iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** XI **Month of publication:** November 2025

DOI: https://doi.org/10.22214/ijraset.2025.75744

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XI Nov 2025- Available at www.ijraset.com

Study on the Effects of Sea Weed Liquid Fertilizer *Caulerpa racemosa* on the Germination and Growth of *Vigna unguiculata subsp. sesquipedalis*

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Abstract: ***Seaweeds are good marine resources that have been known to have agricultural uses especially as natural biostimulants in the form of Seaweed Liquid Fertilizers (SLF). The current paper examines the impact of SLF extract of a green alga, Caulerpa racemosa on germination and early growth of Vigna unguiculata subsp. sesquipedalis (asparagus bean). The extraction of SFL was done under the standard procedures and five percentages (1, 2, 3, 4, and 5) of SFL was applied to certified seeds in the presence of distilled water that acted as the control. It was measured in terms of germination percentage, radicle and hypocotyl length, seedling length, vigor index, growth index, phytotoxicity, phytomass and productivity at 15 days period. The findings indicated that the seeds with lower or moderate concentration of SLF especially 2% 3% and 5% had higher germination (up to 100 percent), radicle length (maximum 3.9 cm at 3 percent) and seedling vigor and growth index, of which the treatment at 3 percent had the greatest overall change. By comparison, the 4% concentration produced low germination and growth parameters. The seedlings that were treated with 3 percent SLF had the highest phytomass and productivity. In general, the results suggest that C. racemosa-based SLF in the optimal level can be successfully used to induce germination and early seedling growth in asparagus bean, which evidences the potential of this substance as an alternative to chemical fertilizers in cultivating legumes.***

Keywords: Caulerpa racemosa, Seaweed Liquid Fertilizer (SLF), Vigna unguiculata subsp. sesquipedalis

I. INTRODUCTION

Modern agriculture has depended on the use of synthetic chemical fertilizers which has allowed agricultural products to multiply in the world, but at a very high price in terms of environmental costs. The pervasive and chronic use of chemical fertilizers is known to cause soil erosion, pollution of freshwater by nutrient runoff and increase in greenhouse gas emissions. The agricultural industry is also responding to these alarming environmental issues by actively seeking more sustainable and greener alternatives to the conventional synthetic inputs. Of all these options, biostimulants are some of the most promising as they are natural products that make plants grow and resilient to stress when applied with low doses. The seaweed extracts have proven to be a very useful category of biostimulants and have been utilized in the coastal agriculture since a long time. These sea macro algae are a good renewable resource, with a wide range of bioactive compounds, such as macro and micro nutrients, amino acids, vitamins, as well as plant growth hormones including auxins, cytokinins, and gibberellins. The carbohydrate and other organic matter which are seen in seaweeds modify the nature of soil and enhance the ability to withhold moisture. It is known that seaweed concentrates bring about numerous positive effects on plants since they include growth promoting hormones (IAA as well as IBA), trace elements (Fe, Cu, Zn, Co, Mo, Mn and Ni), Vitamins and protein (Challen and Hemingway, 1965). Extracts of seaweeds are also liquid extracts, which are effectively applied in the foliage of various crops as foliar sprays (Bokil et al., 1974). It is also found out that the fertilizers offered by seaweeds were not only valuable based on nitrogen, phosphorous and potash, but also based on the presence of trace elements and metabolites. Although many researchers have indicated the overall growth-stimulating properties of seaweed liquid fertilizers in a wide range of crops, there is a significant gap in knowledge in regards to the most appropriate formulation and application plan in individual crop species. There is also a large variation in efficacy of SLF, based on the seaweed species employed, mode of extraction, concentration applied and the physiological stage of crop. Indicatively, other studies have indicated that using enzymatic extraction techniques might produce good results when compared to the simple aqueous methods.

Moreover, how exactly the particular bioactive substances in various SLF formulations influence plant physiology and the soil microbiology is the subject of additional research. The purpose of the study is to examine the impact of a liquid extract made of the algae species *Caulerpa racemosa* on the growth, yield, and nutrient uptake of *Vigna unguiculata subsp. sesquipedalis.* The certain aims of the research include the establishment of the optimum level of *Caulerpa racemosa* liquid fertilizer to achieve the maximum crop yield and the examination of the respective alterations in the biochemical elements of the vegetable and the health parameters of the soil. We will use our results to compare with known findings on other species of seaweeds to achieve new information on the biostimulant potential of *Caulerpa racemosa* and assist in the creation of more effective and sustainable fertilization methods of legume plants.

II. MATERIALS AND METHODS

The seaweeds used in this study were *Caulerpa racemosa.* They were collected from the coastal area of Thikkodi in Kozhikode district. The sample was washed thoroughly with sea water to remove all the unwanted impurities, adhering sand particles and epiphytes. They were taken in polythene bags, kept inside an ice box and transported to the laboratory. Sample was washed thoroughly using tap water to remove surface salt and spread on blotting paper to remove excess water.

A. Asparagus Bean

Vigna unguiculata subsp. sesquipedalis is a legume cultivated to be eaten as green pods. It is known as the yard long bean, bora, bodi, long podded cow pea, asparagus bean, pea bean, snake bean or Chinese long bean. Yardlong beans are one of the ancient cultivated crops, the pods contain large quantities of soluble and in soluble fibres. Fresh Asparagus beans are one of the finest sources of folates.

B. Preparation of SLF

SLF was prepared by following the method of Thirumaran *et.al* (2007). One kg of sea weed was cut into small pieces powdered well and auto calved for one hour. The hot extract filtered through a double layered cloth and allows cooling at room temperature. The filtrate was then centrifuged for 30 minutes. The resultant supernatant was taken as 100 % sea weed extract. By using this extract different solutions with concentrations of 1 %, 2%, 3%, 4% and 5% are prepared.

The crop selected for the present day study was ASPARAGUS BEAN (*Vigna unguiculata subsps. sesquipedalis*) which is a tropical legume plant. The seed for this study were collected from home garden. Seeds with uniform size, colour and weight were chosen for experimental purpose.

A total of 180 seeds were selected to conduct the experiment. Seeds were placed in various petridishes, each with 10 seeds. Each treatment was given triplicate as a standard procedure to minimize error. One sample is watered regularly with distilled water and considered it as control (T0). Other samples were treated with 1% (T1), 2% (T2),3% (T3), 4% (T4) and 5% (T5) concentrations of sea weed liquid fertilizer prepared from *Caulerpa racemosa*. Germination percentage were recorded on 5th day, 10th day and 15th day of the experiment other growth parameters such as vigor index , growth index, phytotoxicity and productivity are calculated based on Erulan et.al (2009).

III. RESULT AND DISCUSSION

Table 1: Effect of SLF on 15th day (C.*racemosa*)

	Radicle length (cm)	Hypocotyl length (cm)	Seedling (cm)	Germination (%)	Phytotoxicity	Growth index	Vigor index
T0	1.5	0.7	2.2	60%	-	1	1.32
T1	1.9	1.1	3	80%	-26.7	1.36	2.4
T2	3.9	0.9	4.8	100%	-160	2.18	4.8
T3	1.8	3.6	5.4	100%	-20	2.45	5.4
T4	1.6	0.1	1.7	40%	-6.7	0.77	0.68
T5	1.2	0.8	2.8	100%	20	1.27	2.8

Table 1 shows the various aspects when treated with C.*racemosa* on fifteenth day.

Vigna unguiculata ssp. sesquipedalis seeds soaked with 2%, 3% and 5% concentration of seaweed extract shows higher rates of germination. 4% concentration shows the lowest germination.

Highest recorded radical length (3.9 cm) is shown in 2% concentration. Least radical length was shown while treated with 5% concentration. The hypocotyl length is varied in treatment of all concentrations. Highest record of hypocotyls length (3.6 cm) and the lowest record (0.1 cm) are seen in T3 and T4 respectively.

The seedling length is observed to be highest in T3 concentration i.e. 5.4 cm and least in T1 concentration. In T2, T3 and T5 concentration 100% germination could be observed.

Growth index was observed to be highest in T3 concentration i.e. 2.6 cm and lowest in T4 concentration and the vigor index is the highest in T3 concentration i.e. 5.4 cm. Comparison between *C.racemosa* and *C.taxifolia* on *Vigna unguiculata ssp. sesquipedalis* showed that maximum radical length, seedling length, growth index, germination percentage and vigor index were observed for *C.racemosa*(Abhilash et al., 2025).

Table 2: Fresh weight and dry weight of Asparagus bean (C.*racemosa*)

	Fresh weight (gm)	Dry weight (gm)
1	0.335	0.024
2	0.139	0.028
3	0.131	0.026
4	0.432	0.031
5	0.173	0.021
6	0.387	0.035

Table 3: Phytomass and productivity (C.*racemosa*)

	Phytomass (gm)	Productivity
T0	0.311	0.0194
T1	0.111	0.0100
T2	0.105	0.007
T3	0.401	0.0308
T4	0.152	0.0084
T5	0.352	0.0207

As far as phytomass is concerned 3% SLF treated *Vigna unguiculata ssp. sesquipedalis* yield phytomass of 0.401gm. It can also be observed that T1, T2 and T4 does not shows much difference if phytomass. Meanwhile T5 shows phytomass of 0.352gm (Table-3).

The maximum productivity was observed for T3 treatment. The productivity of non SLF treated *Vigna unguiculata ssp. sesquipedalis*T2 seedling showed least productivity. The treatments T2 and T4 have showed more or less similar in their productivity. In the current experiment, the biostimulant property of Seaweed Liquid Fertilizer (SLF) of *Caulerpa racemosa* was tested on the germination and early growth parameters of *Vigna unguiculata subsp. sesquipedalis.* The results indicate clearly that, SLF treatment especially at lower levels of 2 and 3 percent has had a tremendous impact on seed germination, root and shoot growth, vigor index, and performance of seedlings in general as compared to the untreated control.

The good response had at the lower concentrations harmonizes with the previous studies that showed that seaweed extracts have physiologically active compounds like auxins, cytokinins, gibberellins, vitamins, amino acids, and micronutrients which promote the growth and activity of seedlings (Challen and Hemingway, 1965; Verkleij, 1992). The improved radicle and hypocotyl growth in the 2 and 3 percentages indicate that the bioactive constituents of *C. racemosa* hasten the cell division and growth in cellular length, which confirm the same results of the same in the *Vigna* species treated with *Sargassum, Ulva* and other seaweed extracts (Sivasankari et al., 2006; Anantharaj and Venkatesalu, 2001).

The 3 percent SLF concentration proved to be the most effective as it had the greatest seedling length, vigor index, phytomass and the productivity. Such gains can be attributed to better nutrient absorption and better physiological performance cited in research on seaweed treated soybean, onion, brinjal and okra (Rathore et al., 2009; Sankar et al., 2001; Zodape et al., 2008). Betaines, and natural growth-promoting hormones present in the seaweed extracts were likely responsible in the improved moisture retention and metabolic activity promotion in the seedlings treated (Whapham et al., 1993).

The lower germination and growth rate at 4% concentration, though, indicate that there is a limiting concentration beyond which the extract is deemed to be inhibitory. The high concentration could cause osmotic stress or excessive build up of some minerals as such, inhibiting the normal development of seedlings. *Asparagopsis*, *Ulva*, and *Dictyota* extracts have also been reported to inhibit several leguminous crops with similar inhibitory effects at a higher concentration (Bai et al., 2007; Divya et al., 2015).

The 5 percent concentration, although with 100 percent germination, was not found to always increase growth parameters which shows that germination stimulation and seedling growth may be more responsive to SLF concentration. This also points to the need to optimize prior to field use.

On the whole, the findings justify the increasing awareness of seaweed extracts as effective organic biostimulants that can be used to enhance early plant establishment. The better performance of *C. racemosa* SLF over other species pervious reported in the previous research (Abhilash et al., 2025; Chitra and Sreeja, 2013) shows that it is likely to be useful in sustainable farming activities. The work in the future should involve long-term field experiments, nutrient absorption kinetics, biochemical characterization, and effects of soil health to confirm its extended usefulness in the cultivation of legumes.

IV. SUMMARY AND CONCLUSION

In the current experiment, the Seaweed Liquid Fertilizer (SLF) that has been made using the green alga *Caulerpa racemosa* is tested to determine its effects on the germination and the initial growth of *Vigna unguiculata subsp. sesquipedalis* (asparagus bean). SLF (1percent, 2percent, 3percent, 4percent, and 5percent) was sprayed on pre-soaked seeds and compared to distilled-water control. The main growth parameters such as the percentage of germination, radicle and hypocotyl length, seedling length, the index of vigor, the index of growth, phytotoxicity, fresh and dry weight, phytomass and productivity, were measured in 15 days.

The findings showed that the low to moderate levels of *C. racemosa* SLF had a significant positive effect on seed germination and seedling vigor. The 2 and 3 percent treatments gave the greatest improvements with 100 percent germination and increased growth between the radicle and seedlings than the control. The 3% SLF treatment had also the highest growth and vigor indices and also showed maximum phytomass and productivity. On the other hand, the lowest germination and growth response was achieved with the 4% concentration and this is an indication of potential inhibitory effect at high doses. The results validate the biostimulant activity of *C. racemosa* extract and are consistent with previous research on seaweed extracts in the leguminous crops in terms of fertilizer.

In this study, it was easily observed that Seaweed Liquid Fertilizer made of *Caulerpa racemosa* could successfully improve the germination and seedling growth of *Vigna unguiculata subsp. sesquipedalis* at a reasonable level of application. The 2 and 3 percent SLF treatments showed specific success, and more germination rates, growth in roots and shoots, and seedling vigor were observed than that of control. The concentration that will produce the maximum phytomass and productivity is 3%.

C. racemosa SLF can provide a viable natural substitute to chemical-based fertilizers because of the current demand of eco-friendly and sustainable agricultural inputs worldwide. Its use can be used to alleviate the environmental load caused by synthetic nutrients and also enhance healthy growth of crops. The researchers indicate that fertilizers made using *C. racemosa* can be used safely to improve the early vegetative growth in asparagus bean and hopefully other leguminous crops but further research is necessary to examine the field level productivity and soil-health effects.

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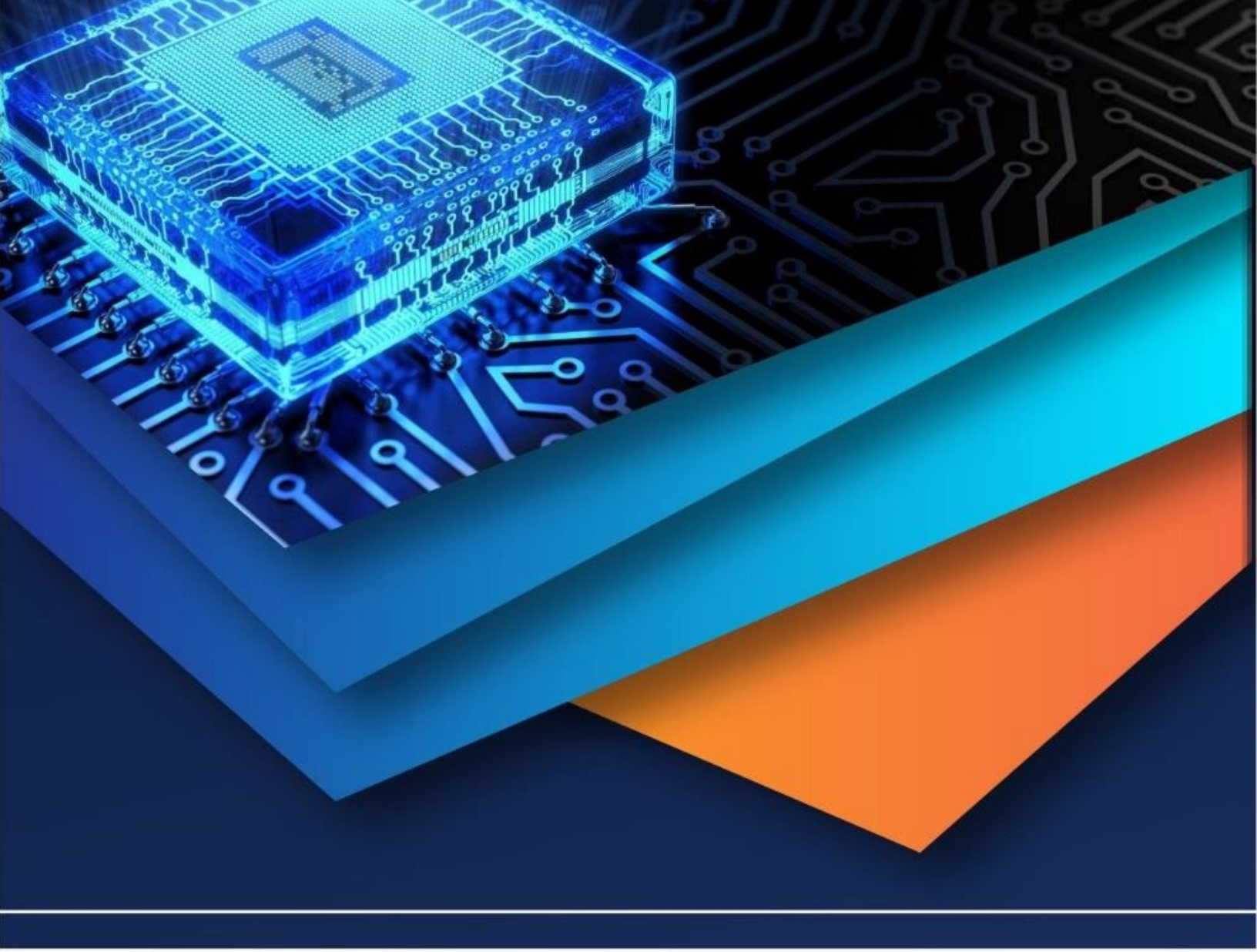

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