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Plant Growth Promoting Effect of Seaweeds Collected from East Coast of Tamil Nadu, India

Radhakrishnan Muthezhilan[1]*, Kuzhandaivel Jayaprakash[1], Chermapandi Parthiban[2], and A. Ajmath Jaffar Hussain[3]

[1]Department of Marine Biotechnology, AMET University (U/S of UGC Act 1956)
Kanathur, Chennai 603112, India.
[2]Centre for Advanced Study in Marine Biology, Annamalai University, Parangipettai – 608 502, India.
[3]Centre for Marine Bioprospecting, AMET University (U/S of UGC Act 1956)
Kanathur, Chennai - 603112, India.

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The continuous use of chemical fertilizers in agriculture field is highly toxic to the nature and also disturbs the soil living beneficial microorganisms. Seaweeds are well known commercially available marine plants and it has many eco-friendly applications. Thus the present study was carried out develop a plant growth promoting seaweed liquid fertilizer (SLF) for agricultural crop plants. In this study commercially available eight different seaweeds such as *Ulva fasciata, Enteromorpha intestinalis, Dictyota dichotoma, Sargassum wightii, Padina boergesenii, Amphiroa anceps, Avanthopleura spicifera* and *Spyridia hypnoides,* were collected from the rocky shore areas of Mandapam Coast, Rameshwaram District, Tamil Nadu, India. The eight different seaweed liquid fertilizer (SLF) was prepared to determine their plant growth promoting ability in agriculturally important crop plants such as, Green gram, Black gram, Mustard and Paddy by seed germination and soil drenching methods in both sterilized and unsterilized soil at laboratory scale experimental setups. In seed germination assay, 100% germination was observed in seeds soaked with *Sargassum wightii, Padina boergesenii* and *Ulva fasciata.* In soil treatment and plant culture study after 15 days of sowing the root length, shoot length and fresh weight of all the seedlings were recorded in all the setups. In that, *Sargassum wightii, Padina boergesenii and Ulva fasciata* seaweed liquid fertilizer (SLF) have shown the maximum plant growth promoting activity in unsterilized soil than the sterilized soil. The results were well demonstrated the effect of seaweed liquid fertilizer (SLF) in plant growth promotion and suggested to use this fertilizer to enhance the profitability in agricultural field.

Key words: Seaweed Liquid Fertilizer (SLF), Seed germination, Soil drenching, Plant Growth Promotion.

India is an agricultural country and there are approximately 70% of the population are located in rural areas and directly occupied in agriculture, making the backbone of our economy. The growing human population is placing pressure on food production and to meet this increasing demand in worldwide. Nowadays, the farmers are using chemical fertilizers in the agricultural soil for the growth of plants and to develop the crop production fast. The use of chemical fertilizers in agriculture field will disturb the nature of the soil and soil living beneficial microbes also it will make health problems in human due to biomagnifications

* To whom all correspondence should be addressed.
E-mail: mycomuthu@gmail.com

(Comargo and Alonso, 2006). To solve the above problem, there is an emerging need of natural bio fertilizers with low cost in agricultural field to improve the plant growth and to enhance the food production.

Generally, bio fertilizer improves crop productivity through the processes such as nitrogen fixation, phosphate solubilization and plant hormone produc-tion (Pereira and Verlecar 2005). Seaweeds (Macro Algae) are major important ma-rine renewable resource and they have several applications in many industries including food and agriculture (Sahoo, 2000). There are about 9,000 species of macro algae broadly classified into three main groups namely green (chlorophyceae),brown (Phaeophyceae) and red (rhodophyceae) based on their pigments such as chlorophylls, carotenoids and phycobiliproteins (Wajahatullah *et al.*, 2009). Seaweeds contains various fine chemicals and micro nutrients and plant growth promoting hormones, Cytokinins, Gibberellins, trace elements, vitamins, aminoacids, antibiotics and micronutrients (Tay *et al*., 1987; Thirumaran *et al*., 2009). The presence of huge amount of water soluble potash, and other trace elements in seaweeds will readily absorbed by plants and its control the deficiency diseases, and also the carbohydrates and other organic matter from seaweeds improve the nature of soil and moisture retaining capacity (Crouch and Van Staden, 1993). Thus the present study was carried out to determine the plant growth promoting effect of commercially available eight different seaweed species such as, *Ulva fasciata, Enteromorpha intestinalis, Dictyota dichotoma, Sargassum wightii, Padina boergesenii, Amphiroa anceps, Avanthopleura spicifera* and *Spyridia hypnoides,* in both dicotyledonous and monocotyledonous plants in sterilized and unsterilized soil, to develop a new eco friendly safe bio fertilizer.

MATERIALS AND METHODS

Collection of Seaweeds

The seaweeds such as, *Ulva fasciata, Enteromorpha intestinalis, Dictyota dichotoma, Sargassum wightii, Padina boergesenii, Amphiroa anceps, Avanthopleura spicifera* and *Spyridia hypnoides,* were collected from Mandapam Coast, Rameshwaram District, Tamil Nadu, India. After the sampling, the seaweeds were immediately washed several times with clean water in order to remove non-algal materials and they were sun dried for further study.

Preparation of seaweed liquid fertilizer (SLF)

All the eight seaweeds (separately) powders were mixed with distilled water in the ratio of 1: 20 (W/V) and the mixture was autoclaved at 121^0C (15 lbs) for 15 minutes. Then, the mixture was filtered through cheese cloth and the filtrate was collected. The obtained filtrate was treated as 100% concentration. For experimental study, 2 ml of concentrated seaweed liquid fertilizers (SLF) were mixed with 100ml distilled water (Sathya *et al*., 2010).

Collection of crop plants seeds

The agriculturally important crop plants seeds such as, Green gram (*Vigna radiate),* Black gram (*Vigna mungo)*, Mustard (*Brassica juncea)* and Paddy (*Oryza sativa)* with uniform size, color and weight were obtained from local farmers.

Effect of seaweed liquid fertilizer (SLF) on Seed germination

The crop plant seeds such as, Green gram, Black gram, Mustard and Paddy were soaked in particular seaweed liquid fertilizer (SLF) for 24hrs. After the incubation period, 25 numbers of each seeds were placed in tissue paper with respective seaweed liquid fertilizer (SLF) coded. Under the humid condition, seed germination was occurred (Muthezhilan *et al.,* 2012). After germination, the percentages of germination for all the four seeds were recorded by the following formula,

$$\text{Germination \%} = \frac{\text{Number of Seeds Germinated}}{\text{Total Number of Seeds}} \times 100$$

Effect of seaweed liquid fertilizer (SLF) on plant growth promotion

For seedling growth promotion, all the crop plant seeds such as, Green gram, Black gram, Mustard and Paddy were soaked in particular seaweed liquid fertilizer (SLF) for 6 hours. The both sterilized and unsterilized soils were individually filled in plastic cups (150 gm each) and one batch of seeds were kept as control and treated with water. The seeds (each 5 numbers) were sowed and observed for germination and early growth in both sterilized and unsterilized garden red soil and labeled. The watering was done once in 2 days. After the 15 days of sowing the root length and

shoot length of the seedlings were recorded (Sathya *et al*., 2010; Muthezhilan *et al.*, 2012). The relative increase was calculated by the following formula.

Seedling vigor = Shoot length + Root length X Germination percentage

Statistical analysis

All the experiments were repeated at least 3 times, and the data were expressed as the mean standard deviation (±SD).

RESULTS AND DISCUSSION

In general, seaweeds have more than one group of plant growth promoting substances or hormones (Wajahatullah,2009). However, in India very little research works are carried out on the beneficial effects of seaweeds to improve the growth of agriculturally important crop plants (Sridhar *et al*., 2010). In this study, a total of eight different seaweed liquid fertilizers (SLF) (SLF) were prepared using all the collected different seaweeds (such as, *Ulva fasciata, Enteromorpha intestinalis, Dictyota dichotoma, Sargassum wightii, Padina boergesenii, Amphiroa anceps, Avanthopleura spicifera* and *Spyridia hypnoides*) to check their plant growth promoting ability in agriculturally important four different crop. (Both dicotyledonous and monocotyledonous) plants such as, Green gram (*Vigna radiate),* Black gram (*Vigna mungo),* Mustard (*Brassica juncea)* and Paddy (*Oryza sativa).* Whereas checking the seed germinating ability of all the Seaweed Liquid Fertilizers (SLF) 100% germination was observed in all the crop plants seeds soaked with *Ulva fasciata*, *Sargassum wightii* and *Padina boergesenii* fertilizer respectively (Table 1 & Fig 1).

While analyzing plant growth promoting effect of all the eight different seaweed liquid fertilizer (SLF) in two types of soil such as, sterilized and unsterilized soil, after 15 days of sowing, the shoot and root length were measured in all the four crop plants from all the experimental and control groups from which the seedling vigor was determined (Table 2 & 3). The results proven that, among all the seaweed liquid fertilizer extracts (SLF) all the crop plants sowed with *Ulva fasciata*, *Sargassum wightii* and *Padina boergesenii* fertilizers have shown a maximum shoot and root length compared to control and other liquid fertilizers in both unsterilized and unsterilized soil conditions. All the three fertilizers have shown a maximum plant growth promotion in unsterilized soil followed by sterilized soil (Fig 2&3).

Among the three different seaweed liquid fertilizers, the crop plants treated with seaweed liquid fertilizer (SLF) of *Sargassum wightii* have shown a maximum shoot length in Green gram (32.73±0.64), Black gram (31.46±0.45), Mustard (13.96±0.20) and Paddy (13.36±0.15) and the maximum root length in Green gram (12.63±0.37), Black gram (8.26±0.20), Mustard (9.1±0.2) and Paddy (11.43±0.30) compared to other liquid fertilizers of *Padina boergesenii* and *Ulva fasciata* respectively. Kumar and Sahoo *et al*., 2011 have also reported that, the shoot length and root length of wheat *Triticum aestivum* was found to be highest when treated with 20 % (0.2 mg SW ml-1) *S. wightii* liquid extract. Thambiraj *et al*., 2012 also observed maximum shoot length (11.9 cm) and root length (4.7 to 4.9 cm) when checking the plant

Table 1. Effect of eight different seaweed liquid fertilizers (SLF) on seed germination of crop plants

Treatments	Green Gram	Black Gram	Mustard	Paddy
Control	89.10±0.50	88.79±0.19	88.33±0.57	90.33±2.30
E.intestinals	90.66±1.52	91±1	91.66±0.57	94.33±2.08
Ulva fasciata	100±0	100±0	100±0	100±0
D.dichotoma	93±1	94±1	95±1	93.33±2.08
S.wightii	100±0	100±0	100±0	100±0
P.boergeseni	100±0	100±0	100±0	100±0
A.anceps	93±1	92.33±0.57	92±1.73	90.33±3.21
A.spicifera	93±1	93±1	94.33±1.52	94.33±2.08
S.hypnoides	93±1	92.66±2.30	94.66±1.15	92.33±1.52

Table 2. Effect of eight different seaweed liquid fertilizers (SLF) on plant growth promotion in unsterilized soil

Treatments	Green Gram			Black Gram			Mustard			Paddy		
	Shoot length (cm)	Root length (cm)	Seedling Vigor	Shoot length (cm)	Root length (cm)	Seedling Vigor	Shoot length (cm)	Root length (cm)	Seedling Vigor	Shoot length (cm)	Root length (cm)	Seedling Vigor
Control	20.83±0.76	7.03±0.15	2479	24.7±0.60	5.1±0.1	2622	10.18±0.07	4.26±0.20	1270	10.2±0.72	8.93±0.11	1721
E.intestinals	25.1±0.17	8.2±0.1	2997	25.86±0.26	5.43±0.15	2847	11.53±0.32	4.86±0.15	1330	12.06±0.37	10.1±0.1	2083
Ulva fasciata	27.73±0.64	11±0.52	3873	27.8±0.26	6.5±0.2	3430	12.63±0.15	7.9±0.1	2053	12.26±0.15	11.1±0.1	2336
D.dichotoma	23.6±0.52	7.5±0.2	2892	27.06±0.05	6.0±0.05	3107	11.46±0.55	7.13±0.11	1611	11.43±0.32	10.06±0.1	1998
S.wightii	32.73±0.64	12.63±0.37	4536	31.46±0.45	8.26±0.20	3972	13.96±0.20	9.1±0.2	2306	13.36±0.15	11.43±0.30	2479
P.boergeseni	30.6±1.96	11.4±0.39	4200	29.43±0.40	7.13±0.11	3656	13.23±0.32	8.73±0.47	2196	12.9±0.1	13.83±4.73	2673
A.anceps	22.83±0.76	8.2±0.2	2885	27.23±0.25	5.96±0.20	3053	11.46±0.64	6.7±0.15	1670	11.33±0.49	9.3±0.1	1856
A.spicifera	22.26±0.64	7.4±0.2	2758	27.36±0.32	6.2±0.26	3121	11.96±0.15	6.26±0.05	1712	12.26±0.15	10.36±0.32	2126
S.hypnoides	24.6±0.52	7.43±0.15	2978	27.8±0.4	6.36±o.32	3142	12.46±0.15	7.2±0.15	1387	11.46±0.15	9.33±0.15	1912

Table 3. Effect of eight different seaweed liquid fertilizers (SLF) on plant growth promotion in sterilized soil

Treatments	Green Gram			Black Gram			Mustard			Paddy		
	Shoot length (cm)	Root length (cm)	Seedling Vigor	Shoot length (cm)	Root length (cm)	Seedling Vigor	Shoot length (cm)	Root length (cm)	Seedling Vigor	Shoot length (cm)	Root length (cm)	Seedling Vigor
Control	20.03±1.05	6.26±0.30	2339	17.4±0.36	3.63±0.15	1850	8.03±0.05	3.3±0.1	997	9.36±0.32	8.4±0.51	1598
E.intestinals	21.4±0.52	7.2±0.1	2574	18.46±0.15	4.56±0.15	2094	9.76±0.15	4.86±0.15	1330	10.16±0.15	8.83±0.11	1785
Ulva fasciata	24.13±0.11	9.13±0.20	3326	24.3±0.26	5.93±0.15	3023	9.76±0.05	5.9±0.2	1566	11.16±0.15	9.03±0.05	2019
D.dichotoma	23.36±0.55	8.16±0.15	2931	17.36±0.32	4.76±0.15	2079	10.26±1.58	6.7±0.43	1611	10.9±0.1	9.46±0.47	1893
S.wightii	26.4±0.36	11.7±0.26	3810	28.36±0.32	6.73±0.20	3509	10.16±0.15	6.96±0.11	1712	12.4±0.2	9.83±0.05	2223
P.boergeseni	25.26±0.25	10.53±0.37	3579	27.2±0.60	6.43±0.20	3363	9.76±0.15	6.36±0.32	1612	11.93±0.05	9.23±0.05	2116
A.anceps	23.1±0.1	8.1±0.1	2901	18.73±0.20	4.36±0.15	2124	9.36±0.15	6.8±0.1	1486	10.7±0.2	8.93±0.05	1766
A.spicifera	22.6±0.1	7.33±0.15	2783	18.5±0.26	5.6±0.1	2241	5.93±5.05	6.46±0.15	1164	10.16±0.15	8.73±0.05	1775
S.hypnoides	21.5±0.26	6.9±0.1	2641	17.66±0.32	4.76±0.15	2062	7.86±0.05	6.9±0.43	1387	9.8±0.1	8.33±0.05	1667

Fig. 1.

Fig. 2. Seed growth study

Fig. 3. Effect of seaweed Liquid Fertilizer (SLF) on growth of suit and root length of four different crop plants

growth promoting effect of seaweed liquid fertilizers (SLF) of *Sargassum wightii* and *Hypnea musciformis* in *Cyamopsis tetragonoloba* (Cluster bean) seeds. Kalidass *et al*., 2010 also reported that, the liquid extract of *Ulva lacuta, Caulerpa scalpelliformis, Padina tetrastromatica* and *Sargassum linearifolium* increased the amount of protein, carbohydrate and amino acid of *Brassica nigra*. Recently, Anisimov *et al*., 2013 also stated that, the beneficial effect of seaweed extracts on seed germination and plant growth promotion may be due to the presence of plant growth promoting substances or hormones present in the seaweed extracts. From the results, the work also suggested that, development of natural seaweed liquid fertilizer (SLF) by using these potential seaweeds (*Sargassum wightii, Ulva fasciata* and *Padina boergesenii*) in agriculture for crop plants will definitely enhance the crop production.

REFERENCES

1. Anisimov, M.M.; Chaikina, E.L.; Klykov, A.G. and Rasskazov, V.A., Effect of Seaweeds Extracts on the Growth of Seedling Roots of Buckwheat (*Fagopyrum esculentum* Moench) is depended on the Season of Algae Collection. *Agriculture Science Developments* 2013; **2:** 67-75.
2. Crouch, I.J. and Van Staden, J., Evidence for the presence of plant growth regulators in commercial seaweed products, *Plant Growth Regulation* 1993;**13:** 21–29.
3. Camargo, J.A. and Alonso, A., Ecological and Toxicological effects of Inorganic nitrogen pollution in aquatic systems. A global assessment. *Environment International* 2006; **32:** 18-49.
4. Kalidass, C.; Daniel, A.; Mohan, V. R., Rapid propagation of *Plumbago zeylanica* L. An important medicinal plant. The *Journal of American Science* 2010; **6:** 1027-1031.
5. Kumar, G. and Sahoo, D., Effect of seaweed liquid extract on growth and yield of *Triticum aestivum* var. Pusa Gold. *Journal of Applied Phycology* 2011; **23:** 251–255.
6. Muthezhilan, R.; Sindhuja, B.S.; Jaffar Hussain, A. and Jayaprakashvel, M., Efficacy of Plant Growth Promoting Rhizobacteria Isolated From Sand Dunes of Chennai Coastal Area. *Pakistan Journal of Biological Sciences* 2012; **15:** 795-799.
7. Pereira, N. and Verlecar, X.N., Role of marine algae in organic farming. *Current Science* 2005; **89**: 593-594.
8. Sathya, B.; Indu, H.; Seenivasan, R. and Geetha, S., Influence of seaweed liquid fertilizer on the growth and biochemical composition of legume crop, *Cajanus cajan* (L.) Mill sp. *Journal of Phytology* 2010; **2:** 50–63.

9. Sridhar, S. and Rengasamy, R., Studies on the effect of seaweed liquid fertilizer on the flowering plant *Tagetes erecta* in field trial. *Advances in Bioresearch* 2010a; **1:** 29-34.
10. Sridhar, S. and Ramasamy, R., Significance of seaweed liquid fertilizer for minimizing chemical fertilizers and improving yield of *Arachis hypogaea* under field trial. Recent *Research in Science and Technology* 2010 b; **2:** 73-80.
11. Saho, D., Farming the Ocean: seaweds cultivation and utilzation. Aravali Boks International, New Delhi, India 2000.
12. Tay, S.A.; Macleod, J.K.; Palni, L.M. and Letham, D.S., Detection of cytokinins in a seaweed extract. *Phytochemistry* 1985; **24:** 2611–2614.
13. Thirumaran, G.; Arumugam, M.; Arumugam, R.; Anantharaman, P., Effect of Seaweed Liquid Fertilizer on Growth and Pigment Concentration of *Abelmoschus esculentus* (l) medikus. *American-Eurasian Journal of Agronomy* 2009; **2:** 57-66.
14. Thambiraj, J.; Lingakumar, K. and Paulsamy, S., Effect of seaweed liquid fertilizer (SLF) prepared from *Sargassum wightii* and *Hypnea musciformis* on the growth and biochemical constituents of the pulse, *Cyamopsis tetragonoloba* L. *Journal of Research in Agriculture* 2012; **1:** 65-70.
15. Wajahatullah Khan, Usha, P.; Rayirath, Sowmyalakshmi Subramanian, Mundaya, N.; Jithesh Prasanth Rayorath, D.; Mark Hodges Alan, T.; Critchley James, S.; Craigie, S. and Prithiviraj, B., Seaweed extracts as biostimulants of plant growth and development. *Journal of Plant Growth Regulation* 2009; **28:** 386–399.