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Effects of Algal Bio-Fertilizer on the Growth of *Vigna Radiata*

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Abstract—**India in its agricultural domain is encountering the problem of feeding the growing population along with using the land sustainably. The use of chemical fertilizers has massively increased the rate of production but indiscriminate use of these chemical fertilizers has further mystified the natural system and have caused many environmental and health related problems. Due to direct uses of chemical and inorganic fertilizers drastic problems has been arisen and the fertility has been decreased since last decades. Algal bio-fertilizers is an emerging option for the present farming era. The aim of this work is an extension of approach towards cultivating *Vigna radiata*, a leguminous plant treated with algal bio-fertilizer and is compared with the different chemical fertilizers to notice the growth parameters which is a biotechnological approach. A pot experiment was carried out for 60 days to evaluate the effect of algal bio-fertilizer on *Vigna radiata* by comparing the growth parameters with respect to FYM, NPK and combination of these three. A finding of the experiment reveals that the treatment of algal bio-fertilizer in combination with FYM showed significant result than the other treatments. The principle of this study is the simple and basic approach for using algae as a bio-fertilizer and large scale experiment has to be conducted in future to prove the sustainability of this approach.**

***Index Terms*— *Vigna radiata*, algal bio-fertilizer, soil fertility, pulse productivity**

I. INTRODUCTION

Highlight. The overall soil health has indiscriminately resulted in bad shape due to mining activities, which has to be improved by adding suitable amendments having the power to improve soil health and genesis to support microbial growth and vegetation [1, 2, 3, 4, 5, 6].

The use of chemical fertilizers/agrochemicals has resulted in the harmful undesirable effects on both the environment as well as the human health [7]. Chemical fertilizers which are mostly used to increase the crop yield and replenish soil nutrients, gradually results in degradation of soil over the years, affects essential soil microbial communities and possess severe health and environmental hazards. They contaminate the environment and accumulate within the food-webs resulting in mortality.

The solution to these lies in the form of organic farming. Organic farming is an eco-friendly practice for sustainable agriculture which makes the ecosystem healthier [8]. It has globally emerged as an important priority area in the view of the growing demand for safe and healthy food, long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals [9]. The most essential component of organic farming is bio-fertilizers.

The current demand of nutrients is much higher than the availability. It is estimated that by 2020 to achieve the targeted production of 321 million tons of food grain, the requirement of nutrient will be 28.8 million tons, while their availability will be only 21.6 million tones being a deficit of about 7.2 million tones [10]. This can be only be achieved by employing bio-fertilizers in agriculture.

Bio-fertilizers are not only the alternative to chemical fertilizers but also tend to increase the soil and plant productivity which we will further discuss in this review article. They play an important role in the nutrient mobilization and development of soil by accelerating microbial processes which supports the entire plant growth system [8].

In India the availability and affordability of fossil fuel based chemical fertilizers at the farm level have been ensured only through imports and subsidies. Today, bio-fertilizers have emerged as a highly potent alternative to chemical fertilizers due to their eco-friendly, easy to apply, non-toxic and cost effective nature. Bio-fertilizers make nutrients that are naturally abundant in soil or atmosphere, usable for plants and act as supplements to agrochemicals. Algae are very large and diverse groups of simple, autotrophic organisms, ranging from unicellular to multicellular form. Most of them can conduct photosynthesis, in which the CO_2 and solar energy are transformed into sugar, subsequently become biomass. The ability of certain species of blue-green algae (also called cyanobacteria) carry out both photosynthesis and nitrogen fixation, which provide them ecological and agricultural advantages as a new type of bio-fertilizer, which can improve soil structure, especially saline–alkaline soil, and increase the yielding and quality of crops.

Bio-fertilizers as cheap and safe inputs for farmers provides lot of scope for local employment through decentralized rural infrastructure, more skills and capacities to address technology, research and production capacities of soils. The production technology for bio-fertilizers is relatively simple and installation cost is very low compared to chemical fertilizer plants [11].

Bio-fertilizers have shown great potential as supplementary, renewable and environmental friendly sources of plant nutrients and are an important component of Integrated Nutrient Management (INM) and Integrated Plant Nutrition System (IPNS) [12]. By using amount of chemical

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N fertilizer can be decreased. Reducing the chemical N fertilizer up to 50 or 75% of the recommended dose and using BGA either as dry seed inoculation or soil drench gave better results than reducing this amount without any cyanobacteria application (or using the recommended N dose only) [13]. Algae are very large and diverse groups of simple, autotrophic organisms, ranging from unicellular to multicellular form. Most of them can conduct photosynthesis, in which the CO2 and solar energy are transformed into sugar, subsequently become biomass [14, 15, 16, 17, 18, 19, 20, 21, 22]. The ability of certain species of blue-green algae (also called cyanobacteria) carry out both photosynthesis and nitrogen fixation, which provide them ecological and agricultural advantages as a new type of bio-fertilizer, which can improve soil structure, especially saline–alkaline soil, and increase the yielding and quality of crops. They are helpful in water purification to some extent [22, 23, 24, 25, 26, 27].

Mungbean (*Vigna radiata* L. Wilczek), an important short duration grain legume crop, is cultivated for its dry seeds, which are a rich source of easily digestible protein, carbohydrates, vitamin C, folic acid, thiamin, iron, zinc, potassium, magnesium, copper, manganese, phosphorus and phytic acid (PA, myo-inositol hexakisphosphate), an anti-nutritional factor that is the main storage form of organic phosphorus (P) [28].

II. Material And Methods

The present experiment was carried out in Rabi Season 2015-16 under edifice and climatic condition of Dhanbad, Jharkhand. The experiment was carried out in the pot culture at EMG, CSIR- CIMFR Dhanbad, Jharkhand India between the Latitude 23.7900 °N and longitude 86.4300 °E at about 761 feet above mean sea level, having a semi-arid sub-tropical conditions of extreme conditions with hot dry summer with cold winter with an average annual precipitations of 1300 mm as monsoon rain. Minimum and maximum temperature prevailing during the experiment was from 10 to 25 °C. Seeds of *Vigna radiata* variety K851 was procured from market. Every care was taken to collect healthy and uniformed sized seed, which were disinfected with 0.01% mercuric chloride for 1 minute and then washed under tap water for 5 minutes. The experiment was having six treatment with algae (T1), FYM (T2), NPK (T3), Algae + FYM (T4), Algae + NPK (T5), NPK + FYM (T6) and Control (C) respectively with ten replicates each. This soil analysis were done with the prescribed ICAR- New Delhi soil testing standards.

The pH of the soil was 6.2 with water holding capacity 33 %, 0.50 to 0.75 kg per hectare organic carbon, 39 kg per hectare available phosphorous, 180 kg per hectare available nitrogen and 296 kg per hectare available potassium respectively.

The morphological parameters such as shoot length, root length, stem thickness, number of leaves and number of nodules per plant were studied. The experimental data was collected after every 15 days from the date of sowing i.e. 15, 30, 45, and 60 days (**Table. I**).

III. Result And Discussion

Growth behavior such as germination, plant height, root length, stem thickness, number of leaves per plant and number of nodules per plant were studied.

A. Germination

The period taken for germination was 8 to 10 days and maximum was achieved by T4, T5, T6 followed by T2. Further T1 was having 90 % with T3 and control 85 % respectively. This shows that organic fertilizer like FYM and Algae and when it is applied with combination of organic and inorganic fertilizer having the same germination percentile in *Vigna radiata* [29].

B. Plant height

There was consistent increase in the plant height with the advancement in age of the plant (**Fig.1**). The maximum growth of shoot was present in (T4) followed by (T5). Only algae treated (T2) and (T3) showed similar moderate growth, whereas only NPK treated (T3) plants showed minimum growth [30, 31,32].

C. Shoot length

The maximum root length was observed in (T4) followed by (T5) and T6 respectively (**Fig.2**). Algae when applied alone (T1) showed considerable increase in height in comparison to the NPK treated pots (T3), whose root length was somewhat near to that of control [30,31,33].

D. Stem thickness

The algae treated plants (T4) showed highest stem thickness followed by (T5). The (T6) and (T1) treatment showed similar stem thickness (**Fig.3**). The minimum stem thickness was observed in NPK treated pots (T3) which is same as in case of control plants [34].

E. Number of leaves per plant

The highest number of leaves per plant were present in (T4) plants i.e. 13 (**Fig.4**) followed by (T5) plants. (T1), (T2), (T6) showed significant increase in leaves whereas lowest no of leaves were present in (T3) similar to control [32, 35].

F. Number of nodules per plant

The (T4) and (T5) pots showed maximum numbers (**Fig.5**) of nodules per plant followed by (T6) whereas lowest were seen in (T2) and (T3), which were slightly greater than the control [31,33,36].

Table I: Effect of different inorganic and organic fertilizers in different combination treatments on *Vigna radiata* growth parameters after 15, 30, 45 and 60 days.

Treatment	No. of days	Avg. shoot height / plant	Avg. root length/plant	Avg. stem thickness/plant	Avg. no. of leaves / plant	Avg. no. of nodules/plant
Control (C)	15	7.26	3.4	0.123	2.01	-
	30	11.39	6.45	0.256	4.11	6.1
	45	31.1	9.93	0.401	6.87	12.3
	60	40.2	13.67	0.501	9	20.5

Algae (T1)	15	6.46	3.68	0.126	2.72	-
	30	15.605	7.4	0.314	5	7.5
	45	35.805	11.72	0.499	8.06	15.3
	60	42.82	16.22	0.528	10.89	23.2
FYM (T2)	15	5.9	3.38	0.131	2.35	-
	30	13.395	6.84	0.292	4.88	6.8
	45	33.175	10.3	0.437	7.57	14.5
	60	41.89	15.7	0.517	10.22	22.5
NPK (T3)	15	6.26	3.3	0.116	2.16	-
	30	13.031	6.59	0.289	4.19	6.5
	45	32.01	10.04	0.428	7.01	13.4
	60	41.06	14.15	0.501	9.46	22.5
Algae + FYM (T4)	15	6.56	5.08	0.124	3	-
	30	16.705	8.01	0.378	6.32	10.95
	45	37.186	12.3	0.521	10.5	17.6
	60	47.51	18.2	0.601	13	27
Algae +NPK (T5)	15	6.1	4.2	0.131	2.94	-
	30	16.01	7.59	0.316	5.87	9.5
	45	36.91	12.15	0.501	9.6	16.9
	60	45.44	17.5	0.587	12.2	26.7
NPK+ FYM (T6)	15	6.28	4.54	0.142	2.86	-
	30	15.1	7.28	0.339	5.35	8.6
	45	36.01	10.84	0.487	8.56	16.2
	60	42.97	17	0.538	11.36	25.3

This experiment showed that the pots in which organic bio-fertilizers were used showed maximum growth rate of plants even when they are used alongside synthetic fertilizers. Whereas alone synthetic fertilizer treated plants showed no significant increase in growth. Synthetic fertilizers whether applied or not showed somewhat similar result, so it's better to end the usage of synthetic fertilizers which only degrades the environment.

The organic bio-fertilizers played an important in part in overall growth of the plants. This results showed that when bio-fertilizers teamed up with another organic nature materials showed better results. Hence it implies the nutrients needed by the plants and soil to enhance their productivity and yield is compensated by usage bio and organic fertilizers.

Dry algae is an organic material which act as humus for the soil which helps in binding the soil, hold nutrient inside it and supply to plants by capillary action for a longer duration, increases the water holding capacity of soil and increase the inter molecular space between soil molecule due to which proper aeration is supplied to root system and hence makes it more beneficial to use as bio fertilizer in comparison to chemical fertilizers [37, 38, 39].

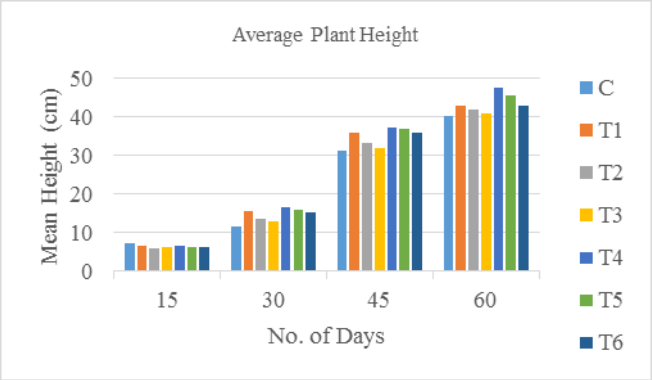

Fig. 1: Average plant height (in cm) of Vigna radiate in different treatments after 15, 30, 45 and 60 days.

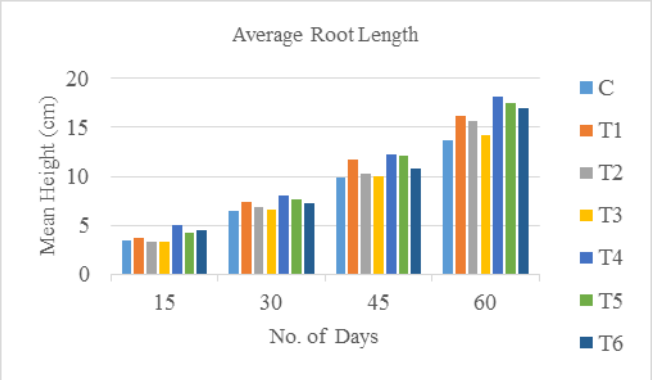

Fig. 2: Average root length (in cm) of *Vigna radiata* in different treatments after 15, 30, 45 and 60 days.

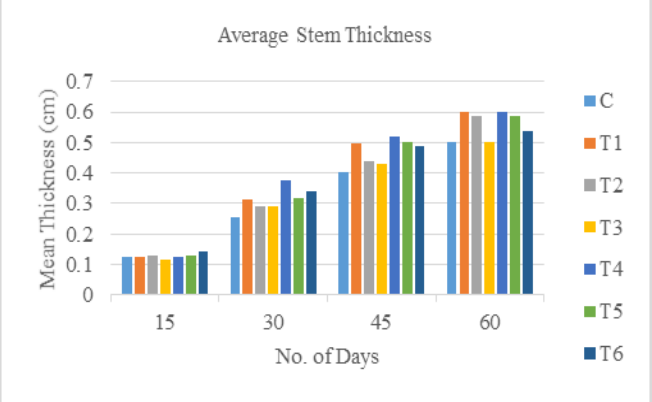

Fig. 3: Average stem thickness (in cm) of *Vigna radiata* in different treatments after 15, 30, 45 and 60 days.

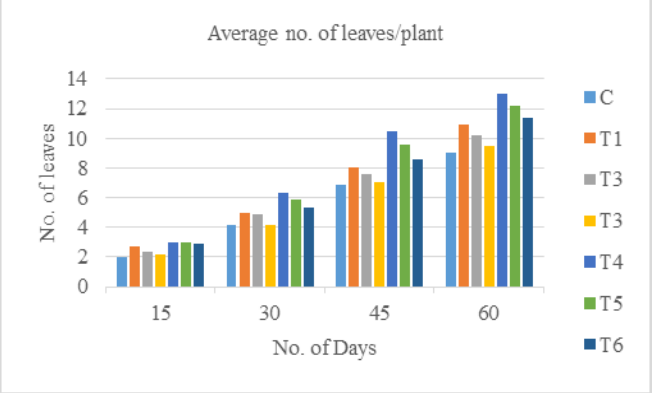

Fig. 4: Average number of leaves/plant of *Vigna radiata* in different treatments after 15, 30, 45 and 60 days.

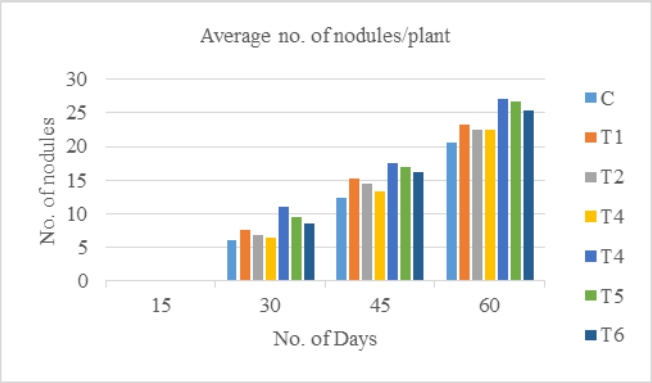

Fig. 5: Average number of nodules/plant of *Vigna radiata* in different treatments after 15, 30, 45 and 60 days

IV. CONCLUSION

Among the bio-fertilizers algae which is grown in fresh and waste water in our country is in practice of bio-fertilizer in paddy crops, were utilized for this experiment. The algal bio-fertilizer were used in *Vigna radiata* in different combination with organic and inorganic fertilizers to notice the effectiveness for the growth grown in pot experiment. The overall experiment was conducted to find the effectiveness of different bio-fertilizer over chemical fertilizer on the different growth parameters. Though, the experiment was done in limited time period with limited boundaries and resources, the experiment findings were significant. Further detailed study is also required at larger scale in all the three seasons for its accuracy and significance.

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