



EFFECT OF CULTURE FILTRATE OF ALGAE ON SOYBEAN (GLYCINE MAX. L.) PLANTS

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Abstract

The present study investigates the effect of algal culture filtrates on plant growth and development. Algal filtrates are known to contain various bioactive compounds, including phytohormones, vitamins, and other growth-promoting substances, which may enhance plant growth. In this study, different treatments (T1, T2, and T3) were applied, and their effects on root length, shoot length, total seedling length, and dry weight were evaluated at 15, 30, and 45 days after sowing (DAS). The results revealed a significant improvement in all growth parameters in treated plants compared to the control. The increase in growth parameters may be attributed to the presence of growth-regulating substances such as auxins in the algal filtrates. The study highlights the potential of algal culture filtrates as eco-friendly biostimulants for enhancing plant growth.

Introduction

The intensive agricultural practices prevalent in the modern times are heavily dependent on the application of chemical inputs; including fertilizers, which affect soil health. The increasing demand for sustainable and eco-friendly agricultural practices has driven significant interest in biological alternatives to chemical fertilizers and growth regulators. Soil microorganisms are very important in the biogeochemical cycles of both inorganic and organic nutrients in the soil and in the maintenance of soil health and quality (Kennedy, 2004; Khalid *et al.*, 2004). Among these, algae have emerged as a promising resource due to their rich composition of bioactive compounds, including phytohormones, vitamins, amino acids, polysaccharides, and micronutrients (Khan *et al.*, 2009; Ronga *et al.*, 2019). Cyanobacteria have drawn much attention as prospective and rich sources of biologically active constituents and have been identified as one of the most promising groups of organisms capable of producing bioactive compounds (Fish & Codd 1994, Schlegel *et al.* 1999). Production of bioactive molecules such as auxins, production of secondary metabolites linked to biocontrol of bacterial and fungal diseases as well as improving soil structure and porosity through secretion of polysaccharides aiding in soil aggregation are the most important functions of these microorganisms (Karthikeyan *et al.* 2007, Sergeeva *et al.* 2002). Algal derivatives,

particularly algal culture filtrates, have gained attention for their potential role in enhancing plant growth, improving stress tolerance, and increasing crop productivity. Algal culture filtrate refers to the liquid medium obtained after the removal of algal biomass, which contains a variety of extracellular metabolites released during algal growth. These metabolites include growth-promoting substances such as auxins, cytokinins, and gibberellins, along with secondary metabolites that may influence plant physiological and biochemical processes (Stirk *et al.*, 2013). The application of such filtrates has been reported to stimulate seed germination, root and shoot development, chlorophyll synthesis, and nutrient uptake in plants (Renuka *et al.*, 2018). These effects are often attributed to the synergistic action of multiple bioactive compounds present in the filtrate (Bulgari *et al.*, 2015). Furthermore, algal-based treatments are considered environmentally safe, biodegradable, and cost-effective, making them suitable for integration into sustainable agricultural systems (Sharma *et al.*, 2014).

The present study aims to investigate the effect of algal culture filtrate on plant growth parameters, with a focus on understanding its potential as a natural plant growth promoter. This research will contribute to the development of eco-friendly agricultural practices and provide insights into the utilization of algal resources in crop improvement.

Material and methods

Soybean (*Glycine max.* L.) is one of the important oilseed as well as leguminous crop. It belongs to family "Leguminosae" and subfamily "Papilionoidae". It is annual leguminous herbaceous plant. Hence, an attempt has been made in the present investigation to assess the influence of culture filtrate of algal mixture on morphological parameters of soybean.

Preparation of algal extract

Mixture of few heterocystous cyanobacteria were grown in 500 mL flasks containing nitrate free BG-11 medium for 20 days at artificial illumination (2000–2500 Lux) at $25^{\circ} \pm 2$ C, with occasional stirring and aeration. The cultures were harvested and the cells washed with distilled water. Cell extracts were made by grinding the algae in distilled water with a mortar and pestle. An algal suspension containing 2.0 g fresh algal material in 200 mL of distilled water is referred to as stock extract. Various concentrations were prepared using this extract.

Experiment was conducted in Pots at Botanical Garden of Institute of Science, Nagpur. The experiments were laid with three replications consisting of three treatments with different concentrations of culture filtrate and one set as control treated with distilled water. Spraying of culture filtrate was done two times with interval of fifteen days on 5th day and 20th day.

Observations were made on 15th, 30th, and 45th day of sowing. Different parameters observed were root length, shoot length, total length of seedling and dry weight of seedling.

Result and discussion

The data on root length at 15, 30, and 45 days after sowing (DAS) revealed a noticeable variation among the treatments. At 15 DAS, all treated plants (T1, T2, and T3) exhibited higher root length compared to the control (8.26 cm), indicating an early stimulatory effect of the treatments.

At 30 DAS, a similar trend was observed, with T2 again showing the highest root length (22.63 cm), followed by T1 (21.90 cm) and T3 (21.68 cm). The shoot length data at 15, 30, and 45 days after sowing (DAS) showed significant variation among treatments. At 15 DAS, all treatments (T1, T2, and T3) exhibited higher shoot length compared to the control (7.21 cm), indicating a positive effect on early shoot growth (Table 1.). Among them, T3 recorded the highest shoot length (11.08 cm), followed by T2 (9.97 cm) and T1 (9.41 cm). At 30 DAS, the increasing trend continued, with T3 (20.45 cm) and T2 (20.22 cm) showing the highest shoot length, followed by T1 (19.35 cm), all significantly higher than the control (13.43 cm) (Fig.1). Total seedling length increased with growth in all treatments. At 15 DAS, T3 showed the highest growth, while at 30 and 45 DAS, T2 performed best. All treatments consistently showed higher seedling length than the control, indicating a positive effect on overall plant growth (Fig.2). Dry weight increased with time in all treatments. At 15 and 30 DAS, T2 showed the highest values, while at 45 DAS, T3 recorded the maximum dry weight. All treatments performed better than the control, indicating a positive effect on biomass accumulation.

Benefits of algal inoculation have often been attributed as an action of biologically potent substances, such as IAA produced by these organisms (Misra and Kaushik, 1989; Sergeeva *et al.*, 2002, Prasanna, *et.al.* 2012). In this study, comparison analysis in pot experiments showed that there is a significant difference between the treated plants and controls in vegetative growth factors. A positive effect of heterocystous Cyanobacteria *Nostoc* on plant growth and nutrient uptake was reported by Obana *et al.* (2007). They believed that the microelements necessary for plant growth can be supplied by these microorganisms. Spraying extracts of *Westiellopsis prolifera* Janet on pumpkin (*Cucurbita pepo* L.) and cucumber (*Cucumis sativus* L.) seedlings results in a significant increase in growth and development of both crops (Nanda *et al.* 1991). Shanab *et al.* (2003) in their study on cyanobacterial extract effect on potato (*Solanum tuberosum* L.) tissue culture confirms that the increase in crop

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yields can not only be attributed to the nitrogen-fixation potency of cyanobacteria, but may be largely due to the growth regulating substances endogenously produced by these algae. This assumption is greatly supported by the fact that non-N fixing species such as *Oscillatoria* sp. and *Phormidium* sp. stimulated the growth of plants such as rice (Gupta and Shukla 1967; Gupta and Gupta 1970). The production of growth-promoting substances and vitamins (Vitamin B12, folic acid, nicotinic acid and pantothenic acid) by the algae may be another reason for the greater plant growth and yield in treated plants (Venkataraman and Neelakantan, 1967). The present study demonstrates that the application of algal culture filtrates significantly influenced plant growth parameters, including root length, shoot length, total seedling length, and dry weight, particularly during the early and intermediate stages of growth. The observed enhancement in growth parameters under treatments (T1, T2, and T3) compared to the control suggests the presence of bioactive compounds in the algal filtrate that promote plant growth.

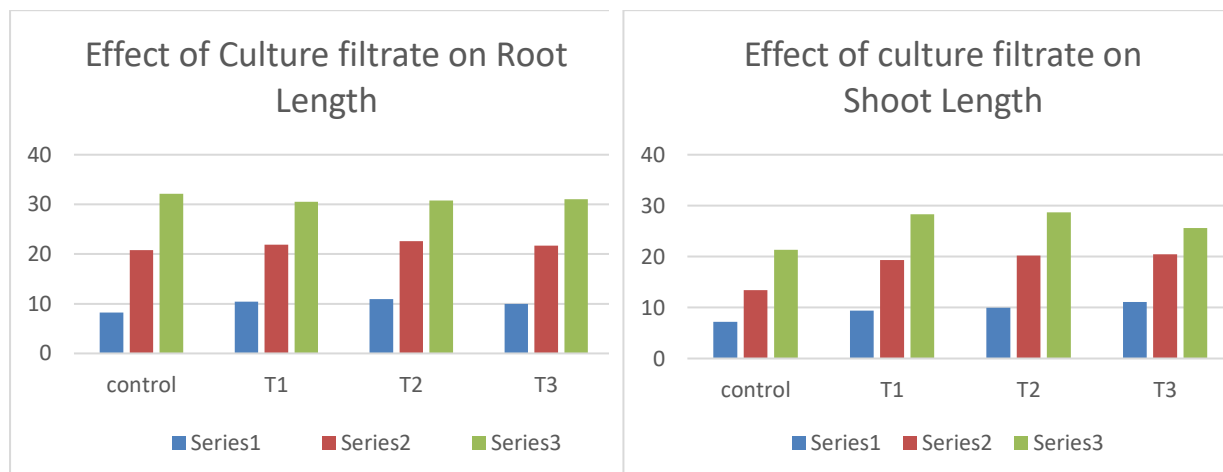
The increased root and shoot lengths at 15 and 30 DAS indicate that algal filtrates play a crucial role in early seedling establishment. This may be attributed to the presence of phytohormones such as auxins, cytokinins, and gibberellins, which are known to stimulate cell division, elongation, and differentiation (Khan *et al.*, 2009; Stirk *et al.*, 2013). Among the treatments, T2 consistently showed superior performance during the early stages, suggesting an optimal concentration or composition of growth-promoting substances. Similar findings have been reported by Renuka *et al.* (2018), who highlighted the role of microalgal metabolites in enhancing plant growth and development. The significant increase in total seedling length further supports the synergistic effect of improved root and shoot growth. Enhanced root systems may have facilitated better nutrient and water uptake, thereby contributing to increased shoot growth and overall plant vigor. These results are in agreement with Bulgari *et al.* (2015), who reported that biostimulants derived from algae improve plant growth by enhancing nutrient uptake efficiency and metabolic activity. Gupta & 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. 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, Thajuddin & Subramanian 2005, Saadatnia & Riahi 2009, Maqubela *et al.* 2008, Karthikeyan *et al.* 2007).
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Several reasons have been proposed for beneficial effects of cyanobacteria on the growth of different plants. The capacity for biosynthesis of growth promoting substances such as auxins, amino acids, sugars and vitamins (Vitamin B12, Folic acid, Nicotinic acid and Pantothenic acid) was reported by Misra & Kaushik (1989 a, b) that can enhance growth of plant.

Dry weight accumulation, an important indicator of biomass production, was also significantly higher in treated plants compared to the control. The higher dry weight observed in T2 at early stages and T3 at later stages suggests that algal filtrates not only promote initial growth but also contribute to sustained biomass accumulation. This may be due to improved photosynthetic efficiency and enhanced synthesis of structural and storage compounds (Sharma et al., 2014).

Table1. Effect of culture filtrate of algae on vegetative parameters of Soyabean plant after 15, 30, and 45 days of sowing.

Days after sowing	Root Length			Shoot Length			Total length of seedling			Dry Wt. of seedling		
	15	30	45	15	30	45	15	30	45	15	30	45
control	8.26	20.82	32.13	7.21	13.43	21.32	15.47	34.25	53.45	0.283	2.22	6.432
T1	10.45	21.92	30.52	9.41	19.35	28.29	19.86	41.25	58.81	0.369	2.76	6.895
T2	10.92	22.63	30.78	9.97	20.22	28.67	20.89	42.85	59.45	0.378	2.79	7.009
T3	10.00	21.68	31.03	11.08	20.45	25.62	21.08	42.18	56.65	0.377	2.67	7.233



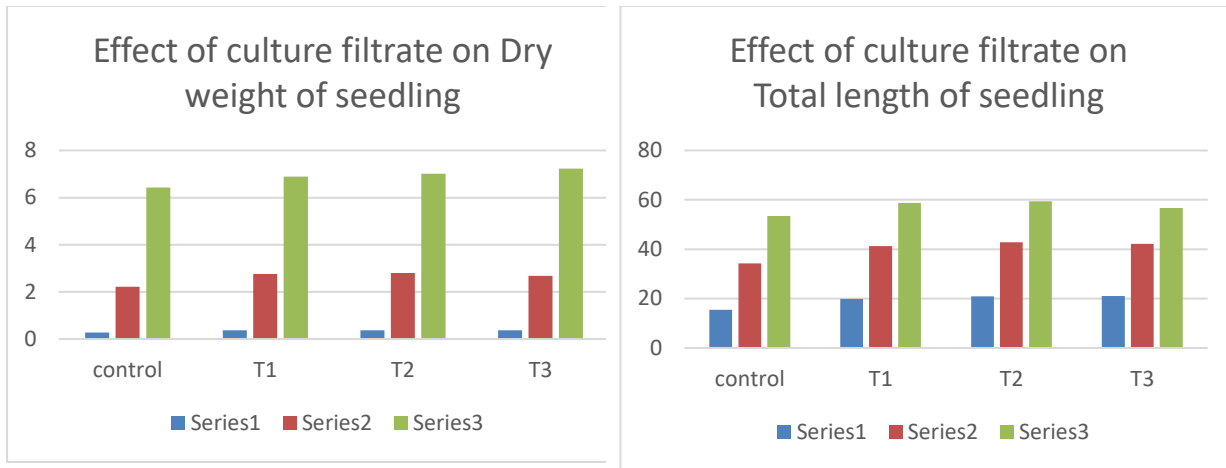


Fig. 1. Graphical representation of effect of culture filtrate on vegetative growth of soybean plant

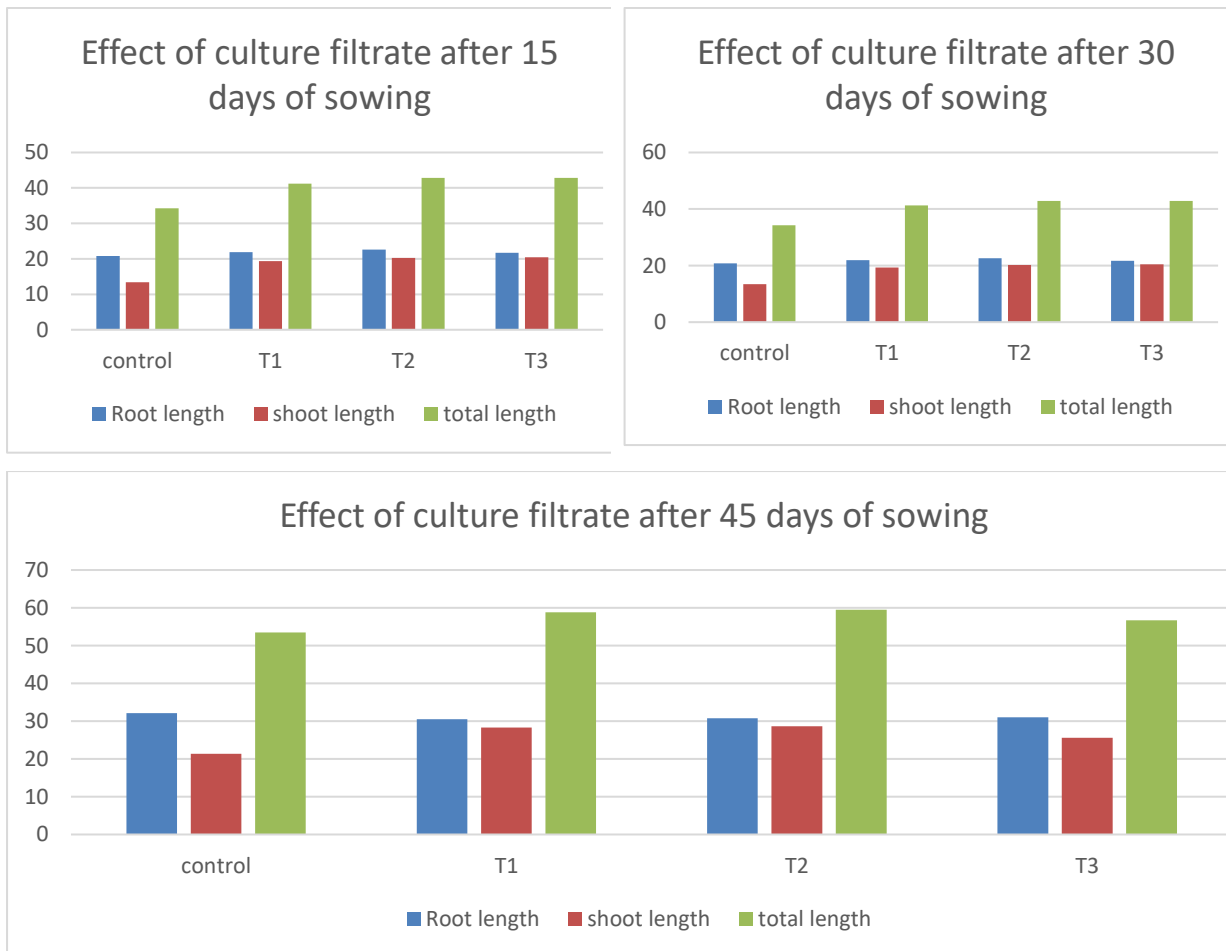


Fig 2. Effect of various concentration of culture filtrate after 15, 30 and 45 days of sowing of Soyabean plant

Overall, the findings of this study confirm that algal culture filtrates act as effective biostimulants, enhancing early growth and biomass accumulation in plants. These results support the growing body of evidence advocating the use of algal-based products in sustainable agriculture as eco-friendly alternatives to chemical inputs.

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