



APPLICATION OF ARTHROSPIRA PLATENSIS (SPIRULINA) AS BIO-FERTILIZER FOR SUSTAINABLE AGRICULTURE

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Abstract:

Abstract: *Arthrospira platensis* (Spirulina) is multi-cellular and filamentous Cyanobacteria which is used as a biofertilizer in agriculture sector for their potential role in food safety and sustainable crop production. The eco-friendly approaches inspire a wide range of application of plant growth promoting ectomycorrhizal fungi, cyanobacteria and many other useful microscopic organisms led to improved nutrient uptake, plant growth and plant tolerance to abiotic and biotic stress. In this present study, *Arthrospira platensis* is used as bio-fertilizer to evaluate soil fertility and growth of *Trigonella foenum- graecum* (Fenugreek).

Objective: To analyze the prior application of *S. platensis* as biofertilizer on soil bag containing *Trigonella foenum- graecum* (Fenugreek) seeds and to compare its effect with subsequent soil bags treated with other organic fertilizers such as Cow dung manure and panchagavya.

Methods: In plant biochemical analysis, the plants which supplemented with *S. platensis* bio fertilizer showed significant increased level in chlorophyll and carotenoids contents. Soil fertility parameters (OC %, available N, P and K, EC and pH) analyzed after plant harvest registered significant improvement over the values than before.

Conclusion: From the study it was concluded that among all the different variations and combinations of *S. platensis* treated plants shows an improvement in the soil physico-chemical properties and enhances plant growth.

Key Words: Bio-fertilizer, Plant growth, Soil fertility, *Arthrospira platensis* (spirulina), *Trigonella foenum-graecum* (Fenugreek).

Introduction:

Modern agriculture plays a significant role to overcome the food demands of growing human population, which this situation leads to increasing the dependence on conventional agriculture. In evolving day's chemical fertilizers has been used to increase the yield. The major problem rising now a day's due to over usage of chemical fertilizers leads to soil acidification happens because of decrease in organic matter in the soil. It will also kills the soil microbes which is responsible for nitrogen-fixation, finally it leads soil to lack fertility¹. To overcome this situation Bio-fertilizers has been emerged. Bio-fertilizers have a high potential on several metabolic processes which it raises the plant growth and development through enhancing photosynthesis, endogenous hormones, ion uptake, nucleic acid, and protein synthesis². Cyanobacterial biomass is the effective bio-fertilizer source to improve soil physico-chemical characteristics and plant growth³. *Arthrospira platensis* (Spirulina) is multi-cellular and filamentous cyanobacteria that achieved a considerable popularity in the health sector, food industry and aquacultures. It develops and grows in water, can be harvested and processed easily. Spirulina is packed with chlorophyll and very high content of macro and micronutrients such as essential amino acids, proteins, lipids, vitamins, minerals and anti-oxidants⁴. *Spirulina platensis*, is a Cyanobacteria which is protein rich substance taken as a dietary supplement. It has also been recommended as a good alternative to chemical fertilizer⁵. The main component responsible for the plant growth is Nitrogen which is most predominantly present in atmosphere (79% of total gases) but cannot be directly absorbed by the plants. Microbes present in the soil metabolize nitrogen into ammonia which is biological nitrogen fixation. Whereas spirulina is quite different from others which it is not nitrogen fixing blue-green algae. In spite of this, it will produce oxygen to the bacteria and improving the productivity of the crops⁶. The fact that approximately 60% of the *S. platensis* biomass is protein allows this biomass to be used to obtain protein hydrolysates containing valuable biomarkers. Decarboxylation of these molecules provides polyamine synthesis and the presence of polyamine enables cyanobacteria to be used effectively in plant growth⁷.

During photosynthesis, chlorophyll captures the sun's rays and creates sugary carbohydrates or energy, which allows the plant to grow and Carotenoids are ubiquitous and essential pigments in photosynthesis. They absorb in the blue-green region of the solar spectrum and transfer the absorbed energy to chlorophylls, and so expand the wavelength range of light that is able to drive photosynthesis. Plant growth depends on photosynthesis, but it is simplistic to think that growth rate directly reflects photosynthetic rate⁸. Soil fertility is ability of soil to provide all essential plant nutrients in available forms and in a suitable balance. Researchers studied that the concentration of soil nutrients e.g. (organic C, N, P, K) are good indicator of soil quality and productivity because of the favourable effects on the physico-chemical and biological properties of the soil⁹.

In the present study, *Spirulina platensis* is used as a Bio-fertilizer to enhance plant growth in *Trigonella foenum-graecum* and soil fertility. The effect of plant growth and soil fertility was estimated and the study results indicated that there was significant improvement in plant growth and soil fertility.

Materials and Methods:

Sample Collection:

Spirulina culture desiccated sample were collected from the “iGreen Firm”, Arachur, Coimbatore, Tamilnadu.

Experimental Setup:

The experimental design was factorial split plot design¹⁰. Observation was taken on six sets of plant samples in soil bags. The main plot was *S. platensis* consisted of two levels, i.e., without *S. platensis* and with *S. platensis* application. The sub plot was application of Cow-dung manure, panchagavya along with spirulina and without spirulina. Control: Soil without fertilizer

Test 1- Soil supplemented with Spirulina (25g)

Test 2- Soil supplemented with Panchagavya 25ml (3:100ml dilution of panchagavya in water)

Test 3- Soil supplemented with diluted 25ml panchagavya and Spirulina (25g)

Test 4- Soil supplemented with Cow-dung manure (25g)

Test 5- Soil supplemented with Cow-dung manure (25g) and Spirulina (25g)

1. Morphological Analysis (Growth parameters)

a) Germination Percentage: The number of seeds germinated was calculated on 10th day. The germination percentage was calculated by using the following formula:

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated} \times 100}{\text{Total number of seeds sown}}$$

b) For Shoots: The length of the shoot of each plant in each (pot) treatment was measured on 20th day after sowing and recorded on the data sheet. Internode distance was also recorded.

c) For Roots: The plants were smoothly uprooted from the pots, cleaned from soil residues and prepared for measurements. The length of the root of each plant in each pot was measured on 20th day after sowing and recorded on the data sheet.

2. Biochemical Analysis of Plant:

Chlorophyll and Carotenoids:

The Quantitative estimation of chlorophyll-a, chlorophyll-b and total chlorophyll¹¹ while carotenoids determined by acetone method¹² fresh leaf material was taken and homogenized with 80% acetone and centrifuged at 5000 rpm for 5 min. Supernatant was adjusted to 100 ml in the volumetric flask. The absorbance (O.D.) of this extracted solution was measured at 480, 510, 645 and 663λ.

3. Soil Fertility Analysis:

Soil fertility parameters (OC % (Walkley-black chromic acid oxidation method), available Nitrogen (Titration method), Phosphorus (Calorimetric method) and potassium (flame photometric method), Electrical conductivity and pH) were quantitatively analyzed after the plant harvest.

Result and Discussion:

1. Morphological Analysis of *Trigonella foenum-graecum* plant



Figure 1 (Control & Test1) Figure 2 (Control, Test2 & Test 3) Figure 3 (Control, Test 4 & Test 5)

The experimental evidence proved that the plant cultivated in soil enriched with Cow-dung manure, panchagavya with spirulina showed increased plant height when compared with the control group and Cow-dung manure, panchagavya without spirulina treated (Fig 1 and Fig.2). When compared to the control the plant cultivated in soil enriched with spirulina alone shows significant increase in plant physical growth among others respectively (Figure 3).

Gahlout et al¹⁴ researched that the effects of the extracts of different cyanobacteria on wheat and mung bean seed germination and seedling development in their studies and they detected that extracts increased the percentage of seed germination (at the end of the 3rd day, more germination percentage -70% excess-was observed than the control group) and extract has a positive effect on seedling development.

Table 1: Morphological Parameters of *Trigonella foenum graecum* in soil

S.No	Treatment	Germination date	Germination %	Shoot length (cm)	Root length (cm)
1	Control	22.01.2020	56	15.3	4
2	Test 1: Spirulina	22.01.2020	82	25.1	6.1
3	Test 2: Panchagavya	22.01.2020	67	20	4.7
4	Test 3: Panchagavya + Spirulina	22.01.2020	78	23	5.6
5	Test 4: Cowdung Manure	22.01.2020	62	17	4.2
6	Test 5: Cowdung Manure + Spirulina	22.01.2020	69	21.2	4.5

In our present study, When all the data related to *Trigonella foenum graecum* seeds (Table 1) are evaluated; it is observed that test 1 spirulina application has positive effects on seed germination (germination rate , 82%) and seedling development. It can be said that S. platensis accelerates the seed germination and have biostimulant effect in plant growth.

2. Biochemical Analysis of *Trigonella foenum- graecum* plant:

Pigment also plays role as an index of plant growth and production of organic matter¹⁵. The extractions of chlorophyll and carotenoids pigment molecules by 80% acetone method from the spirulina treated and control fenugreek plants were measured by spectrophotometer. In the spirulina treated fenugreek plants , chlorophyll-a, Chlorophyll-b, total chlorophyll and Carotenoids content were high (0.18957,0.3358,0.5252,0.1180 mg/g fresh wt respectively.) as compared to the chlorophyll-a, Chlorophyll-b, total chlorophyll and Carotenoids content of control plant (0.1312,0.2491,0.3802,0.0879 mg/g fresh wt. respectively).

Table 2: The Spectrophotometric determination of absorbance for Chlorophylls and Carotenoids of *Trigonella foenum- graecum* plant

Plant Pigments	Control	Test 1 spirulina	Test 2 panchagavya	Test 3 Panchagavya+ spirulina	Test 4 Cow dung Manure	Test 5 Cow dung Manure + spirulina
Chlorophyll a (mg/g fresh wt)	0.1312	0.1895	0.1557	0.1723	0.1339	0.1500
Chlorophyll b (mg/g fresh wt)	0.2491	0.3358	0.2997	0.3192	0.2687	0.2805
Total chlorophyll (mg/g fresh wt)	0.3802	0.5252	0.4553	0.4913	0.4025	0.4304
Total Carotenoids (mg/g fresh wt)	0.0879	0.1180	0.1015	0.1116	0.0838	0.1005

Gehan A et al.,2017 has researched that fresh or dry cyanobacteria as soil additives or as seed pretreatment improved plant nutrients which, in turn, enhances the biochemical routes that lead to a more rapid and proliferated plant growth. The bio-priming treatment of seeds with dried cyanobacterial cells was superior in almost all the estimated growth parameters and physiological processes of *Hordeum* and *Trigonella* studied plants.

3. Soil Fertility:

Soil fertility parameters (OC %, available N, P and K, EC and pH) analyzed after plant harvest registered significant improvement over the values than before.

Experimentation with successive higher fertility level i.e spirulina BF treated fenugreek plant shows (OC-0.22%, N-255.1, P-11.8, K-278.8 kg/ha, EC-0.42 d s/m, pH-7.5) compared to control (N -176, P-7.0, K-329 kg/ha, EC-0.18 d s/m, pH-6.95).

Maximum values of soil fertility at plant harvest were obtained under spirulina treatment on soil before seeding. Focusing on nitrogen and OC % it might be due to involvement of spirulina in N- fixation and also have synergistic effect resulting in higher OC .% due to more root and shoot growth respectively.

Table 3: Physico-chemical properties of soil

Parameters	Organic carbon (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	E.C (ds/m)	pH
Control	0.18	176	7.0	329	0.18	6.95
Test 1: Spirulina	0.22	255.1	11.8	278.8	0.42	7.5
Test 2: Panchagavya	0.19	250.4	11.7	274.3	0.40	8.23
Test 3: Panchagavya + Spirulina	0.20	253.1	11.7	279.8	0.32	8.10

Test 4: Cowdung Manure	0.18	243	11.6	263.2	0.42	8.54
Test 5: Cowdung Manure + Spirulina	0.19	250.4	11.5	265.8	0.23	8.30

Spirulina platensis biomass has been shown to improve soil macronutrients (nitrogen, phosphorus and potassium)¹⁶ act as a biofortification agent, enhance plant protein content¹⁷ and increase crop growth, i.e. 5 g *Spirulina* in 500 g–1 soil increased the height of Bayamred (red spinach) by 58.3% as well as fresh and dry weights by 110.1% and 155.8% respectively, when compared to the control group¹⁸. Dried algal biomass grown on anaerobic digestate from dairy manure increased plant available N and P in soils within 21 days and thereby improved cucumber and corn seedling growth¹⁹. This study supports that *Spirulina platensis* biomass has been shown to improve soil macronutrients.

Conclusion:

From the present study analysis, among all the different variations and combinations of *S. platensis* treated plants, the effect was best observed in the plants. At the end it is concluded that *S. platensis* which is a blue green algae can be helpful in agriculture as an enhancer of plant growth and showed an improvement in the soil physico-chemical properties. All these data indicates that the bio-fertilizers containing Cyanobacterium that are natural and dissolve in nature spontaneously should be preferred instead of artificial fertilizers because of their positive effects on plant growth and non-destructive properties. .

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