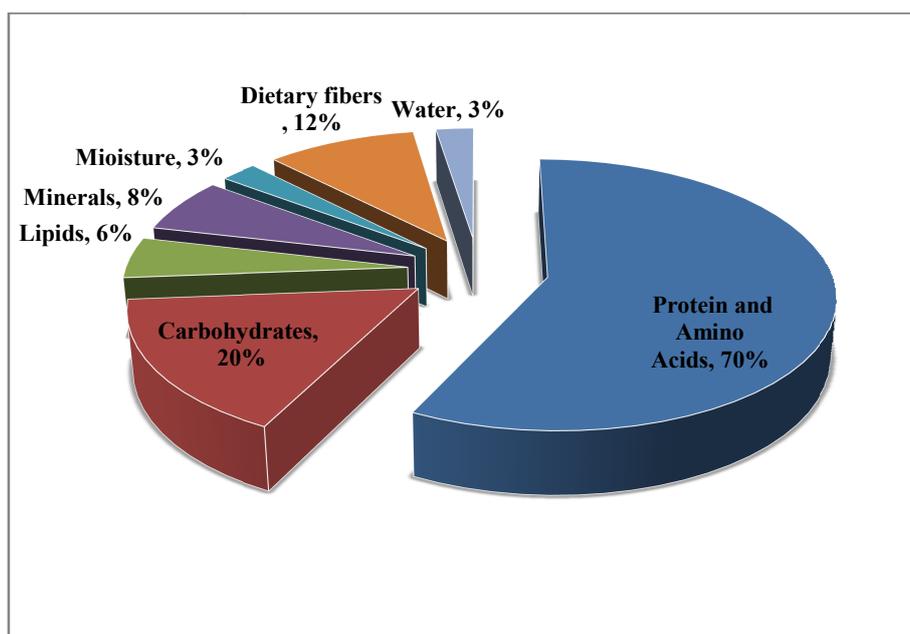


Figure 3: General composition of *spirulina* [4]

Dried powder of *spirulina platensis*

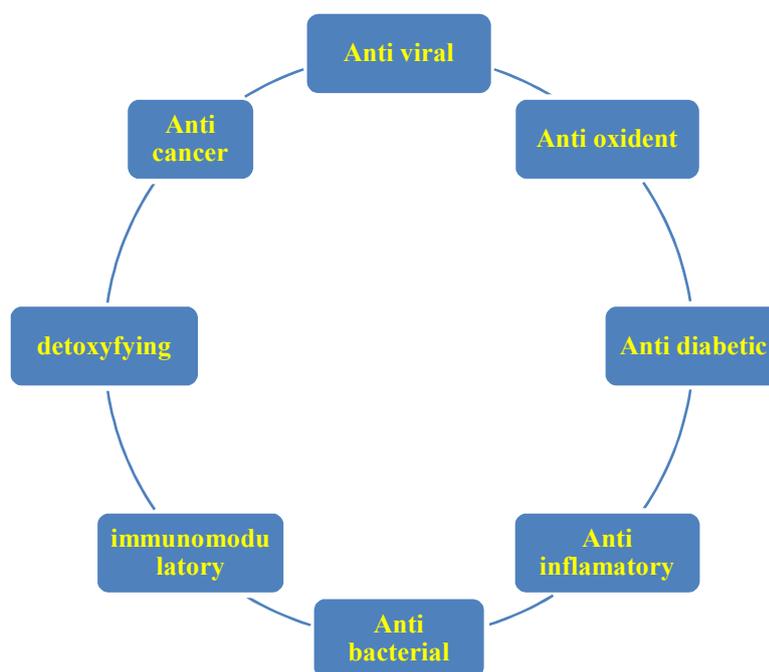


Figure 4: Health benefits of *Spirulina* [1, 4]

Spirulina and pigments:

There are different types of pigments present in the cell and provide certain properties of the cells. *Spirulina* is nature's highest source of chlorophyll pigment. Chlorophyll is one kind of pigment, which is present in all plants, has a similar structure to hemoglobin of blood except the difference in the metal. Chlorophyll shows various anti-bacterial and antiseptic properties and is also effective in removing body odors, improving calcium absorption and counteracting toxins. The blue-colored pigment phycocyanin has been reported to have significant antioxidant, anti-inflammatory, hepatoprotective and broad-spectrum radical scavenging properties. Phycocyanin can be easily extracted out

from the cell and this pigment used in food products. Pure phycocyanins have higher therapeutic value for the treatment of different kind of disorders. Due to a natural compound, it is less toxic. The phycocyanin stimulates production of white blood cells and red blood cells. Wide ranges of animal experiments and clinical experiments conduct in various parts of the world have shown the non-toxic nature of *Spirulina*. United Nations Industrial Development Organization (UNIDO) documents on the toxicological evaluation of *Spirulina* state that when administered at 10%, 20% and 30% levels within the diet, it have not generate any subacute chronic toxicity, so there is no changes in reproduction and

lactation or mutagenicity and teratogenicity [1].

Spirulina Use as a Biofertilizer:

In 1981 the FAO (Food and Agriculture Organization) documented the possibility of blue-green algae replacing chemical fertilizers and rebuilding the structure of depleted soil. Earthen ponds are very suitable kind of environment for growth of blue green algae. When these ponds are dried, algae scooped up and these after sold to farmers. These are a natural nitrogen source of algae, moreover its major benefit are they have only one third cost of chemical fertilizers. Other benefits are they boost up annual rice yield in India by an average of 22 percentages. The algae give the same kind of benefits which a chemical fertilizer gives. This is the same amount of chemical fertilizers; grow in 25 to 30 Kg per acre. The algae have other benefits like used reduction of an equivalent amount of inorganic fertilizer. The *Spirulina* based fertilizers have their own benefits like they are low cost and there are preferred uses of inorganic fertilizer with ready availability. *Spirulina* and other fertilizer combination gave a good yield of tomato. N₂ - fixing Cynobacterium, *Aulosira Fertillissima*, the non N₂- fixing. Cynobacterium, *Spirulina Platensis* and the chemical fertilizer, diammonium phosphate was used in different combinations to tomato seedlings

in post four times at seven day interval. The biological nitrogen is more beneficial of compared to inorganic nitrogen. The nitrogen is very helpful in enhancing plant growth by releasing of carbon components and other nutrients. *Spirulina* as a plant compost is 100% regular and exceptionally nutritious, smaller scale salt water plant. *Spirulina* has incalculable uses as an enhancement for keeping up great plant wellbeing and for forestalling sicknesses. *Spirulina* along these lines goes about as a characteristic bio-energizer for plant development and expanding yields [1, 48, 52, and 54].

Anitha et al. recorded the Micro- and macroelements, as well as other nutrients present in *Spirulina* products play a major role in plant metabolism (e.g., physiological activities like cellular organization, protein and nucleic acid metabolisms)

On the basis of literature, it was shown that the application of *Spirulina* products can increase the content of micro- and macroelements in the crops, fruits, vegetables. [41] studied enrichment of maize with Zn, Mn and Cu derived from a solid *Spirulina* biomass applied as a micronutrient fertilizer. [48] recorded the effect of different concentrations of *Spirulina* suspension in water (5, 10, 15 and 20 g L⁻¹) on the content of zinc in the biomass of *Amaranthus gangeticus*,

Phaseolus aureus and tomato plants The results were observed that Spirulina filtrate applied foliarly can help to accumulate essential substances (e.g., zinc) which are needed for plant growth. In the work of the same author, it was shown that soaking of seeds of *Amaranthus gangeticus*, *Phaseolus aureus* and tomato plants for 1, 2, 3, 4, 5, 25 h in the suspension of 5 g of Spirulina in 100 mL of water generally resulted in the enrichment of plants in zinc [48].

Vermicompost Use as a Biofertilizer:

Biofertilizers is a product which comprises of living or dormant bacteria like bacteria, fungi, actinomycetes, algae; either it is present alone or some time it will present in the combination. As atmospheric nitrogen is not fixed by plants directly, these types of organism present in Biofertilizers help them to fix the atmospheric nitrogen. And alternatively there will be effect on the yield of the crop as it enhances the growth of crops [13].

When the vegetables or food wastes, bedding materials and other organic matter decomposed during the worms and other earthworms, and this decomposed product is called vermicompost provides vital nutrients and useful minerals in soil and plants vermicompost contains water – soluble nutrients and is a superb, nutrient – rich organic and soil conditioner. It is utilized in farming and small scale sustainable, organic farming.

Vermicomposting Also can be applied for treatment of sewage. Vermicompost is a perfect organic matter for improved growth and yield of many plants [16]. It can increase the production of crop and prevent them from hazardous pests without polluting the environment. Vermicompost has a numerous application in increase of seed germination, stem height, number of leaves, leaf area, leaf dry weight, root length, root number, total yield, nutrients, carbohydrates and protein content and improved the quality of fruits and seeds. Pollution of soil, water and air is resulted due to the more use of chemical fertilizers and these also have an adverse effects on the health of human being and cattle. Researchers focus towards organic amendment like vermicompost which can increase the production of crop and prevent them from harmful pests without polluting the environment [16].

General Characteristics of Vermicompost and Vermiculture

Vermicompost is the excreta of worm, which are equipped for improving soil wellbeing and supplement status. Vermiculture is a procedure by which a wide range of biodegradable waste, for example, ranch waste, kitchen waste, showcases waste, bio waste or agro based industry, livestock waste and so forth. Are changed over while going through the worm gut to supplement rich

vermicompost. Vermi worms are utilized here go about as natural specialist to expand those wastes and to store excreta in the process called vermicompost [18].

LITERATURE SURVEY

[3] has performed the experiment by giving following treatments. He has used the different concentration of dried algal biomass in concentration of 25, 50, 75 and 100% [3]. The field experiment was conducted at the experimental farm by Dineshkumar *et al.*, 2018 [2], to understand the impact of using microalgae as Biofertilizers in onion cultivation [2]. Khin Lay Nandar Aung (2011) has carried out the experiment with different treatments of spirulina of different concentrations. The concentration of spirulina are 1, 3, 5, 7, 9 gram/lit. The seeds are soaked in these different concentrations of spirulina and were sown at the depth of approximately 1-2cm [15]. R.Kumaravel, J.Gopalsamy *et al.*, has performed the experiment on rice growth and seed yield productivity by using microalgae use as Biofertilizer. He had used the different concentration of microalgae [13]. Shakila H and Krishnapriya S have evaluated the role of *Spirulina Platensis* as Biofertilizer and biostimulants on Fenugreek (*Trigonella Foenum-Graecum*). The seed was trigonella was soaked in the algal biomass for overnight and then it was sown in the pot and the rate of germination and the

biostimulants ability of *Spirulina Platensis* [20]. Abd El-RheemKh. M. *et al* checked the stimulant effect of the spirulina algae under low Levels of Nitrogen Fertilization on Wheat plants Grownin Sandy Soils. The experiment was applied to check the effect of three level of spirulina algae (25, 50 and 100 ml L-1) as combined with two levels of nitrogen fertilization (80 and 100 kg N/fed).Increasing the extent of spirulina algae from 25 to100 under the low levels of nitrogen fertilization led to the rise of both growth and yield of wheat and not influenced by decreasing nitrogen fertilization rate [41]. Niroj Paudel and Won Hee Kang have studied the use of algae as bio-fertilizer for coffee plant. Experiment was divided as four group; Algae+NPK, Algae, NPK and Control with Water. For each group, 5 plants were used and, every 1 day's gap added 1000 ml of Water in different from [44]. Domenico Ronga, Elisa Biazzi *et.al* examines the effect of Microalgal Biostimulants and Biofertilisers in Crop Productions [45]. Shy Chyi Wuang, Mar Cho Khin *et al.*, Used Spirulina biomass produced from treatment of aquaculture Wastewater as agricultural fertilizers. Potted plants experiments wereconducted with Arugula (*Eruca sativa*), Bayam Red (*Ameranthus gangeticus*), and Pak Choy (*Brassica Rapa ssp. chinensis*) plants. For every plant, four trials were conducted — Control, Spirulina

(5 g/pot), chemical fertilizer (Triple Pro 15-15-15, 0.3 g/pot/week), and Spirulina (5 g/pot) plus chemical fertilizer (0.3 g/pot/week). Each pot consists of 500 g of soil [46]. Layam Anitha, Gannavarapu Sai Bramari and Pilla Kalpana have checked the Effect of Supplementation of *Spirulina platensis* to enhance the Zinc Status in Plants of *Amaranthus gangeticus*, *Phaseolus aureus* and Tomato. The field experiment was carried out using *Amaranthus gangeticus*, *Phaseolus aureus* and Tomato plants in which seed coating by *Spirulina* hydrolysate, with different concentrations of *Spirulina* and water. *Spirulina* is also used as Bio-fortification agent in combination with different fertilizers [47]. K. Godlewska, I. Michalak et.al had studied the Potential applications of cyanobacteria: *Spirulina platensis* filtrates and homogenates in agriculture [48]. R. Dineshkumar et.al the research was undertaken to investigate or observe the influence of *spirulina platensis* on growth yield and quality of onion [2, 13]. The experiment which was conducted by these scientists consistent with soil was treated with *Spirulina* extract and its effect on onion plant was observed in natural environmental condition [2, 13].

Estimation of chlorophyll and total Carotenoids in dried *Spirulina*:

Chlorophyll was estimated by using the method of Holden (1965) [2]. Total

carotenoids content of the leaves were estimated by spectrophotometer as described by Harborne (1973) [2]. The method developed by Cyanotech was followed to estimate the total Carotenoids in dried *Spirulina* [49].

Detection of Biochemical Composition:

Dubios *et al* was estimated the sugar and related substances by anthrone reagent (1951) [14]. The indole content of the root and leaves sample were estimated by the method of Chrastil (1976) [2, 10]. The phenol content of the root and leaves sample was estimated by colorimetric method by following the method of Martin (1949) [2, 37]. The free amino acid content of experimental onion samples was done following the methods of Moore and Stein (1984) [2, 38].

Detection of anti-nutrient composition:

The hydrocyanic content of the experimental onion sample was estimated by the method of Drochioiu and Druta (2000) [2, 13]. Total oxalate was determined by the enzyme method as describe by Liu et.al (2009) [2, 34]. The soluble oxalate was assessed using a thermal conductivity detector by Li *et al* (2014) [2, 33]. The phytic acid of the experimental onion /samples was estimated by Garcia Estepa *et al* (1999) [2, 20]. Brandbury *et al* (1991) and Hong *et al* (2004) was estimated the cyanogenic

glycoside content of onion sample by using standard protocol [2, 8, 26].

Detection of bio molecules:

Extraction and estimation of total protein by Lowry *et al* (1951) [20]. Extraction and estimation of carbohydrates by Anthrone method by Pons *et al* (1981) [20]. Extraction and estimation of total lipids by Bligh and Dyer, 1959 [20]. Protein content (%) of *S. platensis* biomass obtained from different culture media and from different culture conditions were estimated by microkjeldal method [49].

Mineral Analysis:

All the mineral of sodium, potassium, calcium, magnesium, phosphorus and manganese content was estimated. The phosphorus was determined by spectrophotometer while sodium and potassium was determined by flame photometer by Khalil *et al* (1990) [2, 30]. Iron, copper, zinc, manganese, calcium and magnesium were determined by Atomic Absorption Spectrophotometer in 2005.

Growth parameters:

➤ Vegetative Growth:

Based on the supported study the measurement of plant height (cm), number of leaves/plant, fresh weight/plant (g) and dry weight/plant (g) was taken at the end of the experimental study.

➤ Yield Attributes:

Based on the supported study the yield attributes were measured by the neck thickness (cm), bulb diameter (cm) and bulb weight.

Growth criteria:

Dineshkumar *et al.*, 2018, [2] Studied that the effect of algal Biofertilizers of *chlorella vulgaris* and *spirulina platensis* play key role for improving the growth of rice plants. The positive performance of rice plants, in term of plant height, number of leaves, leaf area, fresh and dry weight of plant was enhanced by the both microalgae fertilizers. In comparison between two different microalgae *chlorella vulgaris* and *spirulina platensis*, the *spirulina platensis* fertilizers shows higher parameters, such as plant height, number of leaves, dry weight. The plant fresh weight was found to be very similar both microalgae fertilizers. This evidence was clearly appeared in growth criteria of rice cultivation represented. Cyanobacteria related Biofertilizers can process with wheat, sorghum, maize and it lentils were studied. It was observed that parameters of growth were significantly increased among with control.

CONCLUSION

In this review article we evaluate the role of *spirulina platensis* in the field of agriculture as biofertilizer or bioconditioner and biostimulants. It may be concluded that the blue green algae significantly increase

the protein level in onion and green gram so; as a result in the field of agriculture to improve the nutritional requirement in high yielding cereal crops [20]. From that the dry biomass of *Spirulina platensis* mixed with water and applied to the soil separately. The expansion parameters, yield attributes, bio chemical composition, anti nutritional composition, and mineral were found to be higher in spirulina platensis. This bio fertilizer treatment is helpful compare to opposite control treatment, this increase onion yield respectively, so *Spirulina platensis* often used as bio fertilizer to enhance onion yield so micro algal Biofertilizers can replace the chemical fertilizer so they were, easily renewable cheaper source which help farmers to supply healthy organic foods and make a healthy chemical free organic mankind through micro algal Biofertilizers [2, 13]. From these studies in can be concluded the using of *spirulina platensis* with vermicompost produce good yield of onion similar to that produce with recommended mineral fertilizers with higher quality of bulb at harvested and during storage. Application of 100% vermicompost and only spirulina produce a somewhat low yield. Shy Chyi Wuang *et al* (2016) illustrates the efficacies of *S. platensis* in enhancing the growth of Bayam Red (Red Spinach), Arugula (Rucola) and Pak Choy (type of Chinese cabbage). For Bayam Red,

the plants cultivated in soil enriched with *Spirulina* showed increased plant height by 58.3% as well as greater fresh and dry weights, by 110.1% and 155.8% respectively, when compared with the control group [47].

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