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Effect of different algal powder on growth and productivity of Moongbean (*Phaseolus radiata*)

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ABSTRACT

Various species of algae grow luxuriantly in Ujani reservoir. Those species found in large amount are used for experimental purpose. The effect of selected five algal species (*Synechococcus aeruginosus, Spirulina plantensis, Cladophora crispata, Spirogyra jugalis* and *Chara fragilis*) was evaluated as biofertilizer on growth and productivity of Moongbean. From the study it was observed that application of algae on Moongbean gives higher yield compared to control. Statistical analysis showed that there are significant differences in plant height, number of leaves and yield as compared to control.

Figures : 02 References : 17 Table : 01
KEY WORDS : Algal powder, Growth and Productivity, *Phaseolus radiata* L., Yield.

Introduction

Ujani reservoir is rich in algal biodiversity. Various species of algae are found in Ujani reservoir mainly *Chara fragilis, Spirogyra jugalis, Synechococcus aeruginosus, Spirulina platensis, Cladophora crispata, Chara excelsa, Microcystis aeruginosa, etc.*

Among these *Cladophora crispata, Spirogyra jugalis, Chara fragilis, Synechococcus aeruginosus, Spirulina platensis* are found in large quantities. For these experiments Moongbean (variety Kopargaon) was selected. These crops are the main crops cultivated in Indapur Taluka. For growth and development of these crops suitable environment is there in Indapur Taluka.

Moongbean is an important source of protein and has a great economic value in national market. These crops have a short season for harvesting. In rainfed areas Moongbean (Kopargaon) is cultivated on large scale and in well irrigated land, productivity increases.

For this experiment algae was considered as a biofertilizer because it helps in N_2 fixation. Algal extracts which are known to enhance seed germination, improve plant growth, and induce resistance to frost, fungal and insect attack and increase nutrient uptake from soil[7,15-17]. The recent researches proved that seaweed fertilizers are preferred not only due to their nitrogen, phosphorus and potash content but also because of the presence of trace elements and metabolite similar to plant growth regulators such as auxin, cytokinin, and gibberellins.

Addition of different successive extracts of *Asparagopsis taxiformis* thallus powder to the soil, as a biofertilizer, gave significant increase in the growth of *Vicia faba*[2]. The application of an extract from algae to soil or foliage increased ash, protein and carbohydrate content of potatoes[5]. NPK in plants treated with *Sargassum* sp., reached four folds the negative control[10].

Studies of the algal influence on growth, yield and protein content of rice plants and showed that pre-soaking rice seeds with BGA cultures or extracts enhance germination, promote the growth of roots and shoots and increase the weight and protein content of the grain[3]. Beneficial effects of cyanobacterial inoculation were reported, not only for rice, but for other crops such as wheat, soybean, oat, tomato, radish, cotton, sugarcane, maize, chili, bean, muskmelon and lettuce[1-4,6,8,11-14,16]. Several reasons have been proposed for beneficial effects of cyanobacteria on the growth of different plants.

It was observed that the continuous application of inorganic fertilizers, soil become nonfertile. Inorganic fertilizers are costly so now a days people began to use alternative sources like organic fertilizers & biofertilizers.

Effect of different algal powder on growth and productivity of Moongbean *(Phaseolus radiata)*

TABLE-1 : Effect of different Algal Powder on Growth and Productivity of Moongbean

Pot	No. of leaves after 21 days (cm)	Height of Plant at harvesting time(cm)	No. of pods Per plant	Total No. of grains	Average length of Pod (cm)	Total weight of seeds on Plant (g)
Soil	11±0.66	24±0.57	13±0.57	105±1	8.9±0.11	6.690±0.05
Soil+ compost	12±0.57	25±0.57	16±0.57	133±1.15	9.5±0.05	7.850±0.02
S+A1	12±0.57	28±1	16±1	139±1	7.6±0.17	7.210±0.01
S+A2	14±1.2	30±1	17±0.57	140±0.57	9.9±0.1	8.960±0.01
S+A3	13±0.57	29±0.57	15±0.57	115±0.57	9.2±0.15	7.640±0.01
S+A4	14±0.57	30±1	14±0.57	104±1.15	8.7±0.15	6.890±0.01
S+A5	12±1	28±0.57	13±1	102±0.57	8.7±0.1	6.840±0.01
S+C+A1	12±1	28±1	18±1	123±1	7.8±0.05	8.000±0.01
S+C+A2	16±0.57	29±0.57	19±1.15	151±1	10.3±0.11	9.780±0.03
S+C+A3	15±1	29±0.57	17±0.57	157±1	10.3±0.15	10.090±0.03
S+C+A4	17±1	30±1	20±1.15	178±1.15	10.5±0.20	12.480±0.01
S+C+A5	16±0.57	29±1.15	18±1	154±0.57	9.1±0.15	8.890±0.36
S+NPK+A1	15±1	26±0.57	18±1	131±1	7.5±0.20	8.620±0.01
S+NPK+A2	16±1	28±1	21±1.15	191±0.57	8.8±0.32	10.970±0.01
S+NPK+A3	18±1	30±1	19±1	158±1	10.2±0.03	10.120±0.01
S+NPK+A4	19±0.57	32±0.57	22±0.57	193±1	10.7±0.17	12.270±0.03
S+NPK+A5	17±1.05s	31±0.57	19±1	152±0.57	9.8±0.15	10.030±0.01

*S=Soil *C=Compost *NPK=19:19:19

*A1= *Cladophora crispata* * A2= *Spirogyra jugalis* * A3= *Chara fragilis*

*A4= *Synechococcus aeruginosus* * A5= *Spirulina plantensis.*

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Blue- green algae as well as other algal members are the good sources of biofertilizer. But it has less attention to use of algae as a biofertilizer. That's why we decided to study the effect of selected algae (two algal members of Blue green algae (*Synechococcus aeruginosus and Spirulina plantensis*) and other algal members namely *Cladophora crispata, Spirogyra jugalis* and *Chara fragilis*) on crop productivity.

Materials and Methods

Algae collection and preparation:

Fresh algae of *Cladophora crispata, Spirogyra jugalis, Chara fragilis, Synechococcus aeruginosus, Spirulina platensis* were collected from different locations: Taratgaon, Kandalgaon, Malwadi, Kalthan, Palasdev, Dalaj, and Takrarwadi of Ujani reservoir, Maharashtra, India. Then the algae were washed thoroughly with tap water to remove extraneous materials and brought to the laboratory in plastic bags containing water to prevent evaporation. Samples were then shade dried until constant weight obtained. . After drying, fine powder was prepared in grinder. The powdered samples subsequently stored in refrigerator until used.

Plant material

Seeds of Moongbean (*Phaseolus radiate* L.), were surface sterilized with ethanol 70% and washed by sterile distilled water, then dried in shadow open air. The seeds were planted in 30 cm diameter earthen pots containing mixture of 1:1 autoclaved peat and sand soil. Every pot contained 01 seed. They watered every week.

Growth measurements

Numbers of leaves after 21 days of plantation, plant height at the time of harvesting and total yields of selected crops were recorded.

The treatments

For the above said purpose the experiment was carried out in different five sets.

1. First set was considered as control was treated with only sterilized soil (10kg).
2. Second set was arranged with sterilized soil and compost (10kg sterilized soil + 100g compost).
3. Third set 10kg sterilized soil + 100g algal powder of five selected algae were mixed well and used for the same experiment.
4. Fourth experimental set 10kg sterilized soil and 100g compost (organic fertilizer) along with different selected algal powder 100g mixed well and used for the fourth experimental set.
5. Fifth experimental set 10kg sterilized soil + 100g NPK(19:19:19) Inorganic fertilizer + 100g algal powder of five selected algae.

According to our aim to observe the effect of different algal powder on growth and productivity the experiment was carried out in triplicate and in three different seasons.

To check the growth and productivity of Moongbean some parameters were considered such as number of leaves per plant after 21 days, height of the plant after maturity, number of pods per plant, total number of grains (seed) and total weight of seeds per plant (yield)

Results and Discussion

Compared to all experimental sets less number of grains *i.e.* 105 obtained in controlled condition. (Plants grow with soil only).Moongbean cultivated under controlled condition gave minimum yield 6.69g *i.e.* total weight of seeds per plant.Eleven leaves recorded after 21 days of growth and 24 cm height of the plant and 13 pods were recorded at the time of maturity in control condition.

In second experimental set Moongbean cultivated under soil + Compost condition, it gave better yield compared to control *i.e.* 7.85 g per plant.Twelve numbers of leaves recorded after 21 days of plantation. At the time of maturity height of plant was recorded 25 cm. and 16 numbers of pods were counted per plant and also recorded total number of grains 133.

Third set was designed with soil + different algal powder *i.e.* 1) Soil + *Cladophora crispata*, 2) Soil + *Spirogyra jugalis*, 3) Soil + *Chara fragilis*, 4) Soil + *Synechococcus aeruginosus*, 5) Soil + *Spirulina plantensis*.

Apart from these five combinations soil + *Spirogyra jugalis* gave good yield *i.e.* 8.96 g. per plant. This combination also showed maximum height 30 cm. and 17 pods per plant at the time of maturity. Fourteen leaves were recorded after 21 days of growth and 140 grains recorded after harvesting.

Among these five combinations soil + *Spirulina platensis* gave less yield *i. e.* 6.84 g per plant and other parameters also recorded which were minimum compared to all other algal combinations were studied.

In fourth experimental set algal powder combined with soil and compost. This combination gave best result compared to first three experimental sets. In this experiment plants cultivated with soil + Compost + *Synechococcus aeruginosus* showed maximum yield compared to other algaes *i.e.* 12.48 g per plant.

Plants cultivated under these combinations also showed maximum number of pods per plant and total number of grains *i.e.* 20 and 178 respectively. It also showed maximum height of the plant *i.e.* 30cm at the time of harvesting and also recorded maximum number of leaves *i.e.* 17 after 21 days of growth.

Effect of different algal powder on growth and productivity of Moongbean *(Phaseolus radiata)*

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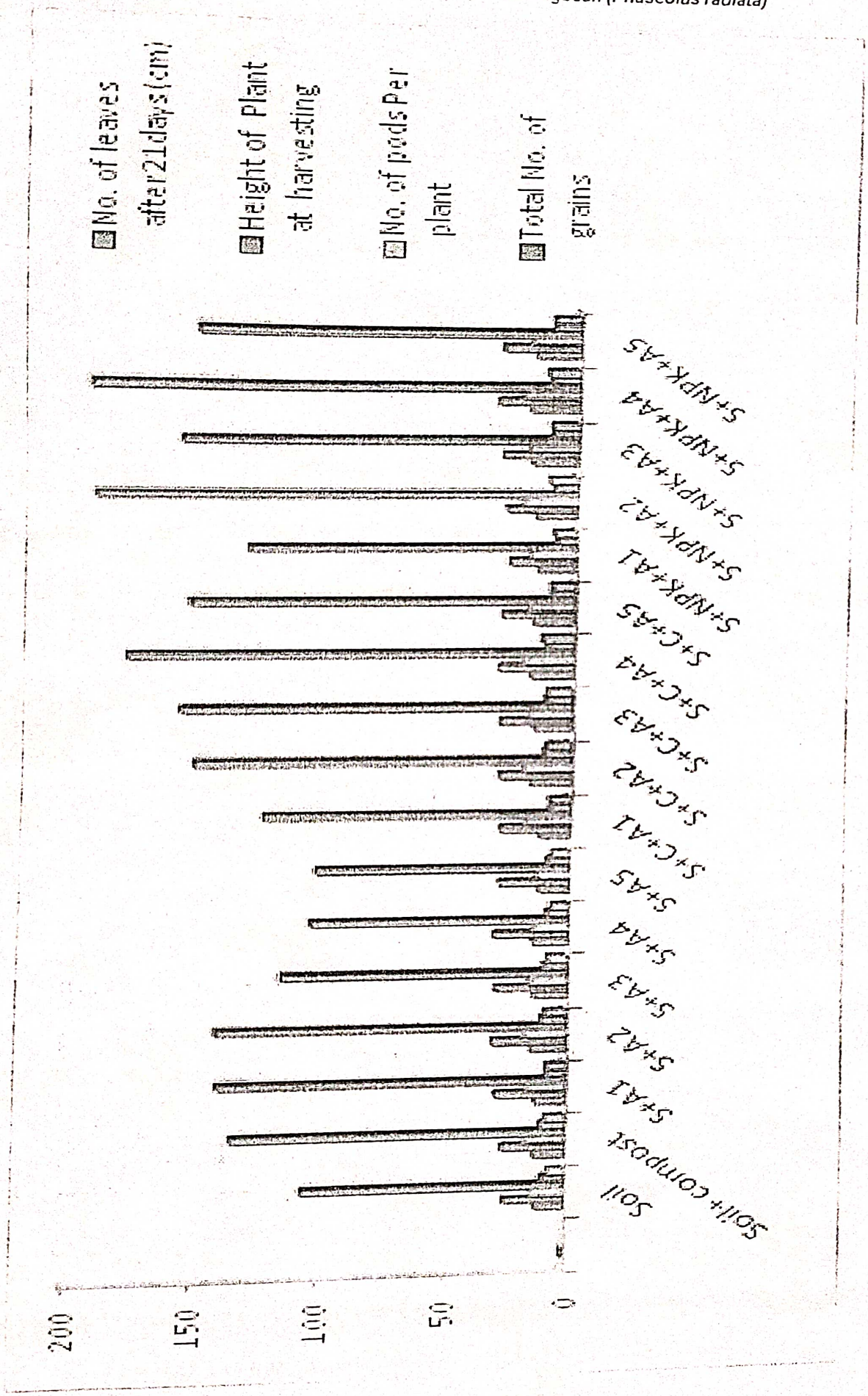

Fig. 1 :-Effect of different Algal Powder on Growth and Productivity of Moongbean

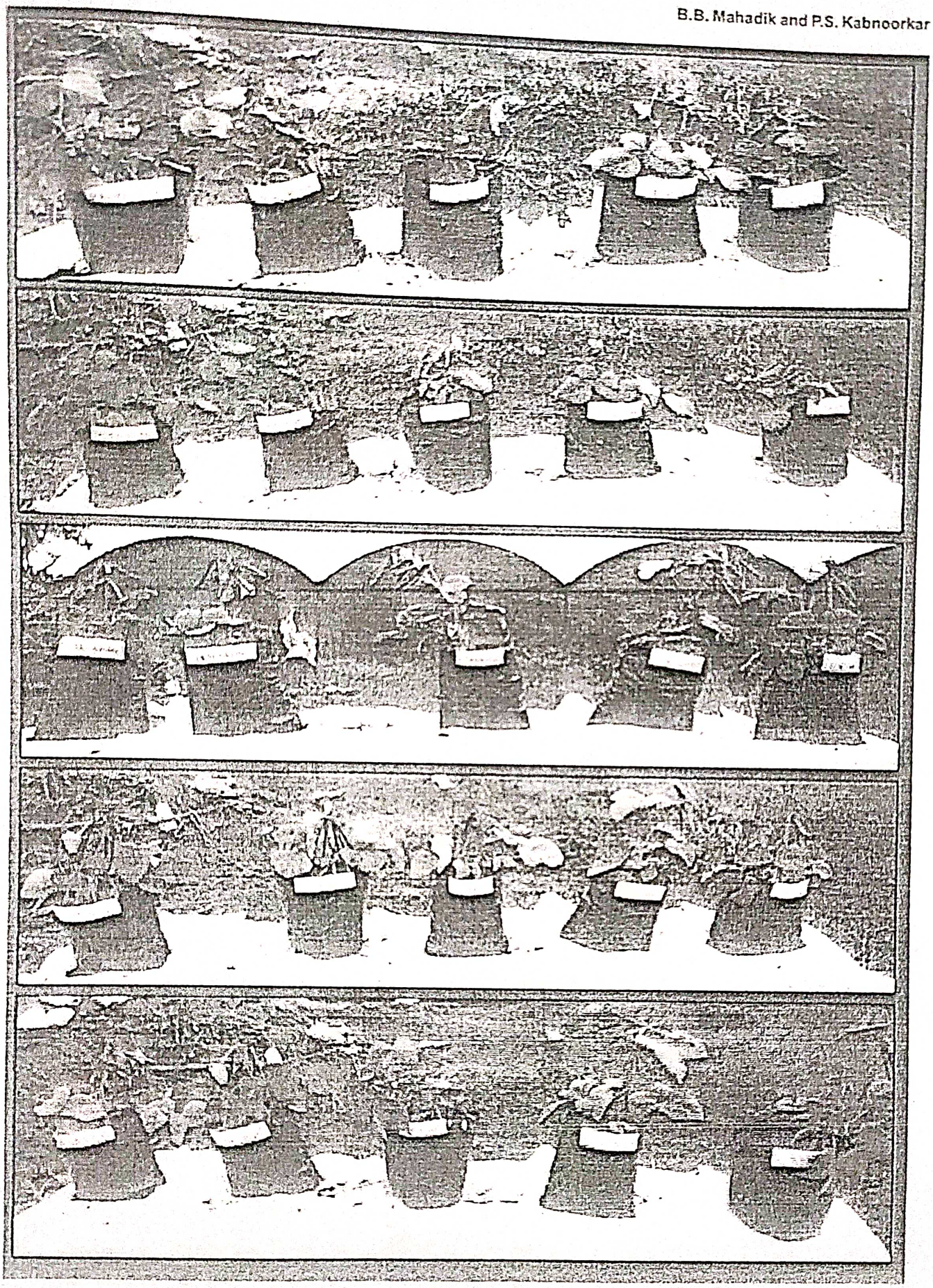

Fig. 2 : Effect of algal powder on growth of Moongbean plant

In all combinations Soil + Compost + *Cladophora crispata* gave less yield 8 g per plant. At the time of maturity height-28 cm, Number of Pods per plant-18, Total number of grains *i.e.*123 recorded which was minimum compared to all soil + Compost + different algal combinations.

In the last set it was observed that Soil + NPK (19:19:19) + *Synechococcus aeruginosus* gave higher yield 12.27 g and soil + NPK (19:19:19) + *Cladophora crispata* gives minimum yield 8.62 g.

At the time of maturity soil + NPK (19:19:19) + *Synechococcus aeruginosus* showed maximum height *i.e.* 32 cm and also recorded maximum number of pods *i.e.* 22 pods per plant compared to all experimental sets (Soil, Soil+ Compost, Soil + Algae and Soil + Compost + algae).

Plants cultivated under different combinations with different experimental sets after maturity average length of the pods also measured and it was found that the plants cultivated under Soil+ NPK+ *Synechococcus aeruginosus* showed maximum length 10.7 cm followed by soil+ Compost + *Synechococcus aeruginosus* 10.5cm and then soil+ *Spirogyra jugalis* 9.9 cm respectively.

Plants cultivated under controlled condition showed 8.9cm length of pod and similarly soil+ Compost combinations showed 9.5cm length of pod.

From the above experimental data (Table-1, Graph 1) it was observed that algae act as a biofertilizer and it gives additional supplement of nutrient to the soil that's why it trigger (boost) the growth and yield of selected plants .

Overall it was observed that algal powder combined with soil gave good results and the same selected algal powder when it combined with soil+ compost it gave best results, but when these powders combined with soil+ NPK it gave better results and all the parameters which were recorded also maximum. From the above data it was observed that apart from five algae *Synechococcus aeruginosus* alga gave higher yield in all three combinations (soil+ algae, soil+ compost+ algae, soil+ NPK+ algae) in Moongbean plants.Moongbean were treated with different selected algal powders,*Cladophora crispata* and *spirulina platensis* gives minimum yield

Conclusion

Blue green algae as well as other algal members are the good source of biofertilizer. For the experimental study, selected algae used as biofertilizer or used as supplement with organic fertilizers as well as inorganic fertilizers and it proves that algae are very good supplements to the inorganic fertilizers as well as organic fertilizers. It helps to increase the yield and productivity of Moongbean crop.

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EFFECT OF ALGAE ON GROWTH AND YIELD OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.)

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Ujani reservoir is one of the prominent wetland in India. Ujani reservoir is well-suited for the growth of different types of algae, that's why it is rich in algal diversity. Dominance of different algal species found in Ujani reservoir, out of that only five species (*Synechococcus aeruginosus* Naegeli*, Spirulina platensis* (Nordst.)Gomont*, Cladorophora crispata* (Roth). Kuetzing*, Spirogyra jugalis* (Fl.Dan.) Kuetzing and *Chara fragilis* Desvaux in Loiseleur-Deslongchamps) selected for the trial of experiment on tomato plants, on the basis of results these algal species (*Chara fragilis, Spirogyra jugalis* and *Synechococcus aeruginosus*) recommended to use as a supplementary fertilizers. Statistical analysis showed that there are significant differences in plant height, number of leaves, and yield as compared to control.

Key words – Algae, compost, tomato, growth and productivity

Ujani reservoir is rich in algal biodiversity. Various species of algae found in Ujani reservoir mainly *Euglena* spp., *Microcystis* spp., *Chroococococcus* spp., *Gloeocapsa* spp., *Oscillatoria* spp., *Lyngbya* spp., *Nostoc* spp., *Ulothrix* spp. *Hydrodictyon reticulatum* (L.) Lagerheim, *Merismopedia* spp., *Volvox tertius* A. Meyer, *Scenedesmus* spp., *Zygnema* spp., *Navicala* spp., *Microcystis* spp., *Oscillatoria* spp., *Plectonema* spp., *Chara fragilis*, *Spirogyra jugalis*, *Synechococcus aeruginosus*, *Spirulina platensis*, *Cladophora crispata*, *Chara excelsa*, *Microcystis* spp., etc.

Amongst these algae, *Cladophora crispata, Spirogyra jugalis, Chara fragilis, Synechococcus aeruginosus, Spirulina platensis* are found in large quantities in Ujani reservoir that's why these algae selected for experimental purpose.

For these experiments Tomato (Variety PKM-1) were selected. Tomato crops are the main crops cultivated in Indapur Taluka. In food Industry, Tomato has a great place.

Selected tomato variety is improved variety and it is continuously demanded in market from Indapur, Pune and Mumbai. Because of good transport facility tomato is transported from Indapur to Pune and Mumbai Market easily.

For the said experiment algae considered as a supplementary biofertilizer because it helps in N_2 fixation primarily and it is also good source of minerals.

Numerous studies have revealed a wide range of beneficial effects of algal extract applications on plants, such as early seed germination and establishment, improved crop performance and yield.

Thirumaran *et al*. (2009) reported that seaweed liquid fertilizer (SLF) contained macro nutrients, trace elements, organic substances like amino acids and plant growth regulators such as auxin, cytokinin and gibberellins. Verklejj (1992) stated that application of that seaweed liquid fertilizer (SLF) enhanced the water retention capacity of soil. Algal extracts are known to enhance seed germination, improve plant growth and induce resistance to frost, fungal and insect attack and increase nutrient uptake from soil (Mohan *et al*., 1994; Venkataraman *et al*., 1993). Thirumaran *et al*. (2009) stated that recent researches proved that seaweed fertilizers are preferred not only due to their nitrogen, phosphorus and potash content but also because of the presence of trace element sand metabolite similar to plant growth regulators.

El-Barody *et al*. (2007) found that addition of different successive extracts of *Asparogopsis taxiformis* thallus powder to the soil, as a biofertilizer, gave significant increase in the growth of *Vicia faba*. Lozano *et al.*

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(1999) stated that the application of an extract from algae to soil or foliage increased ash, protein and carbohydrate content of potatoes. Sabh *et al.* (2008) found that NPK in plants treated with *Sargassum* sp., reached four folds the negative control.

Gupta and Shukla (1967) studied the algal influence on growth, yield and protein content of rice plants and showed that pre-soaking rice seeds with BGA cultures or extracts enhances germination, promotes the growth of roots and shoots, and increases the weight and protein content of the grain. Svircev *et al*. (1997) also reported that plant growth was enhanced in the presence of cyanobacterium, even without organic N fertilizer application. Beneficial effects of cyanobacterial inoculation were reported, not only for rice, but for other crops such as wheat, soybean, oat, tomato, radish, cotton, sugarcane, maize, chili, bean, muskmelon and lettuce (Venkataraman 1972, Rodgers *et al*. 1979, Singh 1988, Arif *et al*. 1995, Thajuddin & Subramanian 2005, Saadatnia & Riahi 2009, Maqubela *et al*. 2008, Karthikeyan *et al*. 2007). 15 million metric tons of algal products are produced annually, a considerable portion of which is used for nutrient supplements and as bio-stimulants or biofertilizers to increase plant growth and yield (Z. Sharitamadari *et al.,* 2011). Several reasons have been proposed for beneficial effects of cyanobacteria on the growth of different plants.

It was observed that the continuous use of inorganic fertilizers, soil become nonproductive, so currently people initiated to practice like organic fertilizers & bio-fertilizers. But it has a less attention to use of algae as a biofertilizer. So, it was plan to study the effect of *Synechococcus aeruginosus, Spirulina plantensis, Cladophora crispata, Spirogyra jugalis* and *Chara fragilis*) on Tomato plants yield.

MATERIALS AND METHODS

Algae collection and preparation - Fresh algae of *Cladophora crispata, Spirogyra jugalis, Chara fragilis, Synechococcus aeruginosus, Spirulina platensis* were collected from different locations such as Taratgaon, Kandalgaon, Malwadi, Kalthan, Palasdev, Dalaj, and Takrarwadi of Ujani reservoir, Maharashtra, India. Then the algae were washed thoroughly with tap water to remove extraneous materials and brought to the laboratory in plastic bag containing water to prevent evaporation. Samples were then shade dried until constant weight obtained. . After drying, fine powder was prepared in grinder. The powdered samples subsequently stored in refrigerator until used.

Plant material - Seeds of Tomato (*Lycopersicon esculentum* L.) Improved variety – PKM – 1, were surface sterilized with ethanol 70% and washed by sterile distilled water, then dried in shadow open air. The seeds were planted in 30 cm diameter earthen pots containing mixture of 1:1 autoclaved peat and sand soil. Each polythene bags contained 1 seeds.

Growth measurements - Number of leaves per plant after 21 days and height of plant after maturity, total number of fruits at the time of harvesting per plant and the total weight of harvested fruits per plant (yield) of Tomato were recorded.

The treatments - For the above said purpose the experiment was carried out in different five sets. First set was considered as control was treated with only sterilized soil (10kg).

Second set was arranged with sterilized soil and compost (10kg sterilized soil + 100gm compost).

For third set 10kg sterilized soil + 100gm algal powder of five selected algae were mixed well and used for the same experiment.

For the fourth experimental set 10kg sterilized soil and 100gm compost (organic fertilizer) along with different selected algal powder 100gm mixed well and used for the fourth experimental set.

For the fifth experimental set 10kg sterilized

soil+ 100gm NPK (19:19:19) Inorganic fertilizer + 100gm algal powder of five selected algae. This combination used for the fifth experiment.

According to our aim to observe the effect of different algal powder on growth and productivity the experiment was carried out in triplicates and in three different seasons.

RESULTS AND DISCUSSION

First set treated as control under these set tomato plants cultivated with soil only. The control set gives less yield i.e.181.12 gm. fruit/plant.

Second set treated with soil+ compost conditions and the yield was recorded 209.28 gm. fruits/plant

For the third set soil was combined with different algal powder. The plants cultivated with soil + *Synechococcus aeruginosus* combinations gives good results compared to the rest combinations. The parameters were recorded in tomato plants with soil+ *Synechococcus aeruginosus* combinations gives maximum number of leaves(8 leaves) and fruits(16 fruits)/plant and 312.93gm total weight of fruits followed by soil + *Spirulina platensis*(289.73gm), soil + *Spirogyra jugalis*(245.70 gm), soil + *Chara fragilis*(220.80 gm), Soil + *Cladophora crispata* (211.2gm) respectively.

For the fourth set tomato plants cultivated with soil + compost + selected algal powders and it was observed that soil+ compost + *Cladophora crispata* gives maximum yield 348.52 gm. Other parameters also measured were

Table 1: Effect of different Algal Powder on Growth and Productivity of Tomato

Pot	No. of leaves after21days (cm)	Height of Plant at Harvesting time(cm)	Total No. of Harvested Fruits	Total weight of Harvested fruits (gm)
Soil	6±1.154	45±0.577	10±0.577	181.12±0.577
Soil+ compost	7±1.154	49±0.577	12±0.577	209.28±0.577
Soil+*A1*	7±0.577	42±0.577	12±0.577	211.200±0.577
S+A2	7±0.577	46±1.452	17±0.577	245.70±0.577
S+A3	7±1.154	44±0.577	15±1.527	220.80±0.577
S+A4	8±0.577	63±0.577	18±1.54	312.93±0.577
S+A5	7±0.577	61±0.577	15±0.577	289.73±0.577
S+C+A1	7±1.154	54±0.577	15±0.577	280.44±0.577
S+C+A2	9±0.577	65±0.577	17±0.577	348.52±0.577
S+C+A3	8±0.577	56±0.577	15±0.577	313.41±0.577
S+C+A4	9±0.577	63±0.577	16±0.577	300.65±0.577
S+C+A5	6±1.154	50±0.577	13±0.577	270.43±0.577
S+NPK+A1	7±0.577	60±0.577	18±0.577	309.30±0.577
S+NPK+A2	8±0.577	65±0.577	19±0.577	322.78±0.577
S+NPK+A3	11±0.577	69±0.577	21±0.577	373.70±0.577
S+NPK+A4	8±0.577	67±0.577	20±0.577	333.48±0.577
S+NPK+A5	9±0.577	64±0.577	19±0.577	328.41±0.577

*S=Soil *C=Compost * NPK=19:19:19
*A1= *Cladophora crispata* * A2= *Spirogyra jugalis* * A3= *Chara fragilis*

*A4= *Synechococcus aeruginosus* * A5= *Spirulina plantensis*

Plate 1: Tomato plants were cultivated with different experimental sets.

maximum.i.e.9 leaves /plant, 65cm height of the plant and 17 fruits /plant after harvesting. Soil + compost+ *Spirulina platensis* gives less yield compare to other combinations.

Tomato cultivated with soil + NPK + selected algae gives higher yield compared to control as well as other three combinations (soil + compost, soil + algae, soil + compost + algae) plants cultivated with soil+ NPK + *Chara fragilis* gives higher i.e.373.70gm fruits compared to rest of combinations.

Under the same combinations maximum height also recorded 69 cm and 21 no. of fruits at the time of harvesting. Maximum no. of leaves also counted in this combination i.e.11 after 21 days of growth and in the control set minimum leaves was counted 6 after 21 days of growth. Total no. of fruits harvested after maturity in control set was 10/plant. After that there was rise in no. of fruits under soil+ compost condition (12fruits/plant).The use of algae with soil, soil+ compost and soil+ NPK gives continuously yield in increasing order. Such as soil+ *Synechococcus aeruginosus*, 16fruits/plant recorded. Soil + compost + *Spirogyra jugalis* gives 17 fruits /plant and soil + NPK + *Chara fragilis* combination gives maximum fruits 21/plant.

Similarly the height of plant also observed in increasing order 63cm, 65cm, and 69cm respectively.

From the above experimental data (Table no.1, Photoplate no.1, Graph no.1) it was observed that algae gives additional supplement of nutrient to the soil that's why it trigger (boost) the growth and yield of selected plants. In all selected five algae *Synechococcus aeruginosus* gives better yield followed by *Spirogyra jugalis* and *Chara fragilis*, *Cladophora crispata* and *Spirulina platensis* gives minimum yield

CONCLUSION

From the study revealed that algal powder can enhance plant growth. Statistical analysis confirms that there is a significant difference in plant height, number of leaf, Percentage germination treated plants as compared to control.

Results of this study showed that *Synechococcus aeruginosus* have ability to promote growth higher than *Spirogyra jugalis, Chara fragilis*, *Cladophora crispata* and *Spirulina platensis*.

On the basis of experimental data, it proves that algae are very good supplements to the inorganic fertilizers as well as organic fertilizers. It helps to increase the yield and productivity of Tomato plants

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