Effect of Seaweed Extracts as Bio Stimulant on Growth Parameters in Spinach

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Abstract**—** *Spinach (Spinacia oleracea), is an important cool season vegetable crop which is widely consumed due to its high nutritional content and eco-friendly techniques has a great role in enhancing the productivity and nutritional quality of spinach in context of human health and sustainable agriculture. Among different organic amendments, seaweed is an important organic extract which can be utilized effectively as biofertilizer in improving the vegetative growth in Spinach. The present study was carried out at Amity Institute of Organic Agriculture, Amity University Noida, UP to study the potential of seaweed extract, a bio stimulant on growth parameters in Spinach (Spinacia oleracea L.). Seaweed is an organic bio-stimulant, which is rich in vitamins, amino acids and phytohormones. The field experiment was conducted at the Amity Institute of Organic Agriculture in Randomized Block Design (RBD) with six treatments as 20, 40, 60, 80 and 100 ml were tested for its stimulative potential of plant growth.*

Keywords— Spinach, Seaweed extract, Biostimulant, Sustainable Agriculture.

I. INTRODUCTION

Spinach (*Spinacia oleracea* L.) is a leafy vegetable crop which is rich in nutrients and bioactive compounds like spinacetin, patuletin and coumaric acid derivatives with potent antioxidant activity (Bergman et al., 2001; Pandjaitan et al., 2005). Spinach being a nutritionally rich crop is also a substantial source of fiber (Antonia et al., 2001). Being a cool season crop, it is cultivated in a temperature range of 7-15 °C with adequate moisture conditions (Chitwood et al., 2017). Spinach which was originally indigenous to Central and Western Asia was later brought to India and then China in 7th century. As the agriculture is proceeding towards sustainability with an aim to utilize organic source for fertilizers for nutrition, more emphasis was made on organic compounds. Utilization of natural seaweed extracts as biofertilizers has thus, made it possible to partially replace the traditional synthetic fertilizers during recent years (Hong et al., 2007). Seaweed extracts are non-toxic, non-polluting, biodegradable which are safer for the environment and human (Khan et al. 2009). Different seaweed products are available that can be utilized as liquid extracts either applied as foliar spray or as soil drench that will act as soil conditioners (Thirumaran et al., 2009).

Among different organic amendments, seaweed is an organic extract that can be effectively utilized as a bio-stimulant by various researchers (Singh et al., 2016; Rouphael et al., 2017). Seaweed extract has been utilized effectively in various vegetable crops with benefits like higher yield and foliar biomass. The beneficial and economic effects of seaweed extracts on overall growth, yield and quality attributes with different horticultural crops have been reported (Kumar et al., 2020). Seaweed extracts are bio-stimulants that improve plant growth and stress tolerance. These extracts have been reported to increase plant tolerance to biotic and abiotic stress conditions (Guinan et al., 2013; Hariharan et al., 2024). The most common seaweed extract (*Ascophyllum nodosum*) positively affects the spinach germination, its vegetative growth as well as antioxidant activity under stressed conditions (Anjos et al., 2020). Seaweed extracts thereby improve the soil health by increasing the plant and soil microbial activity (Moore et al., 2004).

II. MATERIAL AND METHODS

2.1 Experimental location and climatic conditions:

The experimental trial was conducted at Experimental farm of Amity Institute of Organic Agriculture, Amity University Noida UP during the cropping season of 2025. The cropping area was situated at 200 meters above the mean sea level with geographic

coordinates of 77°19′51.64″E longitude and 28°32′37.64″N latitude. The cropping area is under Trans-Gangetic plains having semi-arid, subtropical climate with dry summers and harsh winters having January as the ideal time for cultivation of spinach. Average rainfall of 700 mm followed by dry weather during December to February are ideal for the cultivation of spinach.

2.2 Land preparation and sowing:

Properly drained soil beds were prepared ensuring they are devoid of debris and weeds. The seed beds are prepared manually and sowing of spinach is done by broadcasting method to cover the whole area evenly. Later, the seeds are covered with thin layer of soil followed by light watering that to supply the requisite moisture for germination.

2.3 Treatment details:

The experimental trail was carried out with six treatments and four replications in a Randomized Block Design (RBD) where each plot was about 2m, with 0.5 m separating each plot. ANOVA tests from OPSTAT were used to determine the variance in the data that was recorded with respect to various growth parameters, such as seed germination percentage, shoot length (cm), root length (cm), and yield (kg/plot).

TABLE 1
TREATMENT DETAILS

Sr. No	Treatments
1	T1: Seaweed extract (20ml)
2	T2: Seaweed extract (40ml)
3	T3: Seaweed extract (60ml)
4	T4: Seaweed extract (80ml)
5	T5: Seaweed extract (100ml)
6	T6: Control

III. RESULTS AND DISCUSSION

The data was collected for various growth and yield parameters in spinach as presented in Table 2. Among different treatment combinations, T3 (seaweed extract 60 ml) recorded maximum number of leaves followed by T4 (seaweed extract 80 ml) which are significantly different from each other,

TABLE 2
EFFECT OF SEAWEED EXTRACT AS BIO STIMULANT ON GROWTH PARAMETERS IN SPINACH

TREATMENTS	No. of leaves	Shoot length (cm)	Root length (cm)	Plant height (cm)	Yield (kg/plot)
T1: Seaweed extract (20ml)	5.33^{c}	24.93^{a}	4.50^{c}	16.50^{cd}	4.5
T2: Seaweed extract (40ml)	5.50^{c}	23.40^{cd}	5.00^{c}	16.16^{d}	5.25
T3: Seaweed extract (60ml)	11.00^{a}	24.43^{ab}	6.56^{a}	18.00^{a}	5.80
T4: Seaweed extract (80ml)	6.83^{b}	24.06^{bc}	4.83^{c}	17.40^{ab}	5.30
T5: Seaweed extract (100ml)	5.66^{c}	23.16^{d}	5.83^{b}	17.16^{bc}	4.75
T6: Control	3.33^{d}	22.06^{e}	3.66^{d}	14.83^{e}	4.30
CD (0.05)	**1.64**	**1.91**	**1.22**	**1.78**	**-**

The treatment combinations of T1 and T2 (seaweed extract 40 ml) were statistically at par with each other in comparison to control. For another growth parameter like shoot length, treatments T1 (seaweed extract 20 ml) and T3 were most effective and

statistically at par with each other followed by treatment T4 and T2. Among the different treatments, T5 was significantly different from other treatments in comparison to control (Figure 1),

Plant height as an important growth attribute in spinach crops which was effectively increased by the application of seaweed extracts at different concentrations in comparison to control. Treatment T3 was most effective among all followed by T4 and T5 which are statistically at par with each other. Similar observations were recorded for root length where treatment T3 was found most effective with positive effect on root length followed by T5 and T2 treatments in comparison to control.

The yield parameter was also recorded to study the efficacy of seaweed extracts on yield of spinach crop. Among all the treatments, seaweed extract at 60 ml concentration was recorded as most effective with yield potential of around 5.8 kg per plot followed by treatment involving application of seaweed extract at 80 ml concentration in comparison to the control.

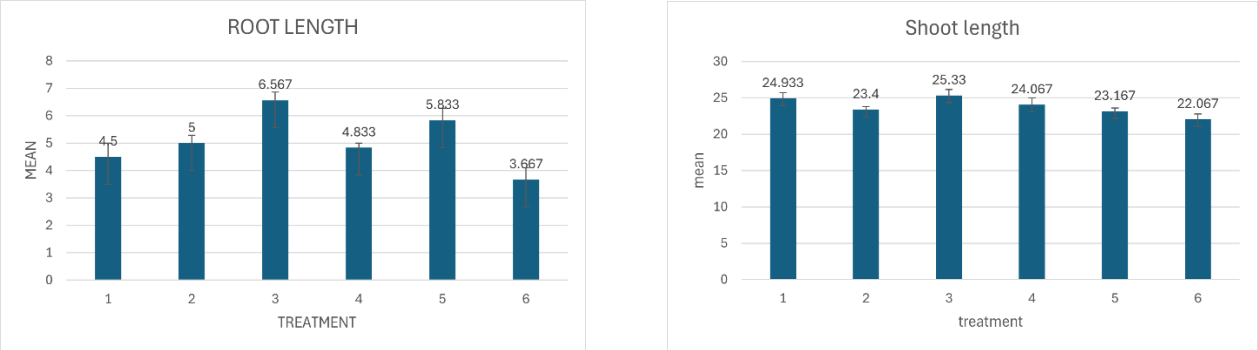

FIGURE 1: Effect of seaweed extracts on root and shoot growth in spinach

The results of the present investigation are in conformity with studies carried out by various workers as seaweed acts a potent biofertilizer for leaf growth, biochemical enhancement under abiotic stress (Khan et al., 2009; Xu and Leskovar 2013; Shukla et al., 2019).

IV. CONCLUSION

This study concluded that the application of seaweed extract at a concentration of 60 ml was the most effective that significantly enhanced the growth parameters like plant height, number of leaves and yield and thus can be utilized as a potent organic bio-fertilizers for spinach production. The increase in vegetative growth can be attributed due to production of natural plant growth regulators and other essential micronutrients and the increase in number of leaves is due to the enhanced photosynthetic activity. Thereby, results suggest the role and importance of seaweed extract as an effective and sustainable biostimulant to improve the early growth in Spinach, which is crucial for achieving sustainability in crop production.

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