Synergistic Effects of Organic Amendments on Coriander Cultivation

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Abstract

The prevalent application of synthetic soil amendments over the last decades has raised environmental issues, fueling a fascination with organic amendments for eco-friendly farming. Organic amendments are believed to enhance plant growth, flowering, microbial activity, and pest control, yet scientific evidence, particularly in containerized plant production, remains limited. This study investigates the impact of biochar (BC), seaweed extract (SWE), and their combinations on the growth and cultivation of corainder (*Coriandrum sativum*) in pot experiments. The study assessed the impact of BC, SWE, and their combined application on plant development, yielding characteristics, and the levels of macro- and trace elements present in the foliage.Measurements were taken every 10 days, starting from seed sowing at 10, 20, 30, and 40 days. Key growth parameters, such as seed germination, plant height, leaf number, node and internode numbers, root length and nutrient concentrations (N, P, K, Mg, Ca, Fe, Mn, Zn, Cu), were assessed. Results indicated that BC and SWE, either individually or combined, significantly enhanced most morphological traits and yield components compared to the control. Notably, the low-level BC treatments, alone or combined with SWE, showed the most pronounced positive effects on growth and nutrient concentrations. The findings suggest that organic fertilizers, particularly biochar and seaweed extract, offer a promising alternative to chemical fertilizers for improving growth and yield in *Coriandrum sativum*.

Keywords: Coriander; Biochar; Seaweed extract; Trace elements; Yield.

R. K. Ramachandra et al. (eds.), *Proceedings of the International Conference on Bio-Based Environment for Sustainable Territory (IC-BEST 2024)*, Advances in Biological Sciences Research 44,
https://doi.org/10.2991/978-94-6463-648-2_5

1. Introduction

Coriandrum sativum L. one of the aromatic herbs belongs to Apiacea family. It is well known most important seed spices for India's exports and foreign exchange earnings [1]. It is also a common component of Ayurvedic medicine and is used in traditional home therapy for number of ailments including flatulence, gastrointestinal complaints, joint pain and rheumatism [2]. Although it is sown in winter for commercial seed production, yield was average and significantly lower than other states [3]. Coriander is a tropical crop that is usually planted in the winter to produce seeds. An early or late sowing could have detrimental effect on the crop's quality and growth yield. Early sowing and selecting a less responsive type for coriander yield have been advantageous [4]. The quality of crop and its yield are the primary importance for the commercial production. Using both organic and synthetic fertilizers, researchers have investigated a number of strategies to increase agricultural yield and quality. It is necessary to investigate method to employ renewable plant nutrients to avoid chemical fertilizer. In recent years organic farming has extensively studied to improve the soil fertility and crop yield.

Biochar (BC) is a porous carbonaceous substance produced generated from the pyrolysis of plant biomasses. It can be utilized as a long-term carbon sink or to replace fossil carbon in industrial manufacturing [5]. BC's delayed release of plant micronutrients may lessen the demand for other chemical fertilizers in agriculture [6-8]. Furthermore, BC might increase the water and nutrient retention capacity [9-11].

Since seaweed extracts contain hormones, macronutrients, micronutrients, and plant growth promoters that encourage quick seed germination and high yield, they are known as biostimulants and organic fertilizers [12]. Seaweed are multicellular, macroscopic marine algae typically found on the worlds sea coast where suitable substrates exist. There are approximately 9000 macroalgal species exist, generally divided into three groups according to their pigments brown, red and green algae. *Kappaphycus alvarezii*, an edible red seaweed and one of the largest tropical algae with a rapid growth rate.

With this knowledge, the primary goal of the current study is to evaluate the effects of biochar, seaweed extract, and their combination on plant development and nutrient allocation.

2. Materials and Methods

2.1 Sample Collection

Coraindarum sativum L. were purchased from Government Approved Susi seed centre, Thyagaraya nagar, Chennai.

2.2 Sample and Foliar spray Preparation

Coraindarum sativum L., seeds were soaked for 24 hours in water before sowing. *Kappaphycus alvarazeii* seaweed 1g powder were boiled for 1 hour and filtered, further the filtrate was used for further study. Similarly, Biochar was purchased from the seed centre for the study.

2.3 Experiment Design

Polybag experiment was conducted with three replicates each replicate containing 3 polybags. Each poly bag containing 5 seeds. To investigate the synergistic effect of foliar spray with bio stimulants like biochar and seaweed extract on plant growth and nutrient content.

Three treatments compared to control with three replicates were designed as follows

1. Control – Water spray (without any treatment)
2. Seaweed extract – 1% foliar spray (1 ml of filtrate in 100 ml water)
3. Biochar – 1.5 % foliar spray (1.5 ml in 100 ml water)
4. Seaweed extract + Biochar – 5 % + 1.5 % foliar spray (5 ml of seaweed extract filtrate + 1.5 ml biochar in 100 ml water)

The treatment was carried out every day 10 days.

2.4 Vegetative growth characteristics

A total five spray were applied at 0^{th} day, 10^{th} day, 20^{th} day, 30^{th} day, 40^{th} day. The spray volume was 100 ml. Foliar application was carried out with manually operated sprayer bottle. Alike in control instead of treatment, an equivalent volume of water was sprayed. The vegetative growth characteristics like plant height (cm), number of leaves, number of nodes, and root length per plant were measured after every 10 days in all the three replicates.

2.5 Macro and Micronutrient Assessment

Leaf samples were collected after 40 days of treatment, oven-dried at 45°C, and pulverized. 1 g of the powdered samples were subjected for macronutrients (N, P, K, Ca,

and Mg) and micronutrients (Fe, Mn, Zn and Cu) analysis according to the method Cottenie et al. [13].

2.6 Statistical Analysis

All the data was plotted using GraphPad Prism 8 software (GraphPad Software, La Jolla, CA, USA). All the data were reported as mean ±standard deviation (SD Experiments were carried out with three replicates, each comprising three polybags. The statistical significance was determined as *$p<0.05$ and **$p<0.01$.

3. Result and Discussion

3.1 Effect of Foliar Spray on Vegetative Growth

The present study aimed to evaluate the following hypothesis plant height, number of leaves, number of nodes, and root length. This section describes the effects of foliar spray with seaweed extract, and biochar, alone and in combination (Figure 1- 4). Figure 1 shows the assessment of plant height affected by foliar spray in our study. It was observed that seaweed extract showed 14.85 ± 0.36 cm (Fig. 1d), and the combination of seaweed extract with biochar showed 15.23 ± 0.30 cm (Fig. 1d) after 40 days of study. However, the foliar spray of seaweed extracts alone, showed consistent plant height 4.37 ± 0.19 cm, on the 10th day of evaluation in contrast to the combination of seaweed extract + biochar (4.32 ± 0.13 cm).

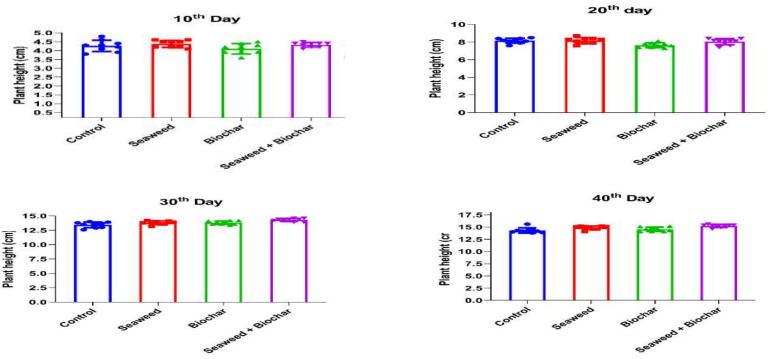

Figure 1: Measurement of Plant Height a). 10th day; b). 20th day; c). 30th day; d). 40th day

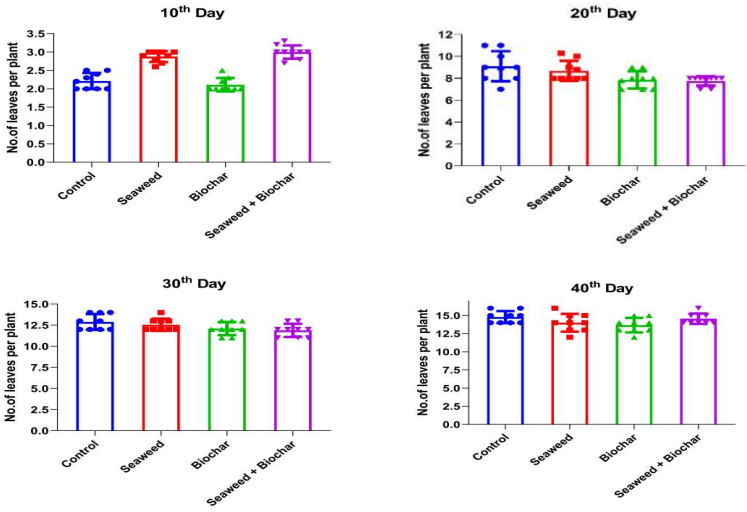

Figure 2: Measurement of Number of Leaves a. 10th day; b. 20th day; c. 30th day; d. 40th day

After the 10th day of the study, it was found that the addition of seaweed extract and biochar combination foliar spray increased the number of leaves (2.77 ± 0.44) compared to the control which has 2.33 ± 0.50 number of leaves. Likewise, the number of leaves was found to be maximum (14.55 ± 0.72) in combined foliar spray at the same time as control (14.0 ± 0.1) (Figure 2).

Likewise, the number of nodes after the 10th day of study was found to be high (2.77 ± 0.44) in foliar spray containing a combination of seaweed extract and biochar (Figure 3), while the number of nodes after 40th day of study was 14.55 ± 0.77 increased in combination foliar spray compared to other foliar sprays such as control, seaweed extract and biochar alone. However, the root length was observed to be high (9.8 ± 0.27 cm) in seaweed extracts foliar spray compared to other foliar spray of our study (Figure 4). From overall study on vegetative growth parameter, foliar spray with *Kappaphycus alvarezii* seaweed extract was found to stimulate the growth of *Coriandrum sativum* L. of our study. The result of our study was similar to the result observed with the seaweed extract foliar spray (Algreen) in strawberry plant [14]. Furthermore, our findings support previous research showing that application of seaweed extract promotes growth and root development [15-18]. Likewise, *Kappaphycus alvarezii* extract as a biofertilizer has been reported to promote seed germination, growth, biochemical composition,

pigment concentration and yield in commercial crops such as rice, groundnut, and chili [19].

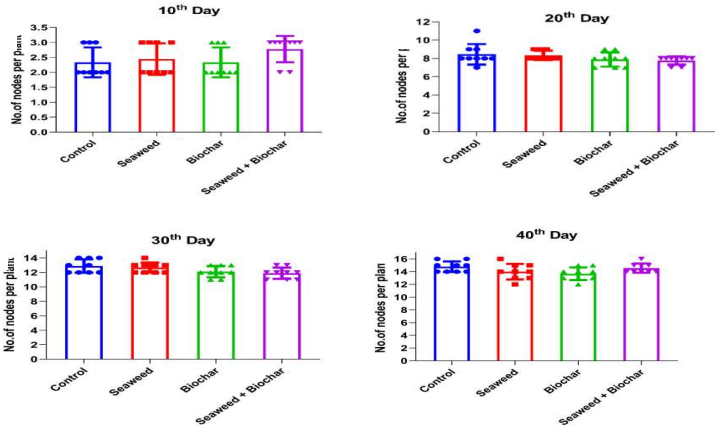

Figure 3: Effect of Foliar spray on Number of nodes (a) 10th day; (b) 20th day; (c) 30th day; (d) 40th day.

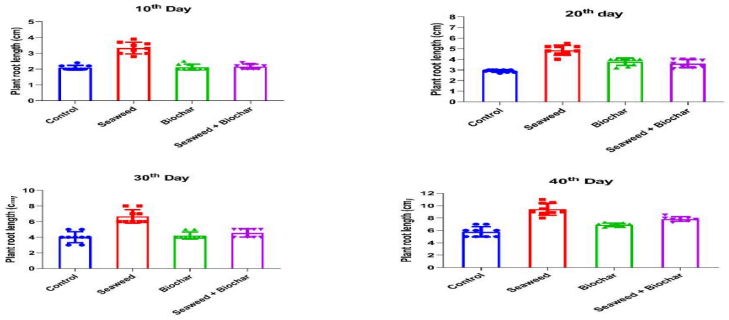

Figure 4: Effect of Foliar spray on root length (a) 10th day; (b) 20th day; (c) 30th day; (d) 40th day.

3.2 Effect of Foliar Spray on Macro and Micro nutrients

Table 1 and 2 shows that there was a significant increase in the macronutrient and micronutrient content in the seaweed extract foliar spray compared to the control and other

foliar sprays in our study. Nadia and Hala [20] reported that cobalt treatment increased the macronutrient content in coriander. The result was similar to the study report by Okasha et al. [21], in tomato leaves sprayed with seaweed extract. Likewise, seaweed extract foliar spray improved the macronutrient, micronutrient and fruit quality [22].

Table 1: Effect of Foliar Spray on Macro nutrient content in leaves of *Coriandrum sativum* L.

	Macronutrients (%)				
	10th day				
	N	**P**	**K**	**Ca**	**Mg**
Control	**3.11**	**0.66**	**2.51**	**1.65**	**76.7**
Seaweed	**4.01**	**0.77**	**2.46**	**2.03**	**88**
Biochar	**3.64**	**0.81**	**2.73**	**1.82**	**80.2**
Seaweed + Biochar	**3.98**	**0.89**	**2.94**	**1.96**	**84.6**
	20th day				
Control	**3.15**	**0.71**	**2.61**	**1.65**	**76.9**
Seaweed	**3.06**	**0.98**	**3**	**2.09**	**91.1**
Biochar	**3.1**	**0.76**	**2.52**	**1.48**	**75.01**
Seaweed + Biochar	**3.28**	**0.82**	**2.68**	**1.72**	**78**
	30th day				
Control	**3.77**	**0.83**	**2.95**	**1.8**	**89**
Seaweed	**4.56**	**0.81**	**2.33**	**2.46**	**90**
Biochar	**4.12**	**1.02**	**3.11**	**2.19**	**79.9**
Seaweed + Biochar	**3.61**	**0.79**	**2.7**	**1.67**	**97.9**
	40th day				
Control	**3.1**	**0.68**	**2.59**	**1.65**	**76.3**
Seaweed	**4.01**	**1.65**	**3.41**	**2.43**	**91**
Biochar	**3.4**	**0.78**	**2.43**	**1.32**	**76.71**
Seaweed + Biochar	**3.86**	**0.79**	**2.66**	**1.13**	**78.6**

Likewise, foliar application of seaweed improved the macro nutrient and micronutrient content in coriander, fenugreek and chilli [23-26]. The result from the present investigation infer that the seaweed extracts foliar spray showed significant influence in the uptake of macronutrient and micronutrient.

Table 2: Effect of Foliar Spray on Micronutrients content in leaves of *Corainder sativum* L.

	Micronutrients (ppm)			
	10th day			
	Fe	**Mn**	**Zn**	**Cu**
Control	**154.2**	**64.2**	**41.6**	**39.2**
Seaweed	**138**	**76.6**	**81**	**44.2**
Biochar	**151**	**66.5**	**44**	**41**
Seaweed + Biochar	**146.9**	**69**	**47.5**	**43.5**
	20th day			
Control	**145**	**64.5**	**41.7**	**39.3**
Seaweed	**141.5**	**74.2**	**83.8**	**46.1**
Biochar	**139**	**66.2**	**40.9**	**37.46**
Seaweed + Biochar	**140**	**66.3**	**43**	**40.3**
	30th day			
Control	**153.2**	**69**	**45.6**	**41.9**
Seaweed	**135**	**78.2**	**79**	**45.1**
Biochar	**152.2**	**63.4**	**40.5**	**39.3**
Seaweed + Biochar	**146**	**76.2**	**47**	**45.5**
	40th day			
Control	**143**	**81.6**	**51.2**	**47.6**
Seaweed	**139**	**75.8**	**54**	**46.2**
Biochar	**135**	**64.28**	**43.12**	**38.41**
Seaweed + Biochar	**153**	**62.89**	**47**	**46**

4. Conclusion:

The study concludes that the foliar spray combination of seaweed extract and biochar has significantly positive impact on the growth, yield and nutrient content of *Corain-drum sativum* L. The results suggest that both seaweed extract and biochar, when used in combination, improved growth parameters such as plant height, leaf number, node number and root length, compared to control. In addition, foliar spray seaweed extract

showed significant benefits in promoting root growth and improving macro- and micronutrient absorption. This result suggests that organic additives such as biochar and seaweed extract can serve as an effective alternative to chemical fertilizers and provide a more sustainable approach to agricultural practices in coriander cultivation. Further research on the effectiveness of biochar and seaweed extract across diverse soil types, climates, and coriander varieties, while exploring their molecular mechanism and long-term sustainability impacts on soil health. Integration with precision agriculture can further optimize application efficiency. Commercially, these findings could lead to the development of low-cost, environmentally friendly biofertilizers and bio stimulants for organic farming. This study would open the door for personalized nutrient delivery system such as foliar sprays or granules, changing sustainable agricultural techniques.

5. Declaration: The authors declare no competing interest.

References

1. Peter, K.V., et al.: Available Technologies to Raise Yield. *The Hindu Survey of Agric.,* 5, 82 – 86 (2006).
2. Said, H.M., et al.: Medicinal Herbal: A Textbook for Medical Students and Doctors. Vol. 1, Hamdard Foundation Pakistan, Pakistan, pp: 1- 82 (1996).
3. Panda, M.R., et al.: Effect of growth regulators on growth, yield and quality of coriander. Indian J. Hort. 64, 369 – 371 (2007).
4. Meena, S.S., Malhotra, S.K.: Effect of sowing time, nitrogen and plant growth regulators on green leaf yield of coriander. Haryana J. Hortic. Sci. 35, 310 – 311 (2006).
5. Bahaa Badry Mosa Salim.: Influence of biochar and seaweed extract applications on growth, yield and mineral composition of Wheat (*Triticum aestivum* L.) under sandy soil conditions. Agricultural Botany Department, Faculty of Agriculture, Ain Shams University, Cairo, Egypt, (2016).
6. Lehmann, J.: Bio-energy in the black. *Front Ecol Environ.*, 5, 381 – 387.
7. Laird, D. A., et al.: Impact of biochar amendments on the quality of a typical Midwestern agricultural soil. Geoderma, *158* (3-4), 443-449 (2010).
8. Zhang, F., et al.: Integrated nutrient management for food security and environmental quality in China. Adv. Agron, 116, 1–40 (2012).
9. Gaskin, J.W., et al.: Effect of low-temperature pyrolysis conditions on biochar for agricultural use. Trans. ASABE, 51, 2061 – 2069 (2008).

10. Uzoma, K.C., et al.: Effect of cow manure biochar on maize productivity under sandy soil condition. Soil Use Manage. 27, 205–212 (2011).
11. Kloss, S., et al.: Characterization of slow pyrolysis biochars: effects of feed stocks and pyrolysis temperature on biochar properties. J. Environ. Qual, 41 (4), 990–1000 (2012).
12. Sasikala, M., et al.: Effect of Seaweed Extract (*Sargassum tenerrimum*) on Seed Germination and growth of Tomato Plant. Int. J. Chemtech. Res., 9(9), 285-293 (2016).
13. Cottenie, A., et al.: Chemical Analysis of Plants and Soils. State Univ. Ghent, Belgium, 63: 44-45 (1982).
14. Alam, M. Z., et al.: Effect of Ascophyllum extract application on plant growth, fruit yield and soil microbial communities of strawberry. Can. J. Plant Sci., 93(1), 23-36 (2013).
15. Slàvik, M.: Production of Norway spruce (*Picea abies*) seedlings on substrate mixes using growth stimulants. J. For. Sci, 51(1): 15-23 (2005).
16. Thompson, B.: Five years of Irish trials on biostimulants: the conversion of a skeptic. USDA Forest Service Proceeding 33, 72–79 (2004).
17. Mancuso, S., et al.: Marine bioactive substances (IPA extract) improve ion fluxes and water stress tolerance in potted *Vitis vinifera* plants. Adv. Hort. Sci., 20, 156-161 (2006).
18. Vernieri, P., et al.: Application of biostimulants in floating system for improving rocket quality. J Food Agri Environ 3, 86–88 (2005).
19. Babu, S., Rengasamy, R.: Effect of *Kappaphycus alvarezii* SLF treatment on Seed germination, growth and development of seedling in some Crop plants. J. Sci. Ind. Res. 1(4), 186-195 (2012).
20. Nadia, G., Hala K.: Influence of cobalt nutrition on coriander (*Coriandrum sativum* L.) Herbs yield quantity and quality. J.Appl.Sci.Res. 8 (10), 5184 – 5189 (2012).
21. Okasha, M.M., et al.: Impact of the application of some friendly environment materials on tomato plants grown under high temperature conditions. Ann. Agri. Sci. 61(1), 59–68 (2023).
22. Harhash, M.M., et al.: Effect of the foliar spraying of fulvic acid, folic acid, and seaweed extract on vegetative growth, yield and fruit quality of grape cv. Flame seedless. Plant Arch, 21(1), 482-492 (2021).

23. Rahimi, A. R., et al.: Effect of Mineral vs. Biofertilizer on the Growth, Yield and Essential Oil Content of Coriander (*Coriandrum sativum* L.). Medicinal and Aromatic Plant Science and Biotechnology. Global Science Books (2009).
24. Mehta, R. S., et al.: Growth, yield and quality of fenugreek (*Trigonella foenum graecum* L.) as influenced by nitrogen, phosphorus and bio-fertilizers. Indian. J. Hort. 69(1), 94-97 (2012).
25. Ingle, V. G., et al.: Effect of foliar spray of auxins, micronutrients with urea on fruit drop and yield of chilli cv. CA 960. Punj. Kris. Vidya. Res. J. 17, 142-145 (1993).
26. Chhibba, M., et al.: Influence of Mode and Source of Applied Iron on Fenugreek (*Trigonella corniculate* L.) in a Typic Ustochrept in Punjab, India. Intl. J. Agric. Biol. 9(2), 254–256 (2007).