

THE EFFECT OF ALGAE ON PLANT GROWTH AND PRODUCTIVITY

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Abstract

India is an agricultural country and its most of the economy is based on agriculture. To obtain maximum yield from agricultural field, farmers are irrationally using chemical fertilizers and pesticides since many years. It is causing direct impact on environment. Organic farming is an eco – friendly practice which is best alternative for chemical fertilizers and pesticides. Due to high content of different bioactive compounds, human being is using algae, since historical period as food, fodder and fertilizer. The bioactive compounds present in algae includes proteins, fats, lipids, carbohydrates, vitamins, free amino acids, organic acids, enzymes, minerals, growth regulators, pigments, toxins and antibiotics. It is observed that several algae have stimulatory effect on seed germination and plant growth. It is also found that some algae have antimicrobial potential against different phytopathogens. Now a days, it has become possible to use algae for management of pests and diseases and for obtaining maximum yield. It is an environment friendly and a safe practice. Algae are admirable sources of antibiotics.

Keywords: *Plant growth, Productivity, Potential, Antifungal*



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Objectives: (i) To study effect of algae on plant growth and productivity.
(i) To understand the antimicrobial potential of algae.

Material, Methods, Discussion and Results:

Algal forms which were found abundant were selected to study their effects on seed germination, on growth and productivity of plants and for antimicrobial potential.

These algae are:

- 1) *Cladophora crispata* (Roth) Kuetzing
- 2) *Spirogyra jugalis* (Fl. Dan.) Kuetzing
- 3) *Chara fragilis* Desvaux
- 4) *Synechococcus aeruginosus* Nag.
- 5) *Spirulina platensis* (Nordst.) Gomont

In order to study the effect of algal extracts on seed germination and effect of algae as a biofertilizer on plants, three plants were selected. These plants are:

- 1) Moongbean or green gram (*Phaseolus radiata* L./*Vigna Radiata*)
- 2) Tomato (*Lycopersicon esculentum* Mill.)

These three plants are extensively cultivated by farmers of Uttar Pradesh. Singh D P (2010) showed relation between planktonic blue green algae and environmental factors from 4 eutrophic Swedish lakes. Mahajan and Mahajan (1988) studied algal communities in Vellhala lake of North Maharashtra and used algae as indicators of organic pollution. Senger (2010) studied algae with reference to water purification. Rajpoot O P (2012) recorded Chlorococcales systematically from Haryana. Chaugule and Patil (1992) extensively studied and recorded Charophytes from Punjab. Pandey (2012) observed species diversity of plankton in Uttar Pradesh. Nandan (2012) studied algal blooms in Vishwamitri river of Gujrat and reported dominance of *Microcystis aeruginosa*, *Microcystis elongate* and *Anabaena reciborskii*.

Kaushik and Chauhan (2008) studied antibacterial potential of aqueous and organic extracts of *Nostoc commune*. Kamble (2008) studied antibacterial activities of cold water and hot water extracts of fresh water algae *Schizomeris leibleinii*, *Cladophora callicoma*, *Hydrodictyon reticulatum*, *Spirogyra plena*, *Chara grovesii*, *Nitella batrachosperma*, *Spirulina platensis*, *Phormidium corium* and *Scytonema coactile* against bacteria *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus albus*, *Salmonella typhi* and *Bacillus megaterium*. Hanan and Hala (2010) tested extracts of *Anabaena flos aquee*, *Anabaena variabilis* and *Oscillatoria angustissima* in different solvents against *Bacillus subtilis*, *Bacillus cereus*, *Staphylococcus aureus*, *Streptococcus faecalis*, *Pseudomonas aeruginosa*, *Aeromonas hydrophila* and *Vibrio fluvialis*.

Jadon Renu (2010) studied antibacterial activities of *Chlorella ellipsoidea*. Justella et. al. (2011) evaluated antibacterial potential of fresh water algae *Oscillatoria sancta*, *Lyngbya birgei*, *Oedogonium echinospermum*, *Spirogyra decimina*, *Spirogyra grantina*, *Spirogyra crassa*, *Spirogyra biformis* and *Spirogyra codensata* against human bacterial pathogen viz. *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, *Proteus vulgaris*, *Proteus mirabilis* and *Streptococcus pyogenes*. Uma et. al. (2011) worked on antibacterial activity of the acetone, methanol, ethanol and DMSO extracts of dried green microalgae *Desmococcus olivaceus*, *Chlorococcum humicola* and *Chlorella vulgaris* against *Klebsiella pneumonia*,

Pseudomonas vibriocholarae, *Streptococcus pyrogenes*, *Escherichia coli* and *Staphylococcus aureus*.

The algal material which is found in abundance and in pure form was collected. Algal material such as *Cladophora crispata*, *Spirogyra jugalis*, *Chara fragilis*, *Synechococcus aeruginosus* were collected separately from selected sites of Ujani reservoir. Collected algal material was washed carefully and thoroughly with fresh water to remove unwanted impurities, epiphytes, adhering sand particles and mud. Algal material placed on filter paper sheet in shade for air drying at room temperature for 4 days. Shade drying of algal material is followed by oven drying at 40°C for 8 hours. After drying fine powder was prepared in grinder and stored in acid washed air tight bottles. Algal extracts in different solvents such as cold water, hot water, acetone, methanol, ethanol, chloroform, petroleum ether and toluene were prepared (Kamble 2008). For the preparation of cold water extract 1gm of fine algal powder was taken in 100ml conical flask. 20 ml cool sterile distilled water added to it, flask plugged with cotton and kept it overnight. Next day it has been filtered through whatman filter paper No.1 and coloured filtrate obtained and used for soaking of seeds. Hot water extract was obtained by taking 1gm of fine algal powder in 100ml conical flask. 50 ml sterile distilled water added to it and boiled for 10 to 15 minutes, cooled it and filtered. Filtrate obtained used for soaking of seeds. Extract in Acetone was prepared by taking 1gm of fine algal powder in 100 ml conical flask. 20 ml of Acetone added to it and flask was plugged with cotton and kept overnight undisturbed in cool and dry place. The volume was restored and content were centrifuged to collect maximum supernatant.

Treatment of seeds with algal extracts:

The healthy seeds of Moongbean (*Phaseolus radiatus* L.) – Improved variety Kopargaon, Tomato (*Lycopersicon esculentum* Mill.) – Improved variety – PKM – 1 and Sunflower (*Helianthus annuus* L.) – Improved variety Mordan were obtained from National seed corporation, Delhi., National seed. Corporation, Akola (M.S.) and Nimkar seeds Phaltan (M.S.) respectively for seed germination study.

Effect of algal powder on growth and productivity of plants:

The experiment was carried out by pot culture method. The pots having height of 45cm and diameter of 30 cm. were selected to carry out the experiments. In first pot only 10 kg sterilized soil was taken and considered as control. For second pot 10kg of soil and 100gm of compost was taken. In third pot 10kg of soil and 100gm of selected algal powder was taken. For fourth pot 10kg of soil, 100gm compost and 100gm algal powder. The fifth pot

consist of 10kg soil, 100gm inorganic fertilizer NPK (19:19:19) and 100gm algal powder. A sufficient water was poured in pot before sowing. In each pot only one seed was sown. In this way pots were prepared for selected algal powder and selected plants. A water is supplied to the growing plants at regular interval as per requirement. The experiment was carried out in triplicates.

Effect of algal extracts on seed germination:

Algal extracts have definite effect on seed germination. In present study promising results were obtained. Moongbean seeds treated with different extracts of algae exhibits maximum percentage of germination and significant growth of shoot and root as compared to control. Cold and hot water extracts of *Chara fragilis* and acetone extract of *Synechococcus aeruginosus* shows 100% seed germination. This is an agreement with the earlier studies. (Venkataraman 2003, Kamble 2008 and D P Singh 2013). Enhancement in seed germination of Mothbean in hot water extract of *Hydrodictyon reticulatum* has been reported by Kamble (2008). Singh (2009) reported stimulatory effect of aqueous extract of *Nostoc muscorum* on lentil seeds. Cold water extract of *Spirogyra jugalis* has stimulatory effect. Toluene and methanol extract also has stimulatory effect in moongbean seed germination.

Cold water extract of *Spirulina platensis* shows less percentage of germination. Senger S (2010) studied delayed in seed germination of *Vigna radiata* due to the aqueous extract of *Microcystis aeruginosa*. Petroleum ether extract of *Cladophora crispata* inhibit seed germination of moongbean. Kamble (2008) reported that methanol extract of *Cladophora callicoma* inhibits seed germination of Sorghum.

In present study results of tomato seed germination indicates that hot water extract of *Synechococcus aeruginosus*, acetone extract of *Spirogyra jugalis* and toluene extract of *Chara fragilis* are the best extracts which shows 100% of seed germination with good development of shoot and root.

Role of algae in plant growth and productivity:

Algal powder as a bio-fertilizer found beneficial in growth and productivity of plants. In presents study effect of selected algal powders on growth and productivity of moongbean, tomato and sunflower have been studied. Increase in growth and productivity of plants have been observed and recorded.

Algal powder treatment in different combinations to moongbean plant reveals that powder of *Synechococcus aeruginosus* shows best performance in growth and development of moongbean plant. Treatment of algal powders of *Cladophora crispata*, *Spirogyra jugalis*,

Chara fragilis and *Spirulina platensis* also shows good performance. Better growth and highest yield of moongbean were recorded in combination of soil, inorganic fertilizer and algal powder of *Synechococcus aeruginosus*. Cold water and hot water extracts shows remarkable antifungal activity, cold water extract of *Cladophora crispata* shows antifungal activity against *Metarhizium anisopliae* and *Aspergillus niger*.

Cold water and hot water extract of *Chara fragilis* strongly inhibits growth of *Metarhizium anisopliae*, *Penicillium oxalicum* and *Curvularia lunata*, *Trichoderma viride* respectively. Cold water extract of *Synechococcus aeruginosus* inhibits growth of *Curvularia lunata* whereas hot water extract shows antifungal activity against *Penicillium oxalicum*. Hot water extract of *Spirulina platensis* shows strong antifungal activity against *Metarhizium anisopliae*. Kamble (2008) found that hot water extract of *Cladophora callicoma*, *Hydrodictyon reticulatum*, *Schizomeris leibleinii*, *Spirogyra plena*, *Plectonema gracillimum* and *Spirulina platensis* inhibited growth of *Fusarium roseum*, *Alternaria alternata* and *Trichoderma harzianum*. Patil and Pingle (2010) found that aqueous extract of *Cladophora crispata* and *Chara zeylanica* inhibits growth of *Macrophomina phaseolina*. Nehul (2014) observed that aqueous extract of *Westiellopsis proliflica* shows antifungal activity against *Aspergillus flavus*, *Fusarium moniliforme*, *Helminthosporium sp.* and *Candida albicans*.

Effect of selected algal powders on growth and productivity of Moongbean:

Experiments were conducted to study effect of selected algal powders on plant growth and productivity of moongbean and the results are shown in Table 15. Moongbean cultivated in control pot shows 11 leaves after 21days. Height of the plant at the time of harvesting was recorded 24cm. Total number of pods/plant was 13 with 105 grains. Total weight of grains was 6.69 gm. In second pot which is having soil and compost shows 12 leaves, height of the plant is 24cm, total number of pods/plant with 133 grains. Total weight of seed was recorded 7.85 gm. In soil and algal powder combination, mixture of soil and algal powder of *Spirogyra jugalis* given maximum result with 14 leaves after 21days, height of the plant 30 cm, number of pods/plant 17 with 140 grains. Total weight of grains was recorded 8.96 gm. A combination of soil and algal powder of *Spirulina platensis* gives less yield i.e. 6.84 gm/plant, 12 leaves were recorded after 21 days, and height of the plant was 28 cm at the time of harvesting, number of pods were 13 with 102 grains.

Effect of Algal Extracts on Seed germination of Tomato :

Experiments were conducted to study effect of different algal extracts on seed germination of tomato and the results are shown in Table 13. Tomato seeds treated with different extractives of *Cladophora crispata* favours maximum shoots and root development. *Cladophora crispata* extracted with acetone and methanol shows higher percentage of seed germination i. e. 80% with 7.6cm and 8.3 cm, 7.8cm and 8.6 cm shoot and root length respectively. Cold and hot water extracts shows 60% germination which is similar to control but shows maximum growth of shoot and root. Chloroform and toluene extracts of *Cladophora crispata* shows 70% germination but maximum shoot and root length recorded in chloroform extract i.e. 6.8 cm and 8.3 cm. Petroleum ether extract totally inhibited seed germination. In control 60% seed germination with 5.5 cm shoot length and 4.8cm root length recorded.

Spirogyra jugalis extracted in acetone shows 100% seed germination with 5.4cm shoot length and 6.4cm root length, whereas methanol extract shows 90% germination with 5.7cm shoot length and 8.2cm root length. Cold water, hot water and toluene extracts also favours seed germination by showing 80% of seed germination and significant increase in shoot and root length. Extract of *Spirogyra jugalis* in chloroform shows 70% germination. *Spirulina platensis* extracted in different solvents shows 60% to 90% range of seed germination. *Spirulina platensis* extracted in acetone shows maximum percentage of seed germination (90%) with maximum shoot and root length i. e. 7.5cm and 6.4cm respectively. The ethanol and toluene extracts shows 80% of seed germination with good development of shoot and root. Hot water and petroleum ether extracts shows 70% of seed germination with less development of shoot and root. The methanol and cold water extracts shows 60% of seed germination which was similar to control but very poor development of shoot and root was recorded as compared to control.



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