Journal of Phytology 2010, 2(5): 50–63
Phycology

ISSN: 2075-6240
Available Online: www.journal-phytology.com

REGULAR ARTICLE

INFLUENCE OF SEAWEED LIQUID FERTILIZER ON THE GROWTH AND BIOCHEMICAL COMPOSITION OF LEGUME CROP, *Cajanus cajan* (L.) Mill sp.

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SUMMARY

Seaweed or benthic marine algae are the group of plants that live either in marine or brackish water environment. Like the land plants seaweed contains photosynthetic pigments and with the help of sunlight and nutrient present in the seawater, they photosynthesize and produce food. Seaweeds are found in the coastal region between high tide to low tide and in the sub-tidal region up to a depth where 0.01 % photosynthetic light is available. The application of seaweed fertilizer for different crop was of great importance to substitute the commercial chemical fertilizers and to reduce the cost of production. Liquid fertilizers derived from seaweeds are found to be superior to chemical fertilizers due to high level of organic matter, micro and macro elements, vitamins and fatty acids and also rich in growth regulators. In the present study the effect of seaweed liquid fertilizer prepared from different seaweeds *Grateloupia lithophila* (Red algae), *Chaetomorpha linum* (Green Algae), *Sargassum wightii* (Brown algae) at different concentrations (10%, 20%, 30%, 40%, 50%, 100%) on the plant *Cajanus cajan* were studied. At 30% concentration the SLF prepared from *Chaetomorpha linum* showed maximum growth parameters on *Cajanus cajan*. Similarly SLF of *Sargassum wightii* promoted maximum photosynthetic pigments and biochemical parameters at 20% concentration than the control. Among the three seaweeds used *Sargassum wightii* and *Chaetomorpha linum* showed better results than the *Grateloupia lithophila* at lower concentration. (SLF- Seaweed Liquid Fertilizer).

B. Sathya et al. Influence of Seaweed Liquid Fertilizer on the Growth and Biochemical Composition of Legume Crop, *Cajanus cajan* (L.) Millsp. J Phytol 2/5 (2010) 51-63.
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1. Introduction

Seaweeds are the macroscopic marine algae found attached to the bottom in relatively shallow coastal water. They grow in the intertidal, shallow and deep sea areas upto 180 meter depth and also in estuaries and backwaters on the solid substrate such as rocks, dead corals and pebbles. The seaweeds are totally different from higher plants as they neither have true leaves, stems and roots nor vascular systems with specialized organs. Seaweeds are classified into three groups namely green (Chlorophyceae), brown (Phaeophyceae), red (Rhodophyceae) based on their pigments like chlorophylls, carotenoids and phycobilins. Seaweeds are one of the most important marine resources of the world and being used as human food, animal feed and raw material for many industries. Seaweeds are rich in minerals, protein, lipid, carbohydrate, vitamins, bromine, iodine etc. So algae have been harvested by man for centuries particularly in China and Japan where they form a part of the staple food. Seaweeds have been used as manure, cattle feed, food for human consumption and as a source of phycocolloids such as agar, alginic acid and carrageenan (Chapman, 1970).

Seaweed fertilizer is a natural bioactive material, water soluble derived from marine macro algae. Seaweed extract is a new generation of natural organic fertilizers containing highly effective, nutritious and promotes faster generation of seeds and increase yield and resistant ability of many crops. Seaweed fertilizer could be absorbed by plant within several hours after application and safe to human, animals and environment. The growing agricultural practices need more fertilizers for higher yield to satisfy food for human beings. The seaweed extracts contain plant growth hormones, regulators, promoters, carbohydrates, amino acids, antibiotics, auxins, gibberellins and vitamins consequently which enhance the yield and quality which are induce the yield of crops, seed germination, resistance to frost, fungal and insect attacks (Erulan *et al*., 2009). An adequate amount of potassium, nitrogen, growth promoting hormones, micronutrients, humic acid etc. present in seaweeds make it an excellent fertilizer. Fertilizers derived from seaweeds (*Fucus, Laminaria, Ascophyllum* and *Sargassum*) are biodegradable, nontoxic, nonpolluting and non hazardous to human, animals and birds. Chemical fertilizers have degraded the fertility of the soil by making it acidic, rendering it unsuitable for raising crops. Seaweed manure besides increasing the soil fertility increases the moisture holding capacity and supplies adequate trace elements thereby improving the soil structure (Dhargalkar and Neelam Pereira, 2005). Recently adopted technique, of spraying fertilizer on the plants has increased nutrient absorption in the plants. Leaves absorb nutrient within 10 to 15 minutes of its application. Many brands of seaweed liquid fertilizers like Maxicrop (UK), Kelpak 66 (South Africa), Seagrow (New Zealand), Algifert (Norway), plantozyme, Shaaktizyme (India) etc are available in the market. The diluted extract when sprayed on plants, increase in rate of growth, resistance to pests, higher yield of 25 to 30% etc., Experiments on the use of seaweeds as manure have been carried out by Thivy (1960), who showed higher rate of growth and higher yield in crop plants. Bhosle *et al*., (1975) prepared a Seaweed liquid fertilizer and studied its effects on *Phaseolus vulgaris*. Rama rao (1979) reported good yields of *Zizyphus rugosa* fruits, where leaf spray of SLF obtained from *Sargassum* was used. Seaweed manures have the advantage of being free from weeds and pathogenic fungi. Seaweeds are known to contain appreciable quantities of plant growth regulators (Mooney and Van Staden, 1985), IAA (Abe *et al.,* 1972), gibberellins and gibberellin like substance (Radley, 1961; Sekar *et al.,* 1995). Hence marine algae, particularly seaweeds have vital role to play in agriculture, especially in third world country where irrational use of chemical fertilizer and pesticides is a cause of concern. Main seaweed extract known to play useful role in agriculture are Maxicrop, Algifert, Germar GA14, Kelpak 66, Seaspray, Seasol, S.M.3, Seacrop16, Citex[10], Cytokin[11], Algistim[12] , Biozyme, Ujazyme, Agrimore[13], Seamac and Alginex[14], and MAC[8]. Application of seaweed extract as an organic biostimulant is fast becoming unaccepted practice in horticulture (Turan & Kose, 2004). Seaweed liquid fertilizer contained macronutrients, trace elements, organic substances like amino acids and plant growth regulators such as Auxin, Cytokinin and Gibberellins (Williams *et al*., 1981). The use of natural seaweed products as substitutes to the conventional synthetic fertilizers has assumed importance. In agriculture, the application of seaweeds are so many, as soil conditioners, fertilizers and green manure, due to the presence of high amount of potassium salts, micronutrients and growth substances. The present study is additional information for an alternate to synthetic fertilizers and further study is necessary to recompense the constraints. Seaweed liquid fertilizer contained macronutrients, trace elements, organic substances like amino acids and plant growth regulators such as auxin, cytokinin and gibberellins. They are particularly suitable content (Chapman and Chapman, 1980), it has been proved that SLF promoted, the growth and the yield of crop plants (Nelson and Van Staden, 1984; Rama Rao 1991; Rama Rao, 1992). The SLF obtained from brown, red and green seaweeds are now available commercially in trade names such as 'Maxicrop' (sea born), 'Algifert' (Manure), 'Golmar', 'GA 14', 'Kelpak 66', 'Seaspray', 'Seasol', 'SM3', 'Cytex and Seacrop 16' for use in agriculture (Jeanin *et al*., 1991). Beneficial effects from the use of seaweed extracts as natural regulators have included increased crop yield, delay of fruit senescence, improved overall plant vigour, improved yield quantity and quality, and improve ability to withstand adverse environmental conditions (Featonby-Smith and Van Staden, 1983). Application of seaweed extract as organic biostimulant is fast becoming accepted practice in horticulture due to its beneficial effects (Verkleij, 1992). Recent researches have proved that SLF is better than other chemical fertilizers (Rajkumar Immanuel and Subramanian, 1999). Seaweeds have recently gained importance as foliar sprays for several crops (Thivy, 1961; Metha *et al*., 1967; Bokil *et al*., 1974) because the extract contains growth promoting hormones (IAA and IBA), cytokinins, trace elements, vitamins and amino acids (Challen and Hemingway, 1965). Seaweed fertilizer was found to be superior to chemical fertilizer because to the high level of organic matter aids in retaining moisture and minerals in the upper soil level available to roots (Wallen Kemp, 1955).

The pulse crop take for this study is *Cajuns Cajan* (Pigeon pea) it is an important grain legume commonly grown and consumed in tropical and subtropical regions of the world. India accounts for over 80% of the world supply of pigeon pea [ICRISAT, 1986]. The pigeon pea is a perennial member of the family Fabaceae. Pigeon pea is a rich source of protein, carbohydrates and certain minerals. It is made of three anatomical structures; the seed coat, the cotyledons and the embryonic tissue. It is the major pulse crop of the semiarid tropics, has been used for centuries in intercropping systems, and is an ideal source of fodder, food and firewood in agro forestry systems.

Pigeon peas were reported to contain moisture, 15.2; protein, 22.3; fat (ether extract), 1.7; mineral matter, 3.6; carbohydrate, 57.2; Ca, 9.1; and P, 0.26%; carotene evaluated as vitamin A, 220 IU and vitamin B_1, 150 IU per 100 g. Sun-dried seeds of *Cajanus cajan* are reported to contain (per 100 g) 345 calories, 9.9% moisture, 19.5 g protein, 1.3 g fat, 65.5 g carbohydrate, 1.3 g fiber, 3.8 g ash, 161 mg Ca, 285 mg P, 15.0 mg Fe, 55 mg b-carotene equivalent, 0.72 mg thiamine, 0.14 mg riboflavin, and 2.9 mg niacin. (Duke, 1981).

The present study has been designed to evaluate the effect of seaweed liquid fertilizer on the growth, photosynthetic pigments and biochemical composition of *Cajanus cajan* (L.) Millsp. The Aim & Objective of the present study is:

❖ To prepare seaweed liquid fertilizer at different concentrations

❖ To treat the crop plant with different concentration of seaweed liquid fertilizer viz., 10%, 20%,

❖ To study the morphological characteristics like shoot length, root length, dry weight and fresh weight of the plants after seaweed liquid fertilizer treatment.

❖ To analyze the biochemical characteristics like lipid, protein, amino acid content of the plants after application of seaweed liquid fertilizer.

❖

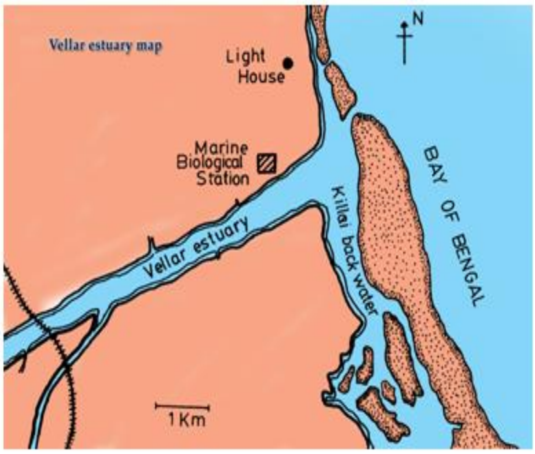
❖ To evaluate the pigment content (carotenoids, chlorophyll 'a', chlorophyll 'b' and total chlorophyll) of the plants after seaweed liquid fertilizer treatment.

2. Materials and Methods

Study area

The study area of the sample collection was Vellar estuary, Parangipettai. The Vellar estuary is located at Porto Novo (Lat.11°29; Long. 79°46' E). Having its origin in the Servarayan hills in Salem district in Tamil Nadu, South Arcot District for over distance of 480 km and drains into Bay of Bengal at Porto Novo.

Fig: 1. Map showing Vellar estuary



Seaweeds

The three seaweed species used in this study are ***Grateloupia lithophila*** **Boergesen,** ***Sargassum wightii*** **Greville,** ***Chaetomorpha linum*** **(Muller) Kutzing**

Collection of sample

Three seaweed samples (i) *Chaetomorpha linum (ii) Grateloupia lithophila (iii) Sargassum wightii* were collected from the vellar estuary, Parangipettai during the month of January 2010. The algal sample was hand picked and washed thoroughly with seawater to remove all the impurities, sand particles and epiphytes. It was kept in an ice box containing slush ice, transported to the laboratory and washed thoroughly using tap water to remove the salt on the surface of the sample. The water was drained off and the algal material was spread on blotting paper to remove excess water. They were shade dried. The dried seaweeds are finally pulverized in the commercial grinder and the powdered seaweed samples are used for further analysis.

Collection of seeds

The crop plant, selected for the present study was *Cajanus cajan* The seeds for the study purpose were collected from regional pulses research station, Tamilnadu agricultural University, Vamban, Pudukottai district, Tamilnadu, India. Healthy seeds free from visible infection with uniform size, colour and size were segregated and then stored in metal tin containers as suggested by Rao (1976) and used for experimental purpose.

Preparation of seaweed liquid fertilizer (SLF)

The seaweed liquid fertilizer was prepared by the method of Rama Rao (1990). The coarse powder of seaweeds was mixed with distilled water in the ratio of 1: 20 (W/V). It is then autoclaved at 121°C, 20 lbs for 20 minutes. The mixture was filtered through cheese cloth and the filtrate was collected at 4°C. The supernatant was centrifuged and dried on an oven at 60º C for 48 hours. Then 100% seaweed extract was collected using distilled water.

Seed soaking and plant culture

The seaweed liquid fertilizer was prepared with different doses viz., 10%, 20%, 30%, 40%, 50%, and 100%. Then the sowing seeds were soaked in particular doses of SLF for 12hrs. One batch of seeds was kept as control and treated with water. Then the seeds were sowed and observed for germination and early growth. In this experiment polythene bags were used for raising the crops which is filled with 5kg of the garden soil for plant culture. Ten seeds were sown at a depth of 1.5 cm in each bag. The polythene bags were labeled in particular doses and rearranged at regular intervals so as to ensure uniform environmental impact on the plants growth. The weeds were removed regularly and watering was done once in 2 days for the test plants.

Analysis

Plants from each treatment were randomly drawn for various analyses. Plants from the bags were uprooted carefully and washed in tap water. They were then processed for different analyses. All the parameters such as growth and biochemical characters were analyzed only at the end of 45 days after seed sowing. Triplicate samples were used for all the parameters and the mean values were presented.

Growth Parameters

Measurement of root length and shoot length

The shoot length was measured from the collar region to tip of the shoot and the root length was calculated from the collar region to tip of the primary root. The mean values were expressed in cm. (Erulan *et al*., 2009).

Measurement of fresh weight and dry weight

The uprooted plants were washed and separated into root and shoot; they were blotted in blotting paper and weighed. They were dried in a hot air oven at 80º C for 24 hours and then dry weight was taken by using an electrical single pan balance. The mean values were expressed in mg g^{-1}.fr.wt. (Erulan *et al*., 2009).

Photosynthetic pigments

Estimation of chlorophyll

Chlorophyll was estimated spectrophotometrically according to the method of Arnon (1949).

Estimation of carotenoids

Carotenoid content was estimated as described by Kirk and Allen, (1965). The same chlorophyll extract was measured at 480 nm in spectrophotometer to estimate the Carotenoid content. Carotenoid: µg/g.fr.wt. = ΔA.480 + (0.114 X ΔA. 663) – (0.638 X ΔA. 645). ΔA = Absorbance at respective wave length.

Estimation of total sugar

The total sugar content was estimated by Anthrone method (Roe, 1955).

Extraction and estimation of lipid

The lipid was estimated by using chloroform methanol mixture as described by Folch et al., (1956).

Extraction and estimation of total amino acids:

The total amino acid content of algal species was determined according to the method of Moore and Stein (1948).

Estimation of protein:

The protein was estimated by Biurette method (Raymont et al., 1964).

3. Results

Statistical analysis was calculated by one way ANOVA followed by Student's Newman Keul's test.

Growth parameters

Root length

The root length of the plants varied from 1.86±0.5 to 5.06±0.4 cm/seedlings. The maximum root length recorded was 5.06±0.4 cm/seedlings in the plants that received 30% SLF of *Chaetomorpha linum* (Green algae). The values of root length of the plants after the application of SLF is presented in the Fig. 2.

Shoot length

The shoot length of the plants varied from 11.25±1.8 to 13.1±1.7 cm/seedlings. The maximum shoot length noted was 13.1±1.7 in the plants that received 30% SLF of *Chaetomorpha linum*. The values of shoot length of the plants is depicted in Fig. 3.

Fresh weight

Fresh weight of the Cajanus cajan varied from 6.03±1.7 to 8.98±1.8 mg g^{-1}.fr.wt .The results of fresh weight of the plants is depicted in the Fig. 4.

Dry weight:

The dry weight of *Cajanus cajan* ranged from 0.262±6.0 to 0.459±9.0 mg g^{-1} .fr.wt. The results of the dry weight of the plants after the application of seaweed liquid fertilizer is depicted in the Fig. 5.

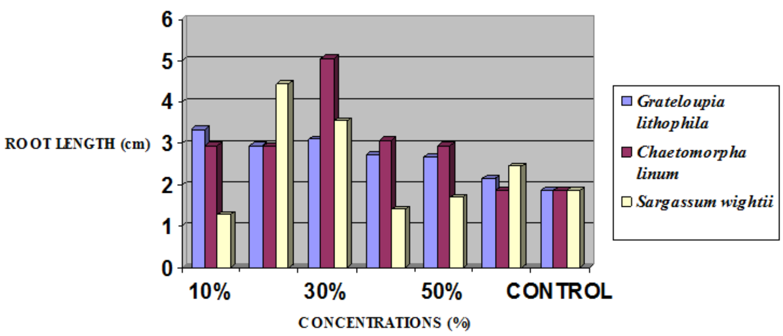


Figure 2. Root length of *Cajanus cajan*

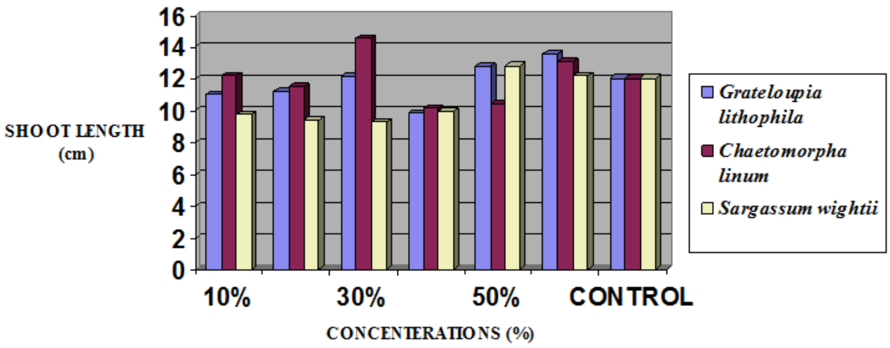


Figure 3. Shoot length of *Cajanus cajan*

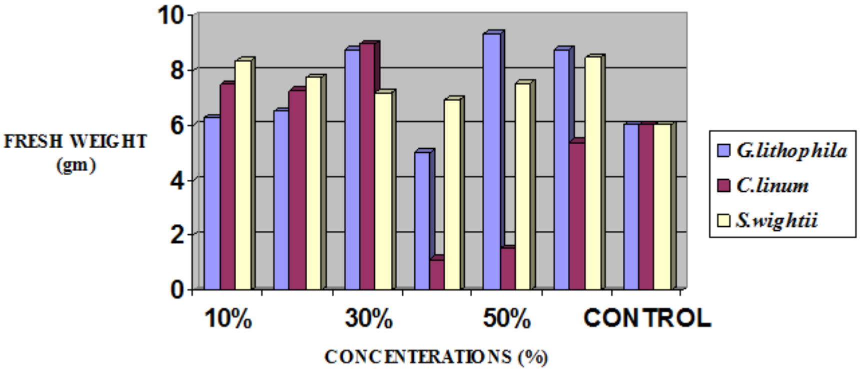


Figure 4. Fresh weight of *Cajanus cajan*

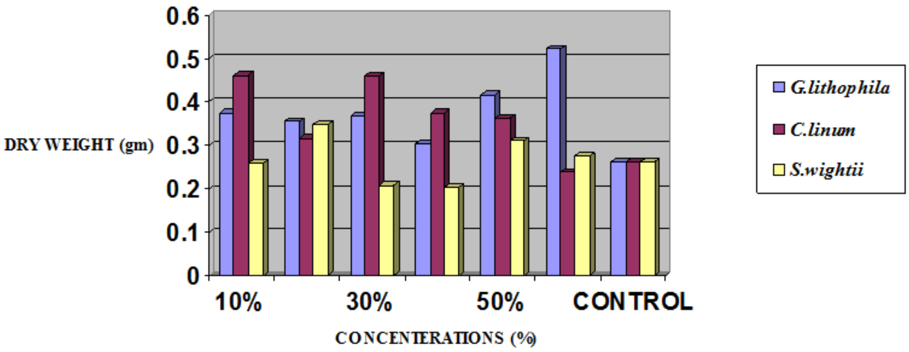


Figure 5. Dry weight of *Cajanus cajan*

Photosynthetic pigments

The photosynthetic pigments like chlorophyll 'a', chlorophyll 'b', total chlorophyll and carotenoid content of *Cajanus cajan* after the application of SLF of *Grateloupia lithophila*, *Chaetomorpha linum* and *Sargassum wightii* were estimated and presented in the table 1, 2, 3 and 4. The maximum chlorophyll 'a' (19.17±1.00) and chlorophyll 'b' (14.74±2.51) and carotenoid (0.80±3.51) and total chlorophyll (966.95±1.52) was recorded in the plants that was treated with 20% SLF of *Sargassum wightii*.

Table 1. Chlorophyll content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	16.27±3.0	15.95±2.0	7.97±2.0	6.61±2.0	4.73±2.0	4.27±1.5	7.45±2.0
C. linum	10.85±2.0	10.07±1.5	8.09±1.5	7.56±2.0	6.24±2.0	4.67±2.0	7.45±2.0
S. wightii	8.5±0.20	19.17±1.0	7.77±2.0	5.03±1.5	3.87±2.0	1.58±2.0	7.45±2.0

Table 2 Chlorophyll 'b' content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	5.46±0.2	8.49±2.0	4.87±2.0	3.55±2.0	3.25±2.0	1.96±1.5	6.70±1.0
C. linum	2.77±1.5	6.29±2.0	5.96±1.0	5.33±2.0	4.19±2.0	1.18±2.5	6.70±1.0
S. wightii	4.25±1.5	14.74±2.5	12.96±1.	10.73±2	6.40±0.2	0.57±0.2	6.70±1.0

Table 3. Total chlorophyll content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	0.54±1.5	0.48±2.0	0.43±2.0	0.36±2.0	31±2.0	0.16±1.5	0.26±1.5
C. linum	0.47±2.0	0.66±1.5	0.55±2.5	0.27±2.5	0.27±2.5	26±3.0	0.26±1.5
S. wightii	0.58±2.5	0.80±3.5	0.67±2.0	0.55±2.0	0.52±2.0	0.51±2.0	0.26±1.5

Table 4. Carotenoid content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	130.67±2.0	805.74±0.5	751.76±2.6	745.57±2.0	235.43±2.0	166.52±0.5	316.33±1.1
C. linum	611.07±1.5	570.73±2.0	480.37±1.5	395.97±2.5	393.95±1.5	331.67±1.5	316.33±1.1
S. wightii	233.17±2.0	966.95±1.5	628.67±2.0	414.10±1.5	357.86±1.5	207.05±1.5	316.33±1.1

Biochemical analysis

The biochemical parameters of the *Cajanus cajan* like protein, lipid, amino acid and total sugar content were analyzed and depicted in the Table 5, 6, 7 and 8.

Protein

The protein content ranged from 0.21±2.5 to 0.43±0.3 mg g^{-1} f. wt. The maximum protein content noted was 0.43±0.3 mg g^{-1} f. wt in the plants that received 20% seaweed liquid fertilizer of *Sargassum wightii* and the minimum protein content observed was 0.20±1.5 mg g^{-1} f. wt in the plants that received 20% seaweed liquid fertilizer of *Grateloupia lithophila* (Table 5).

Lipid:

The lipid content varied from 4.13±1.0 to 8.16±2.0 mg g^{-1} f. wt. The maximum lipid content recorded was 8.16±2.0 mg g^{-1} f. wt in the plants that was treated with 20% SLF of *Sargassum wightii* and the minimum lipid content observed was 2.61±1.0 mg g^{-1} f. wt in the plants that received 40% SLF of *Grateloupia lithophila* (Table 6).

Amino acid

The amino acid content of *Cajanus cajan* varied from 1.66±5.7 to 1.00 to 5.00±1.0 mg g^{-1} f. wt. The maximum value noted was 5.00±1.0 mg g^{-1} f. wt in the plants that received 20% SLF of *Sargassum wightii* and the minimum value recorded was 1.33±5.7 mg g^{-1} f. wt in the plants that were treated with 50% SLF of *Chaetomorpha linum* and 100% SLF of *Sargassum wightii* (Table 7).

Total sugar

The total sugar content ranged from 1.16±0.1 to 1.57±2.5 mg g^{-1} f. wt. The maximum value recorded was 1.57±2.5 mg g^{-1} f. wt in the plants that was treated with 20% SLF of *Sargassum wightii* and the minimum content was noted in the plants that were treated with 100% SLF of *Sargassum wightii* (Table8).

Table 5. Protein content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	0.22±3.6	0.28±1.5	0.26±3.0	0.23±2.6	0.21±2.5	0.20±1.5	0.21±2.5
C. linum	0.25±1.5	0.31±3.2	0.28±4.9	0.25±4.5	0.23±2.5	0.23±2.5	0.21±2.5
S. wightii	0.28±2.0	0.43±0.3	0.25±3.3	0.24±0.7	0.23±2.5	0.23±2.5	0.21±2.5

Table 6. Lipid content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	4.44±2.0	5.80±0.1	5.72±1.5	5.61±1.5	5.61±1.0	2.61±1.0	4.13±1.0
C. linum	2.65±1.5	6.43±2.0	4.38±1.5	4.28±1.5	3.60±2.0	3.42±1.0	4.13±1.0
S. wightii	5.33±1.5	8.16±2.0	6.11±1.5	5.55±5.5	5.51±1.5	5.16±1.5	4.13±1.0

Table 7. Amino acid content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	2.33±1.5	4.33±1.5	3.66±1.5	3.33±1.5	2.66±2.0	2.00±1.0	1.66±5.7
C. linum	2.00±2.0	3.66±1.5	3.33±2.0	1.33±5.7	1.33±5.7	1.33±5.7	1.66±5.7
S. wightii	3.00±2.6	5.00±1.0	2.66±2.08	2.33±2.30	2.00±1.0	1.33±5.7	1.66±5.7

Table 8. Total sugar content of *Cajanus cajan*

SEAWEED	10%	20%	30%	40%	50%	100%	Control
G. lithophila	0.22±1.5	0.44±2.0	0.33±1.0	0.27±2.0	0.26±2.5	0.24±1.5	1.16±0.1
C. linum	0.76±1.5	0.47±2.0	0.45±1.0	0.31±1.5	0.29±1.0	0.26±2.6	1.16±0.1
S. wightii	0.18±0.2	1.57±2.5	1.50±0.1	0.31±3.0	0.24±2.6	0.16±2.6	1.16±0.1

4. Discussion

Seaweeds are primitive non flowering plants without root, stem and leaves. They comprise one of the commercially important marine renewable resources. They contain different vitamins, minerals, trace elements, protein, iodine, bromine and bioactive substances. The utilization of seaweed in agriculture and horticulture has a long history. Ancient Greeks and Chinese applied seaweed mulches to the soil. Some of the commercially available liquid seaweed like Cytex, Geomar GA 14, Kelpak 66, Maxicrop sea crop 16, Seaspray, Seamac, and Seamagic-3 etc. Booth (1969) reported that the value of seaweeds as fertilizer is not from mineral contents but from their trace elements and the metabolites similar to cytokinin, auxin, gibberellins and other related growth hormones.

The *Cajanus cajan* seeds soaked in the lower concentrations of the seaweed liquid fertilizer of *Chaetomorpha linum* (30%) have attained maximum growth parameters (Root length, shoot length, fresh weight and dry weight) than the seeds that are soaked in the higher concentrations (100%). Vijayanand *et al*. (2004) reported that lower concentration of SLF from *Stoechospermum marginatum* promoted the growth of brinjal and Sivasankari *et al*. (2006a) also reported similar effect in Cowpea and Ramamoorthy and Sujatha (2007) reported linear growth of both root and shoot in black gram seeds. Thirumaran *et al*. (2006) reported with *Chaetomorpha antennina* and *Rosenvingea intricata* on the growth of *Abelmoschus esculentus* and *Raphanus sativus.*

Stephenson (1974) recorded that lower concentration of SLF prepared from Brown algae *Ascophyllum* and *Laminaria* accelerated the growth in maize. Similar results were recorded in *Padina*, which induced maximum growth in *Cajanus cajan* (Mohan *et al*., 1994). Dhargalkar and Untawale (1980) also reported similar findings with *Hypnea* *musciformis*, *Spatoglossum asperum*, *Stoechosperum marginatum* and *Sargassum* on the growth of green chilies, turnips and pineapples. The effect of Seaweed Liquid fertilizers (SLF) of *Caulerpa recemosa* and *Gracilaria edulis* on growth and biochemical constituents of *Vigna catajung* has been studied by Anandharaj and Venkatesalu (2001). The lowest concentration (10%) of aqueous extract promoted the seedling growth, fresh and dry weight in *Vigna catajung*. Foliar application of SLF at lower concentration was most effective compared to control and other concentrations of seaweed liquid fertilizer, which is in conformity with green gram and black gram (Mohan *et al*., 1994). Aitken & Senn (1965) and Abetz (1980) reported that SLF at very high concentrations retard plant growth may be due to very high salt index observed in seaweed extracts that may be affecting growth and yield.

The lower concentrations of the seaweed liquid fertilizer (20% *S. wightii*) promoted the maximum chlorophyll content of *Cajanus cajan* when compared to control. Higher concentrations decreased the chlorophyll content. A similar observation was made in *Scytonema* sp. (Venkataraman Kumar and Mohan, 1997a), *Vigna mungo* (Venkataraman Kumar and Mohan, 1997b) and in *Vigna sinensis* (Sivasankari *et al*., 2006b). The seaweed extract applied as foliar spray enhanced the leaf chlorophyll level in plants (Blunden *et al*., 1996). Similar results were also reported by Jothinayagi and Anbazhagan (2009). They studied the effect of *Sargassum wightii* on the growth of *Abelmoschus esculentus* and concluded that 20% SLF of *Sargassum wightii* is more effective than the control and 100% SLF of *Sargassum wightii*.

Thirumaran *et al*. (2009a) reported that the SLF treatment of *Sargassum wightii* increased total chlorophyll and carotenoids content of both the test plants at lower concentration (20%) of SLF with or without chemical fertilizer. Whapham *et al*. (1993) observed that the application of SLF of *Ascophyllum nodosum* increased the chlorophyll of Cucumber cotyledons and tomato plants.The seaweed liquid fertilizer (SLF) and seagrass liquid fertilizer (SGLF) not only promoted the seedling growth but also increased the chlorophyll 'a' and 'b' contents in the leaf up to 12 days of germination in *Zea mays* which was reported by Asir Selin Kumar *et al*. (2004).

The highest protein content was recorded at 20% (*S. wightii*) concentration of SLF soaked treatment in *Cajanus cajan*. Similar results were obtained in *Vigna sinensis* that was treated with *Sargassum wightii* (Sivasankari *et al*., 2006b) and they reported that 20% SLF is more effective than the control. The increase in the protein content at lower concentration of SLF might be due to absorption of most of the necessary elements by the seedlings (Kannan and Tamilselvan, 1990; Anantharaj and Venkatesalu, 2001). The results coincide with the *Abelmoschus esculentus* that received 20% SLF of *Sargassum wightii* by Jothinayagi and Anbazhagan (2009). Thirumaran *et al*. (2009a) Studied on the effect of *Chaetomorpha antennina* and *Rosenvingea intricata* on seed germination, fruit settling and weight of vegetable of *Abelmoschus esculentus*. They got better results at lower concentration than that of higher concentration. The growth rate was increased up to 0.50% concentration and thereafter it showed a decreasing trend. This result was coinciding with study of Bhosle *et al*., (1975).They showed better growth when *S. tenerrimum* extract was used especially in lower concentrations.

Erulan *et al*. (2009) reported that Seaweed liquid fertilizer (SLF) at low concentrations enhanced the growth parameters *viz*., shoot length, root length, leaf area, fresh weight, dry weight and moisture content. Biochemical parameters like chlorophyll 'a' and 'b', protein, sugars, starch, ascorbic acid and *in vivo* nitrate reductase activity were also found higher at 1.5%. The higher concentrations like 2, 2.5 and 5% appeared to be the inhibitory levels for *Sorghum* reported by Vijayanand *et al.* (2004). The investigation on the effect of crude extract was performed using the seaweed *S. plagiophyllum* (SLF) and the commercial seaweed extract-SM3 on the seed germination and seedling growth in green gram and black gram. Both SLF and SM3 promoted seedling growth upto a concentration of 0.75% in black gram. Green gram showed the maximum of 0.75% in black gram. Green gram showed the maximum concentration of SM3 (Venkataraman Kumar *et al*., 1993).

The amino acid content was also found to be high in 20% SLF (*Sargassum wightii*) than that of the higher concentrations and control. The sugar content increased up to 20% concentration of SLF and the content decreased at higher concentrations. Similar results were also reported in *Vigna sinensis* by Sivasankari *et al*. (2006a), the same trend was observed in the *Hypnea musciformis* with NPK application in black gram (Tamilselvan and Kannan, 1994), *Vigna catajung* and *Dolichos biflorus* (Anandharaj and Venkatesalu, 2001). Jothinayagi and Anbazhagan (2009) also reported that the total sugar content increased at 20% SLF concentration in *Abelmoschus esculentus* after *Sargassum wightii* treatment and the content decreased at higher concentrations. The lipid content increased upto 20% concentration and the content decreased at higher concentrations.

In general, it was observed that the seaweed liquid fertilizer prepared from the brown alga, *Rosenvingea intricata*, applied to crop plant gave better results in all aspects of growth to yield and soil nutrient content when compared to the seaweed fertilizer of green alga (Kannan and Tamilselvan, 1987 and Whapham, 1993). Similar results were reported that the brown alga applied to crop plants gave better results when compared to the plants that received *Chaetomorpha linum* and *Grateloupia lithophila*. It is probably due to the presence of growth promoting hormones and nutrients in more quantities in the brown alga than in other groups of algae, seaweed liquid fertilizer can be applied to various crop plant in order to enrich the nutrient content of the soil and intern to increase the growth and yield of cultivable plants.

Chaetomorpha linum showed better results in case of growth parameters in *Cajanus cajan* at 30% SLF concentration where as the photosynthetic pigments and biochemical parameters were found to be high in the plants that received 20% SLF of *Sargassum wightii* and thereafter in the higher concentration it declines

5. Conclusion

Seaweed fertilizer is a natural bioactive material, water-soluble derived from marine macro algae. Seaweed fertilizer could be absorbed by plant within several hours after application and safe to humans, animals and the environment. Seaweed liquid fertilizers will be useful for achieving higher agricultural production, because the extract contains growth promoting hormones, Cytokinins, Gibberellins, trace elements, vitamins, amino acids, antibiotics and micronutrients. From the present study, the following conclusion can be drawn on the effect of seaweed liquid fertilizer on the growth and biochemical composition of *Cajanus cajan*: The maximum growth parameter (root length, shoot length, fresh weight and dry weight) was recorded in the plants that received 30% SLF of *Chaetomorpha linum*. The maximum photosynthetic pigments were observed in the plants that were treated with 20% SLF of *Sargassum wightii*. The maximum biochemical composition was observed in the plants that were treated with 20% SLF of *Sargassum wightii*. The seaweed liquid fertilizer of *Sargassum wightii* is more effective at 20% concentration for biochemical composition and photosynthetic pigments. The 30% SLF of *Chaetomorpha linum* is more effective in *Cajanus cajan* for growth parameters. Based on the findings of the study *Sargassum wightii* can be used as the fertilizer for the plants at 20% concentration in order to increase the agricultural production. Among the three seaweeds used *Sargassum wightii* and *Chaetomorpha linum* showed better results than the *Grateloupia lithophila* at lower concentration and at higher concentration it declines. Thus the SLF was found to be a good source of plant growth but further more research is need to strongly establish the mechanism of action of the seaweed extract on the plant growth.

Acknowledgments

We would like to thank the Hon. Chancellor Dr. G. Viswanathan, Mr. Sankar Viswanathan, Vice President

(Administration), Mr. G.V. Sampath, Vice President (Operations), and authorities of VIT University, Vellore, India for providing all necessary support and laboratory infrastructure.

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