E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(10): 160-163
Received: 05-07-2025
Accepted: 09-08-2025

Venkatesh R
Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu, India

Raman R
Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu, India

Kandasamy S
Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu, India

Srinivasan S
Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu, India

Corresponding Author:
Venkatesh R
Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu, India

Impact of foliar nutrition of biostimulants on the yield, biochemical parameters, nutrient uptake and profitability of greengram

Venkatesh R, Raman R, Kandasamy S and Srinivasan S

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i10c.3967

Abstract
Biostimulants are biologically derived substances that, when applied to plants or soil, enhance plant growth or improve its tolerance to abiotic stress. A field experiment was conducted during February to April 2024 at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, to evaluate the impact of biostimulants on the biochemical properties, nutrient uptake and profitability of greengarm. The experiment was conducted in a Randomized Block Design (RBD) with eight treatments and three replications. Results indicated that foliar application of seaweed extract at 3% on 30 and 45 DAS (T_2) significantly improved seed nitrogen content (3.90%), crude protein content (24.38%), and nutrient uptake of nitrogen (44.62 kg ha^{-1}), phosphorus (12.46 kg ha^{-1}), and potassium (48.97 kg ha^{-1}) compared to other treatments. T_2 also recorded a 51.35% increase in seed yield over the control, with the highest net returns (₹36,281 ha^{-1}) and a benefit-cost ratio of 2.27. Therefore, it can be concluded that foliar application of seaweed extract at 3% on 30 and 45 DAS, in conjunction with the recommended dose of fertilizer, is the most effective treatment for improving biochemical parameters, nutrient uptake, and economic returns in greengram cultivation.

Keywords: Biostimulants, greengram, nutrient uptake, seaweed extract

Introduction
Green gram (*Vigna radiata* L.), commonly referred to as mung bean, is a nutritious legume indigenous to India and Central Asia. It is a highly cultivating pulse crop in India, contributing to 10% of overall pulse production and covering 16% of the total land. With more than 70% of the world's production area dedicated to greengram cultivation, India is the world's leading producer. The potential yield of greengram remains low, primarily due to its cultivation under rainfed conditions, as a rice fallow, bund crop, border crop, or intercrop, often accompanied by poor management practices. Additionally, physiological constraints such as inadequate assimilate partitioning, poor pod setting due to flower abscission, and nutrient deficiencies during critical growth stages further limit productivity. The reduction in production was also due to number of pests and diseasea (Krishnaveni *et al*., 2021) [11]. To enhance the productivity of greengram, various strategies have been employed, among which foliar application of biostimulants plays a significant role in maximizing the crop's genetic potential. Unlike soil-applied nutrients, which are often subject to losses through processes such as leaching and volatilization, foliar application offers a more efficient route of nutrient delivery. Moreover, soil-related constraints like acidity, alkalinity, waterlogging, and inadequate moisture can hinder nutrient availability to plants. Foliar application of biostimulants helps mitigate the negative impacts of such conditions. Biostimulants, derived from biological sources, promote plant growth and improve stress resilience when applied to plants or soil (Yakhin *et al*., 2017) [18]. Additionally, they contribute to enhancing soil biological activity and health through various biochemical and physiological mechanisms (Sible *et al*., 2021) [17]. Furthermore, biostimulants may serve as a sustainable alternative to reduce the negative impacts associated with excessive use of agrochemicals (Lucini *et al*., 2020) [14]. Foliar nutrition helps reduce the cost of cultivation by minimizing the quantity of fertilizers required, while also decreasing nutrient losses and enhancing the overall efficiency and economy of crop production.

Biostimulants such as seaweed extract, fish amino acid, PPFM, jeevamrutham, panchagavya, vermiwash, and humic acid play a vital role in enhancing nutrient availability and uptake in plants. Biostimulants contribute to improved crop growth and yield while simultaneously enhancing soil fertility by increasing nutrient use efficiency, thereby reducing the dependency on chemical fertilizers. The choice of appropriate inputs and effective nutrient delivery methods is crucial for optimizing crop productivity and quality, ultimately supporting both food and nutritional security (Kumar *et al*., 2022) [12]. Research on the use of organic foliar biostimulants in greengram is limited; however, their application under irrigated conditions is essential to enhance the crops productivity. Therefore, the present field investigation was undertaken to develop a productive, profitable, and sustainable nutrient management strategy for irrigated greengram.

Materials and Methods

A field experiment on greengram was carried out during February to April 2024 at the experimental farm of the Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu. The textural class of soil of the experimental site is clay loam with pH (7.23), EC (0.4 dS m-1) and organic carbon content (0.49%). Prior to the experiment, the available nitrogen, phosphorus, and potassium contents in the soil were 219, 22, and 283 kg ha^{-1}, respectively. A field experiment was undertaken to assess the efficacy of different organic biostimulants, seaweed extract, fish amino acid (FAA), pink-pigmented facultative methylotrophs (PPFM), jeevamrutham, panchagavya, vermiwash, and humic acid—on sustainable productivity, profitability, and soil health in greengram cultivation. The study was arranged in a randomized block design (RBD) with three replications. The treatments included are, T_1 - Control (No Spray), T_2 - Foliar application of Seaweed extract at 3% on 30 and 45 DAS, T_3 - Foliar application of Fish amino acid at 1% on 30 and 45 DAS, T_4 - Foliar application of PPFM at 1% on 30 and 45 DAS, T_5 - Foliar application of Jeevamrutham at 3% on 30 and 45 DAS, T_6 - Foliar application of Panchagavya at 3% on 30 and 45 DAS, T_7 - Foliar application of Vermiwash at 5% on 30 and 45 DAS, T_8 - Foliar application of Humic acid at 3% on 30 and 45 DAS. All treatments plots received a basal application of the recommended fertilizer dose (25:50:25 kg NPK ha^{-1}), with urea, single super phosphate, and muriate of potash serving as the sources of nitrogen, phosphorus, and potassium, respectively. Greengram was sown at a seed rate of 25 kg ha^{-1} with a spacing of 30 cm × 10 cm to ensure optimal plant population. Standard agronomic practices and plant protection measures were adopted as per the recommended guidelines. At maturity, greengram plants from each plot were harvested and bundled separately, and both seed yield and haulm yield were recorded on a plot-wise basis. The crude protein content (%) in seeds was estimated using the Kjeldahl method as described by Humphries (1956) [6]. Nitrogen content was determined first, and protein content was calculated using the standard conversion factor (N × 6.25). The Micro Kjeldhal method (Yoshida *et al*., 1976) [19] was used to analyse the powdered samples for N, and the Triple Acid Digestion Method (Jackson, 1973) [8] was used to estimate P and K using a photoelectric calorimeter and a flame photometer, respectively. The nutrient value (expressed in%) were multiplied by the respective treatments dry matter production (DMP) to compute nutrient uptake, which was expressed in kg ha^{-1}.

$$\text{Nutrient uptake} = \frac{\text{Percentage nutrient} \times \text{Total dry matter production (kg ha}^{-1}\text{)}}{100}$$

Economic analysis was conducted using the prevailing input costs, operational expenses, and market price of produce for each treatment. The benefit-cost ratio (B:C ratio) was computed by dividing the net returns by the total cost of cultivation. The recorded data were compiled and analyzed statistically to interpret treatment effects. Analysis of variance (ANOVA) was performed using MS Excel 2016, and treatment means were compared using the multiple comparison test as outlined by Gomez and Gomez (1991) [5].

Results and Discussion

Seed yield and Halum yield (kg ha^{-1})

Foliar application of biostimulants significantly enhanced the yield performance of greengram. Among the treatments, T_2 (Foliar spray of seaweed extract at 3% on 30 and 45 DAS) recorded the highest seed yield (699 kg ha^{-1}) and haulm yield (1976 kg ha^{-1}), while the lowest yields were observed in the control (T_1) with 340 kg ha^{-1} and 1015 kg ha^{-1}, respectively (Table 1). The increase in grain yield under T_2 could be attributed to improved branching and a higher number of pods per plant, likely due to the nutrient-rich composition of seaweed extract. These findings align with the results reported by Karthik *et al*. (2023) [9]. Seaweed extract influenced the root nodulation and the availability of various nutrients. The positive impacts of seaweed extract might be the existence of growth stimulating chemicals such as IAA, IBA, gibberellins, cytokinin, minerals, and amino acids. Additionally, which improved stomatal conductance, enhanced photosynthesis, and better allocation of photosynthesis to sinks, ultimately leading to an increase in the yield attributes. These results are consistent with the findings of Hussein *et al*. (2021) [7], who also reported yield enhancement with seaweed extract application. Seaweed extract likely improved the source capacity of leaves, thereby increasing assimilate supply for pod filling. This may have enhanced sink strength by increasing pod weight, cotyledon cell number, and final seed mass. The higher haulm yield could be attributed to a sustained nutrient supply, which promoted greater leaf area development and dry matter accumulation. These results are in line with Kiritkumar (2022) [10]. The treatment T_1 (Control-no Spray) observed the lower yield attributes and yield because some insufficient essential and micro nutrients to the crop might be the reason for yield reduction.

Biochemical parameters

The observations on biochemical characteristics of greengram were presented in Table 1. Among the treatments, foliar application of seaweed extract at 3% on 30 and 45 DAS (T_2) significantly enhanced grain nitrogen (2.17%) and protein content (13.56%) compared to the control (T_1), which recorded the lowest values (1.39% and 8.69%, respectively). The increase in grain nitrogen content contributed directly to the rise in protein content, as these parameters are closely interrelated. The foliar application of seaweed extract in combination with the recommended dose of fertilizers (RDF) enhanced grain nitrogen uptake and protein content. This improvement may be attributed to the increased availability and absorption of essential inorganic elements such as Ca, Na, K, Mg, N, and Zn present in the seaweed extract. These findings are in agreement with the earlier report by Raverkar *et al*. (2016) [16].

Nutrient uptake (kg ha^{-1})

The result presented in Table 2, shows that foliar application of various biostimulants positively influenced nutrient uptake. All treatments recorded higher NPK uptake compared to the control. The highest uptake of nitrogen (44.62 kg ha^{-1}), phosphorus (12.46 kg ha^{-1}), and potassium (48.97 kg ha^{-1}) was observed in T_2 (Seaweed extract at 3% on 30 and 45 DAS), followed by T_8. The lowest nutrient uptake (N: 28.08, P: 6.38, and K: 31.62 kg ha^{-1}) was recorded in the control (T_1). The increased nutrient uptake was primarily attributed to efficient absorption through foliar application, which minimizes nutrient losses, along with enhanced root nodule activity that facilitates atmospheric nitrogen fixation, thereby improving soil nutrient status. These findings are consistent with the results reported by Aslam *et al.* (2019) [2] and Chaudhary *et al.* (2021) [3]. Seaweed extract, being a rich source of potassium, plays a key role in regulating plant water status, stomatal function, and photosynthesis. It also supports meristematic activity, translocation of photosynthates, and disease resistance. Moreover, the manganese content in seaweed extract supports nitrogen fixation in legumes, as Mn is a key component of cation-activated enzymes such as decarboxylases, kinases, and oxidases, which are crucial for chlorophyll synthesis, nitrate reduction, and respiration. Due to its rich composition, including macro- and micronutrients, phytohormones, amino acids, vitamins, and bioactive compounds, liquid seaweed extract promotes root development, biomass accumulation, plant growth, flowering, assimilate partitioning, and pod formation, while also mitigating chlorophyll degradation and disease incidence. These effects collectively contribute to improved nutrient uptake and crop performance. These findings are in agreement with the results reported by Raverkar *et al*. (2016) [16].

Economics

The adoption of modern agricultural technologies is feasible and acceptable to farmers only when economically viable. The treatment-wise cost of cultivation and benefit-cost (B:C) ratio was depicted in Table 3. The economic analysis showed that the highest net return of Rs. 36,281 ha^{-1} was obtained from treatment T_2 (Foliar application of seaweed extract at 3% on 30 and 45 DAS) which also recorded the highest benefit cost (B/C) ratio of 2.27. The high profitability observed in T_2 was attributed to the highest seed yield (699 kg ha^{-1}), achieved with a cultivation cost of ₹28,605 ha^{-1}. This may be due to favorable variations in both cost of cultivation and net returns. The increased yield likely resulted from greater biomass accumulation and efficient nutrient translocation to the reproductive organs, leading to higher net returns and an improved benefit-cost ratio (BCR). Results in these lines were reported by Layek *et al.* (2018) [13]. Foliar application of seaweed extract resulted in the highest net returns and benefit-cost ratio compared to the use of conventional fertilizers alone. Variations in BCR were primarily due to differences in yield and input costs across treatments. The integration of seaweed extract with conventional fertilizers proved to be more economically beneficial. Similar findings were reported by Manjhi *et al.* (2020) [15].

Table 1: Impact of foliar application of biostimulants on yield (kg ha^{-1}) and biochemical parameters of greengram

Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Seed nitrogen (%)	Crude protein (%)
T_1 - Control (No Spray)	340	1015	2.17	13.56
T_2 - Foliar application of seaweed extract at 3% on 30 and 45 DAS	699	1976	3.90	24.38
T_3 - Foliar application of fish amino acid at 1% on 30 and 45 DAS	493	1419	2.69	16.81
T_4 - Foliar application of PPFM at 1% on 30 and 45 DAS	410	1220	2.47	15.44
T_5 - Foliar application of jeevamrutham at 3% on 30 and 45 DAS	539	1545	2.93	18.31
T_6 - Foliar application of panchagavya at 3% on 30 and 45 DAS	544	1559	3.00	18.75
T_7 - Foliar application of vermiwash at 5% on 30 and 45 DAS	588	1678	3.28	20.50
T_8 - Foliar application of humic acid at 3% on 30 and 45 DAS	657	1855	3.55	22.19
S. Ed	17.83	50.60	0.06	0.47
CD (p=0.05)	38.25	108.53	0.14	1.01

Table 2: Impact of foliar application of biostimulants on the nutrient uptake (N, P, and K) (kg ha^{-1}) of greengram

Treatments	Nutrient uptake (kg ha^{-1})		
	N	P	K
T_1 - Control (No Spray)	28.08	6.38	31.62
T_2 - Foliar application of seaweed extract at 3% on 30 and 45 DAS	44.62	12.46	48.97
T_3 - Foliar application of fish amino acid at 1% on 30 and 45 DAS	33.82	8.15	37.10
T_4 - Foliar application of PPFM at 1% on 30 and 45 DAS	30.68	7.40	34.41
T_5 - Foliar application of jeevamrutham at 3% on 30 and 45 DAS	36.41	8.93	39.87
T_6 - Foliar application of panchagavya at 3% on 30 and 45 DAS	37.24	9.04	40.72
T_7 - Foliar application of vermiwash at 5% on 30 and 45 DAS	39.79	9.85	43.47
T_8 - Foliar application of humic acid at 3% on 30 and 45 DAS	42.23	10.96	46.17
S. Ed	0.94	0.34	1.18
CD (p=0.05)	2.03	0.74	2.53

Table 3: Impact of foliar application of biostimulants on on economic analysis of greengram

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	BCR
T_1 - Control (No Spray)	23305	31615	8310	1.36
T_2 - Foliar application of seaweed extract at 3% on 30 and 45 DAS	28605	64886	36281	2.27
T_3 - Foliar application of fish amino acid at 1% on 30 and 45 DAS	25585	45789	20204	1.79
T_4 - Foliar application of PPFM at 1% on 30 and 45 DAS	27605	38120	10515	1.38
T_5 - Foliar application of jeevamrutham at 3% on 30 and 45 DAS	26205	50055	23850	1.91
T_6 - Foliar application of panchagavya at 3% on 30 and 45 DAS	26205	50519	24314	1.93
T_7 - Foliar application of vermiwash at 5% on 30 and 45 DAS	27605	54598	26993	1.98
T_8 - Foliar application of humic acid at 3% on 30 and 45 DAS	28605	60995	32540	2.14

Conclusion
The results of the study suggest that foliar nutrition of seaweed extract at 3% on 30 and 45 DAS can be recommended as a cost-effective nutrient management strategy for achieving sustainable yield, enhanced quality, improved profitability, and better soil health in greengram cultivation.

References

1. Ali O, Ramsubhag A, Jayaraman J. Biostimulant properties of seaweed extracts in plants: Implications towards sustainable crop production. Plants. 2021;10(3):531.
2. Aslam M, Nagavani AV, Subramanyam D, Murthy BR. Influence of foliar nutrients and biostimulants on growth, yield attributes, and yield of greengram (*Vigna radiata* L.). Int J Curr Microbiol Appl Sci. 2019;8(6):2540-2545.
3. Chaudhary MG, Malav JK, Vala YB, Desai NA. Influences of different organic sources and seaweed extract on quality, nutrient content, uptake, soil fertility status, and soil microbial population after harvest of summer greengram (*Vigna radiata* L.). J Pharmacogn Phytochem. 2021;10:1390-1394.
4. Choudhary GL, Sharma SK, Choudhary S, Singh KP, Kaushik MK, Bazaya BR. Effect of panchagavya on quality, nutrient content, and nutrient uptake of organic blackgram (*Vigna mungo* (L.) Hepper). J Pharmacogn Phytochem. 2017;6(5):1572-1575.
5. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. New York: John Wiley and Sons; 1984. p. 1-680.
6. Humphries EC. Mineral components and ash analysis. In: Paech K, Tracey MV, editors. Modern Methods of Plant Analysis. Vol. 1. Berlin: Springer-Verlag; 1956. p. 468-502.
7. Hussein MH, Eltanahy E, Al Bakry AF, Elsafty N, Elshamy MM. Seaweed extracts as prospective plant growth bio-stimulant and salinity stress alleviator for Vigna sinensis and Zea mays. J Appl Phycol. 2021;33:1273-1291.
8. Jackson ML. Soil chemical analysis. 2nd Indian reprint. New Delhi: Prentice Hall of India Pvt. Ltd.; 1973. p. 1-41.
9. Karthik T, Jayasri MA. Systematic study on the effect of seaweed fertilizer on the growth and yield of *Vigna radiata* (L.) R. Wilczek (mung bean). J Agric Food Res. 2023;14:100748.
10. Kiritkumar PR. Response of blackgram (*Vigna mungo* (L.) Hepper) to foliar nutrients and biostimulants. Junagadh: Junagadh Agricultural University; 2019.
11. Krishnaveni SA, Supriya C, Sridhar SM. Impact of foliar nutrition on the yield and economics of greengram (*Vigna radiata*). Int J Chem Stud. 2021;9(2):11-13.
12. Kumar AT, Somasundaram E, Thavaprakaash N. Influence of various organic nutrient sources on dry matter partitioning and physiological parameters of vegetable cluster bean (*Cyamopsis tetragonoloba* (L.) Taub.). Biol Forum Int J. 2022;14(2):1575-1579.
13. Layek J, Das A, Idapuganti RG, Sarkar D, Ghosh A, Zodape ST, *et al*. Seaweed extract as organic bio-stimulant improves productivity and quality of rice in eastern Himalayas. J Appl Phycol. 2018;30:547-558.
14. Lucini L, Miras-Moreno B, Ertani A, Schiavon M, Nardi S, Michalak I, *et al*. Biostimulants for sustainable crop production. Sawston, Cambridge (UK): Burleigh Dodds Science Publishing; 2020.
15. Manjhi K, Masram P, Kushwaha HS, Singh D. Effect of foliar nutrition on yield and economics of mungbean (*Vigna radiata* (L.) Wilczek). J Food Legumes. 2020;33(3):160-163.
16. Raverkar KP, Pareek N, Chandra R, Chauhan S, Zodape ST, Ghosh A. Impact of foliar application of seaweed saps on yield, nodulation and nutritional quality in greengram (*Vigna radiata* L.). Legume Res Int J. 2016;39(2):315-318.
17. Sible CN, Seebauer JR, Below FE. Plant biostimulants: A categorical review, their implications for row crop production, and relation to soil health indicators. Agronomy. 2021;11(7):1297.
18. Yakhin OI, Lubyanov AA, Yakhin IA, Brown PH. Biostimulants in plant science: A global perspective. Front Plant Sci. 2017;7:2049.
19. Yoshida S, Forno DA, Cock JH, Gomez KA. Laboratory manual for physiological studies of rice. 3rd ed. Los Baños, Philippines: International Rice Research Institute; 1976. p. 7-76.