Effect of Seaweed Liquid Fertilizer of *sargassum wightii* on the Yield Characters of *Cluster Bean* and *Lettuce Pland* Growth

RUSA 2.0 Rashtriya Uchchatar Shiksha Abhiyan

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***Abstract*- Seaweeds are marine macroalgae growing in the intertidal and subtidal zones of marine waters. Based on pigmentation, seaweeds are classified as green seaweeds (Chlorophyta), brown seaweeds (Phaeophyta) and red seaweeds (Rhodophyta). Seaweeds are thalloid plants having immense economic uses as human food, animal feed, fuel, fertilizers, source for fine chemicals, iodine, mannitol and phycocolloids. Seaweeds are the sole source for phycocolloids which are catagorised into agar, carrageenan and algin. These phytochemicals find use in various industries as solubilizer, solidifier and sizer agents. In recent years, liquid extracts of seaweeds known as Seaweed Liquid Fertilizers (SLF) and that of Seaweed termed as Seaweed Liquid Fertilizers (SGLF) are being used. There are a number of methods of extracting SLF and SGLF. The mode of application of SLF and SGLF could be soaking, foliar spray or as a soil drench. SLF can be used both for horticultural crops and other crops especially the pulses. All the three kinds of seaweeds (green, brown and red) could be employed for SLF preparation. Although a number of seaweed based commercial extracts have come out in the international markets, our country is lagging behind, in spite of plethora of research work on the application of SLF.**

***Key words*: Sargassum wightii Extract, SLF and SLF Cluster Bean and Lettuce Pland Seeds.**

INTRODUCTION

Seaweeds are marine macroalgae growing in the intertidal and subtidal zones of marine waters. Based on pigmentation, seaweeds are classified as green seaweeds (Chlorophyta), brown seaweeds (Phaeophyta) and red seaweeds (Rhodophyta). Seaweeds are thalloid plants having immense economic uses as human food, animal feed, fuel, fertilizers, source for fine chemicals, iodine, mannitol and phycocolloids. Seaweeds are the sole source for phycocolloids which are catagorised into agar, carrageenan and algin. These phytochemicals find use in various industries as solubilizer, solidifier and sizer agents (Venkataraman Kumar, 2005, 2010).

Seaweed are the marine angiosperms constituting a small taxanomic group. However their uses are plenty such as acting as nursery beds for fishery production, exclusive food for sea animals like Dugong (Sea cow) and green turtles, buffer between coral and mangrove ecosystem, recycling of mineral nutrients and resistance of water currents. Apart from these ecological services, seagrasses find use as human food (Kannan, 2010), nutraceuticals and antioxidant resources (Athiperumalsami *et al*, 2008, 2010) and in recent years as fertilizers (Venkataraman Kumar, 2011).

Intensive crop cultivation demands excessive use of chemical fertilizers at the cost of soil health. Utilization of organics in agriculture particularly for seed treatment would be ecofiiendly and cost effective. Seaweeds constitute one of the important living sources of the ocean that might serve as an alternative to synthetic fertilizers (Metting *et al*, 1991). Seaweed extracts marketed as fertilizer additives for the beneficial effects (Booth, 1965), owing to the presence of plant growth substances, particularly kinetin and cytokinins (Tay *et al*, 1985; Mooney and Van Staden, 1986; Crouch and Van Staden, 1993) and antioxidants (Arnold *et al*, 1993). The use of seaweeds as substitutes for conventional synthetic fertilizers is increasing (Ramamoorthy *et al*, 2006).

Application of fertilizers plays an important role in the yield of crops. But the continuous use of inorganic fertilizers has made the soil infertile for cultivation, besides eutrophication of surface water and contamination with nitrogen of sub surface water. In order to overcome this problem, the use of organic fertilizers is recommended now-a-days. There are many types of organic manures; they are blood, bones, farmyard manure, fish, garden refiise, horn shavings, leaves, malt dust, night soil, woolen rags and seaweeds. these, the most abundant and easily available source is seaweeds. Seaweeds can be used in many ways to increase soil fertility (Sylvia *et al*, 2005). Indian coastal area is rich in algal diversity. Our coastal area covers about 7000 km and harbors about 844 marine algal species belonging to different families and genera (Oza and Zaidi, 2001). The potential areas in India for luxuriant growth of species of red, brown and green algae are the south east coast of Tamil Nadu from Mandapam to Kanyakumari covering 21 islands in the Gulf of Mannar, Gujarat coast, Lakshadweep and Andaman - Nicobar islands (Kaliaperumal and Kalimuthu, 1999).

An adequate amount of potassium, nitrogen, growth hormones, micronutrients, humic acids etc, present in seaweeds make its excellent fertilizer. Unlike chemical fertilizers derived from seaweeds *{Fucus, Laminaria, Ascophyllum, Sargassum,* etc.) are biodegradalde, non-toxic, non-polluting 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 rising crops. Further, althroughout the world are switching over to organic fertilizers. Seaweed manure besides increasing the soil fertility, increase the moisture holding capacity and supplies adequate trace metals thereby improving the soil structure (Dhargalkar and Pereira, 2005).

Use of seaweeds is a common practice in coastal areas throughout the world. In India, it is used for coconut plantations especially in coastal Tamil Nadu and Kerala (Silas *et al*, 1986). Most of the seagrasses are used extensively as soil fertilizer for coconut and other plantations (Kannan and Thangaradjou, 2005).

In recent years, liquid extracts of seaweeds known as Seaweed Liquid Fertilizers (SLF) and that of Seaweed termed as Seaweed Liquid Fertilizers (SGLF) are being used. There are a number of methods of extracting SLF and SGLF. The mode of application of SLF and SGLF could be soaking, foliar spray or as a soil drench. SLF can be used both for horticultural crops and other crops especially the pulses. All the three kinds of seaweeds (green, brown and red) could be employed for SLF preparation. Although a number of seaweed based commercial extracts have come out in the international markets, our country is lagging behind, in spite of plethora of research work on the application of SLF (Venkataraman Kumar, 2010).

MATERIALS AND METHODS

Collections of seaweeds

The brown seaweed *Sargassum wightii* were collected from Rameshwaram.

Preparation of SLF (Seaweed Liquid Fertilizer)

After collection marine plants were brought to the laboratory and washed thoroughly with water for the complete removal of extraneous matter and then subjected to extraction by the following method.

Autoclave method (Rama Rao, 1990)

100g of the seaweed was weighed and cut into small pieces to which IL of distilled water was added. It was autoclaved at 15 lb pressure for one hour. The extract was filtered and stored in a refrigerator.

Hot Extraction Method

Collect the fresh brown and wash thoroughly to remove all epiphytes and sand particles with tap water. Dry the washed and cleaned seaweed in shade for three to five days at room temperature. Keep the shade dried seaweed in an oven at 60ºC for 24 hours.

Hands crush the shade dried seaweed and make coarse powder of the dried seaweed with the help of a mixer-grinder. Soak the seaweed coarse powder in tap water (Do not use saline water) in the ratio of 1:20 W/V (50 grams powder in one liter tap water) and then boil or steam boil or autoclave at 121ºC, 20 lbs for 60 minutes. Filter the hot extracts of the seaweed through double-layered cheese cloth and allow cooling at room temperature. The hot extract after cooling at room temperature can be centrifuged at 10,000 rpm for 30 minutes or keep it overnight so that small suspended particles will settle down and do not clog the spray.

Collect the remains of the biomass from the double-layered cheese cloth and squeeze the remaining water with the help of a squeezer. Dry the biomass obtained from squeezer at 60ºC in an oven for 48 hours. This dried biomass can be used as feed for poultry and other domestic animals, after addition of rice flour or wheat flour. This dried biomass can also be used as soil fertilizer. The resultant concentrated seaweed extract is considered as 100% seaweed extract. As the seaweed liquid fertilizer contains organic matter therefore add a preservative (1 gram of Potassium nitrate to 1 litre of seaweed extract) before packing in bottles, cans or drums.

Process Flow sheet

Preparation of Seaweed Liquid Fertilizer
(Hot Extraction Method Using Powdered Seaweed)

Collect the fresh brown or green seaweed

↓

Wash thoroughly with tap water to remove all epiphytes and sand particles

↓

Shade dry for 3-5 days and Keep in an oven at 60ºC for 24 hours

↓

Hand crush and Grind using mixer-grinder

↓

Collect the coarse powder

↓

Mix the coarse powder with Tap water in ratio of 1:20 (W/V)
(50 grams powder in one liter tap water)

↓

Boil or steam boil or Autoclave at 121°C, 20 1bs for 60 minutes

↓

Filter through cheesecloth

↓

Gather the Biomass from the cheesecloth, dry and use as Poultry feed or soil fertilizer

↓

Collect the filtrate and centrifuge or keep it overnight

↓

Add a preservative (1 gram of Potassium nitrate to 1 litre of seaweed extract)

↓

Pack in bottles, cans or drums and store

↓

Prepare 1-5 % dilutions of SLF and spray on the crops

RESULTS

SPECIES DESCRIPTION

***Sargassum wightii* (J.Agarth)**

Division : Phaeophyta
Class : Phaeophyceae
Order : Dictyotales
Family : Dictyotaceae
Genus : S*argassum*
Species : *wightii*

Fig. 1. *Sargassum wightii*

Key for identification:

Plants dark brown, 20-30 cm length in height with a well-marked hold fast, upper portion richly branched axes cylindrical, glabrous leaves 5-8 cm an long 2-9 broad leaves tapering at base apex mid inconspicuous vesicles large spherical or ellipsoidal being 5-8 cm long and 3-4 m (broad plate)

Table 1. The Macronutrients & Trace Elements Analyzed In The Seaweeds Extraction of SLF

S.No.	**Nutrient**	***Sargassum wightii*** (mg/l)
1	Calcium	170
2	Magnesium	167.1
3	Sodium	490
4	Potassium	310
5	Iron	6.931
6	Phosphorus	54.17
7	Chloride	1180
8	Sulphate	39.45
9	Copper	0.858
10	Zinc	1.037

11	Nitrate	114.14
12	Cobalt	0.049
13	Manganese	1.095
14	Boron	3.891

The resultant concentrated seaweed extract is considered as 100% seaweed extract. As the seaweed liquid fertilizer contains organic matter therefore add a preservative (1 gram of Potassium nitrate to 1 litre of seaweed extract) before packing in bottles, cans or drums.

Application on Crop Plants:

Dilute this seaweed extract in the ratio of 1-3 % and apply as spray on the crops.

1 % = 1 litre seaweed extract in 99 litre water
2 % = 2 litre seaweed extract in 98 litre water
3 % = 3 litre seaweed extract in 97 litre water

Application on Seeds:

Soak the seeds in 1-3 % dilution of seaweed extract for 24 hours. Shade dries the treated seeds and then sow or disseminate in the fields.

Plants / crops on which SLF can be used or applied

Can be used for any kind of plants (crop plants, ornamental plants, flowering plants etc.)

How it affects the plants / crops

Seaweed Liquid fertilizer is a natural bio-product, non-toxic, completely biodegradable and can be used for all crops at any stage of growth. SLF increases plant productivity, uptake of soil nutrients, resistance to some pests, drought and stress and improves seed germination. Plant response is immediate and positive. SLF also stimulates beneficial microorganisms of the root systems and plant growth, improves soil crumb structure and moisture retaining capacity of the soil.

Comparative study Paddy seed germination between SLF concentrations

The paddy seeds are soaked into the different concentrations (1 % to 3%) of SLF for 24 hours than Shade dries the treated seeds and then sow fields. Three percentages (3%) of SLF is more seed germination then others.

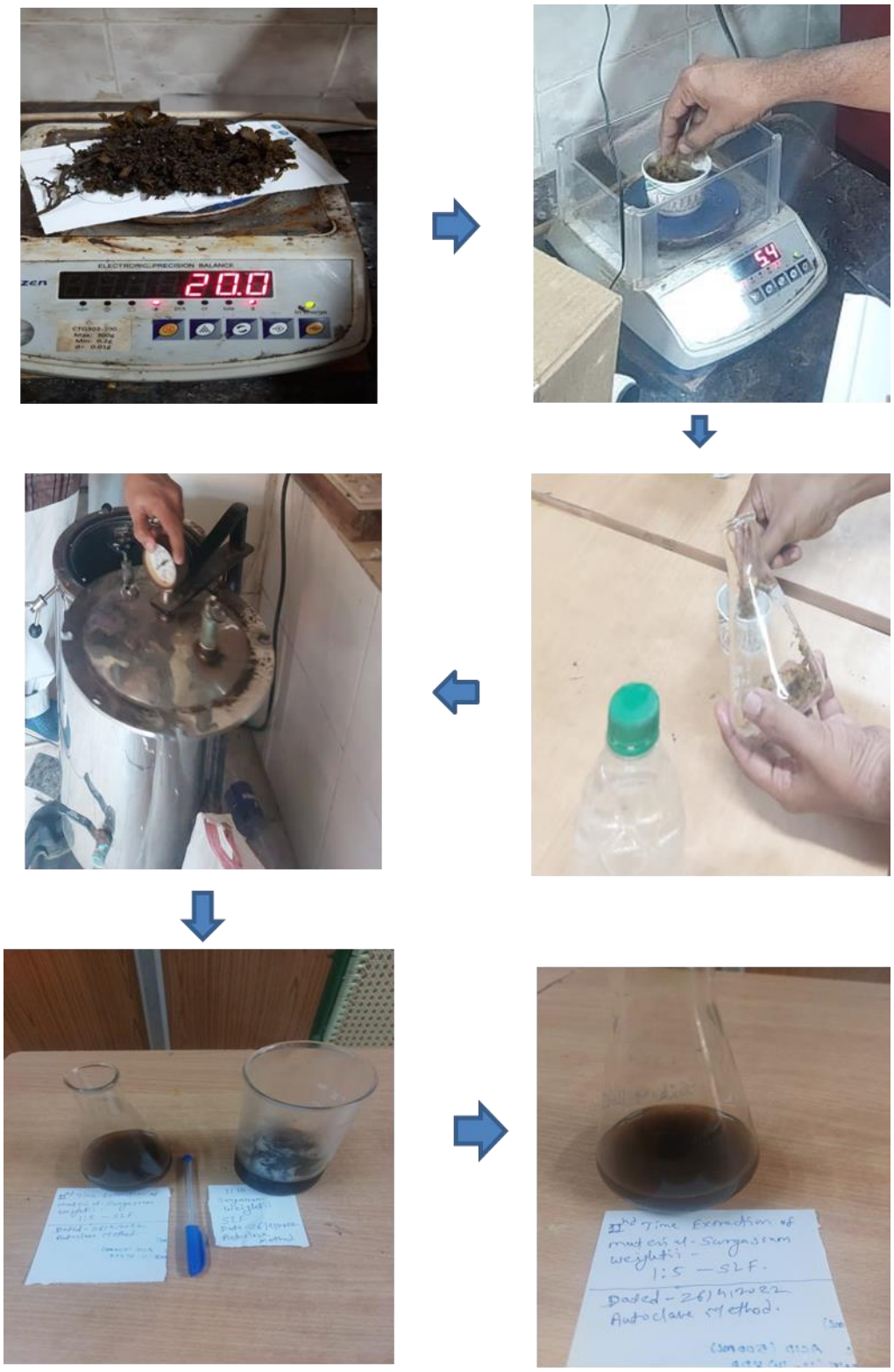
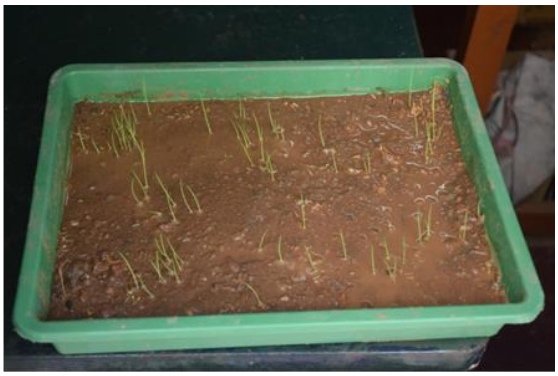
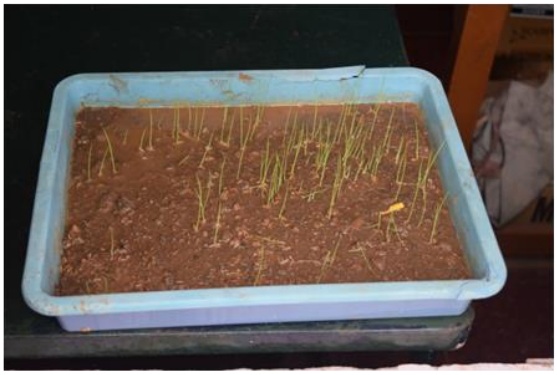


Fig. 2. SLF Extraction Process

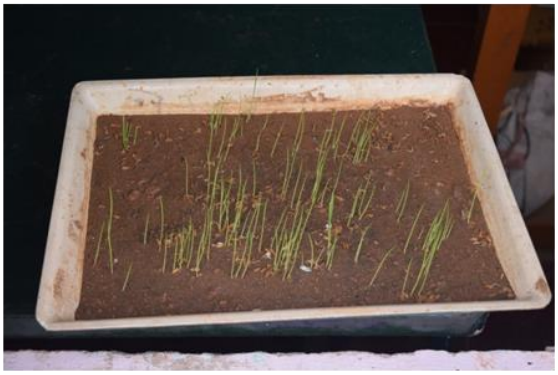
Seed Soaked in SLF



Control



1% SLF



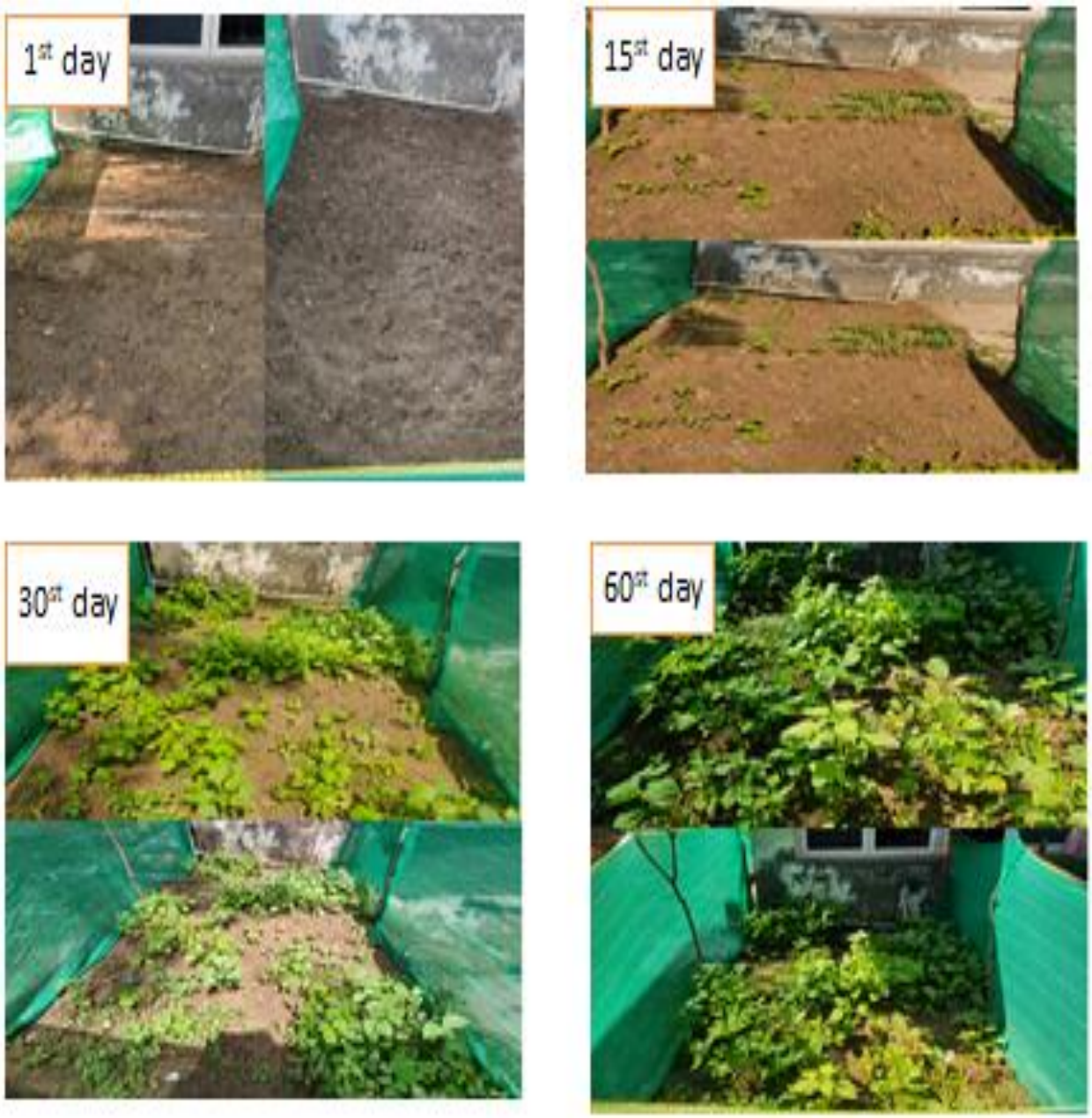
2% SLF

3% SLF

Fig. 3. Seed Germination with Different Concentration of SLF

A. Lettuce Seed **B. Cluster Bean Seed**

Figur: 3 SLF SEEDS

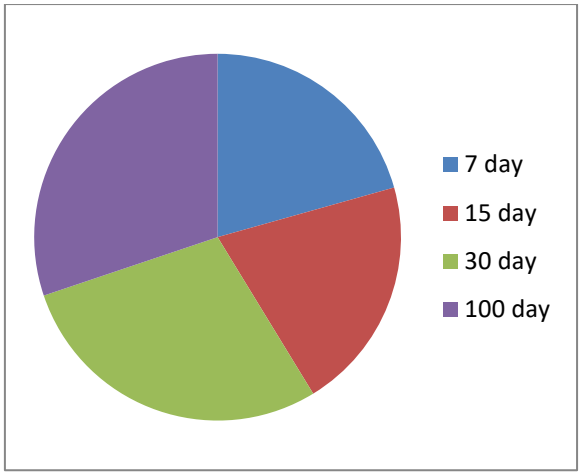


Figur:4 SLF Grouth Values Day

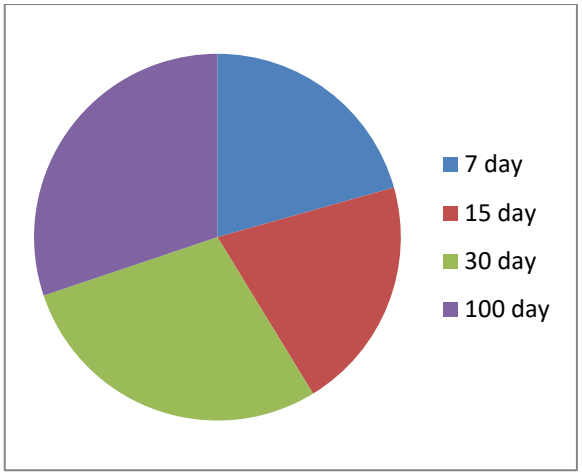
Table :3 SLF Plants Grouth Values

Seaweed Extract	0%				5%			
	7th day	15th day	30th day	60th day	7th day	15th day	30th day	60th day

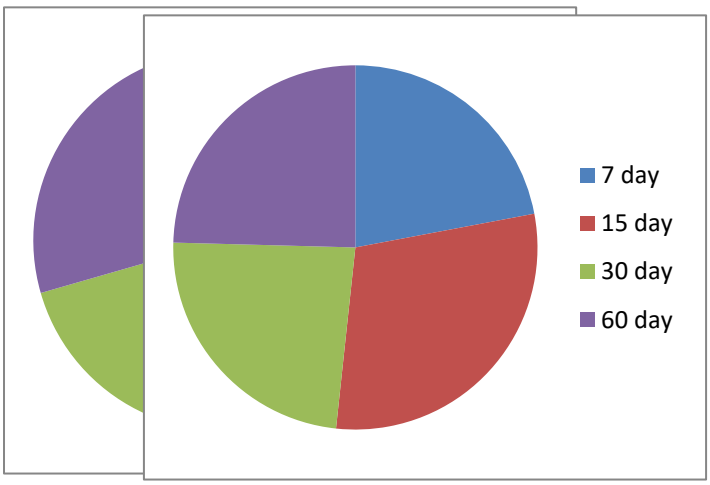
Cluster Bean Seed (cm)	29	34	45	100	28	53	60	100
Lettuce Seed (cm)	26	35	48	50	30	60	67	70



Cluster Bean seed Control



Cluster Bean seed Sample



Lettuce seed Control

Lettuce seed Sample

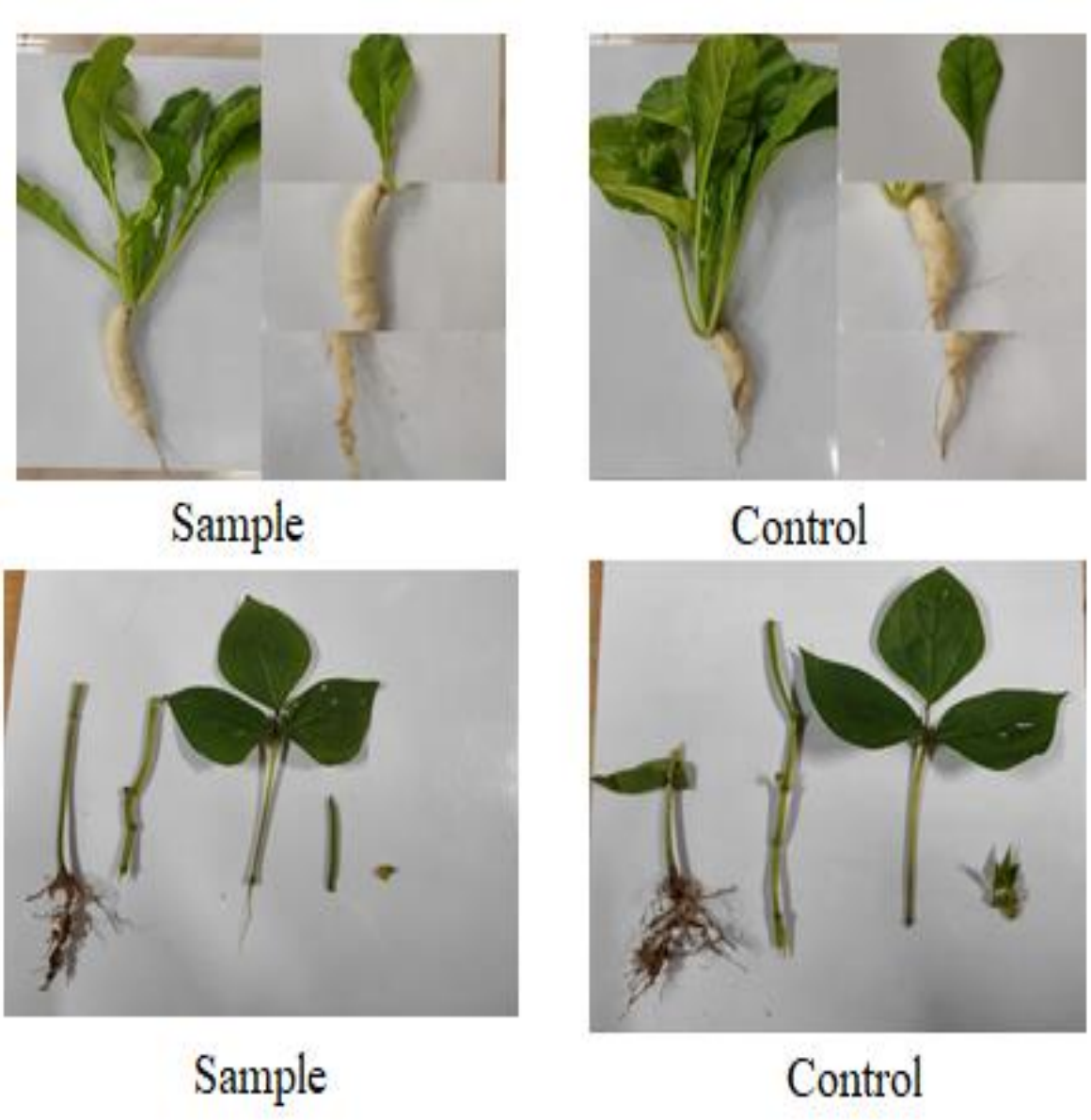


Figure:5 Grouth of SLF Plants

CONCLUSIONS

The efficacy of the three different SLF concentrations 3% of SLF is more efficient seed germination than others. The detailed study on the determination of the most effective percentage of seaweed liquid fertilizer (SLF) extraction three different concentrations Paddy resulted in suggesting the following recommendations:

- Out of three concentrations of 3% of SLF is most effective seed germination.
- SLF thus obtained could be used for soaking seeds, foliar spray or even as a soil drench.
- 100% SLG thus obtained should be much diluted and then used in different ways as suggested above.

REFERENCES:

1. Anantharaj, M and V. Venkatesalu, 2001. Effect of seaweed liquid fertilizer on Vigna catajang. *Seaweed Res. Utiln*., 23:33-39.
2. Anantharaj, M. and V. Venkatesalu, 2002. Studies on the effect of seaweed extracts on Dolichos biflorus. *Seaweed Res. Utiln.,* 24:129-137.
3. Arnold, R. N., Arp, K.K. Scheller, S.N. Williams and D.M. Schaefer 1993. Tissue equilibration and sub cellular distribution of Vitamin E relative to myoglobin and lipid oxidation is displayed *beef J. Anim. Sci*, 71:105-118.
4. Balakrishnan, C.P., Venkataraman Kumar and, V.R. Mohan, 2007. Studies on the effect of crude seaweed extracts on seedling growth and biochemical parameters in Pennisetum typhoides (Burm.f) Stapf C.E. Hubbard. *Seaweed Res. Utiln*., 29 (l&2):89-96.
5. Bhosle, N.B., A.G Untawale. and, V.K. Dhargalkar1975. Effect of seaweed extract on the growth of Phaseolus vulgaris L. *Indian J. Mar. Sci.,* 44:208-210.

6. Blunden, G, P.B Wildgoose. and F.E. Nicholson, 1974. The effects of aqueous seaweed extract on sugar beet. Abstracts 8* Int. *Seaweed Symp. Bangar.*
7. Blunden, G. T. Jenkins and Liu-yan-wen. 1997. Enhanced leaf chlorophyll levels in plants treated with seaweed extract. *J. Appl. PhycoL*, 8(6):535-543.
8. Blunden, G. and P.B. Wildgoose, 1977. The effect of aqueous seaweed extract and kinetin on potato yield. *J. Sci. Food. Agric*, 28:121-125.
9. Bokil, K.K., V.C. Mehta and, D.S Datar. 1974. Seaweed as manure: II Pot culture manorial experiments on *wheat. Phykos*. 13:1-5.
10. Bokil, K.K., V.C. Mehta, and, D.S Datar. 1972. Seaweeds as manure field manorial trials on Pennisetum typhoides and Arachis hypogea. *Bot. Mar.*, 15:148-150.
11. Booth, E., 1965. The manorial value of seaweed. *Botanica Marina*, 8:138-143.
12. Booth, E., 1969. The manufacture and properties of liquid seaweed extracts. *Proc. Sixth Int. Seaweed Symp., Madrid, pp*.655-662.
13. Bukhari, S.S. and A.G. Untawale, 1978. Seaweeds as liquid fertilizer and foliar spray. *Seaweed Res. Utiln*., 3:71-IS.
14. Chapman, V.J and D.J. Chapman1980. Seaweeds and their uses. *Third Edutuin. Chapman and Hall, Newyork.*
15. Crouch, I.J., and J. Vanstaden. (1993). Evidence for the presence of plant growth regulators in commercial seaweed products. *Plant Growth. Reg.* 13, 21-29.
16. Delfm Chitra, P., R . Sobitha Bai and R. Asir Selin Kumar, 2010. Effect of seaweed Hypnea musciformis extract on germination, growth and pigment changes in Vigna radiata *L. Seaweed Res. Utiln*., 32 (1&2): 57-61.
17. Dhargalkar, V.K. and A.G. Untawale, 1983. Some observations of the effect of SLF on higher plants. *Indian J. Mar. Sci*., 12:210-214.
18. Dhargalkar, V.K. and Neelam Pereira 2005. Seaweed: Promising plant of the millennium. *Sci. Cult*., 71:60-66.
19. El-Sheikh, M.M. and El-Saied, A.E.F. 1999. Effect of seaweed extracts on seed germination, seedling growth and some metabolic process of Fabe beans (Vicia faba L.). *Phykos*, 38:55-64.
20. Featonby Smith, B.C. and J. Van Staden, 1983. The effect of seaweed concentrate and fertilizers on the growth of Beta vulgaris. *Zeitschrift Fur Pflanzenphysiologie*, 112:155-162.
21. Gandhimaniyan, K., S.Jeyachandran, , C. Manoharan, and S. Vijayakumar, 2010. Studies on effect of Gracilaria verrucosa extract as liquid biofertilizer on Sesamum indicum L. *Seaweed Res. Utiln*., 32:(l&2):63-68.
22. Hu, X., X. Jiang, H.Hwang, , S. Liu, and H. Guan, 2004. Promotive effects of alginate derived oligosaccharide on maize seed germination. *J. Appl. Phycol*. 16:73-76.
23. Immanuel Rajkumar, S. and S.K. Subramanian, 1999. Effect of fresh extracts and seaweed liquid fertilizers on some cereals and millets. *Seaweed Res. Utiln.*, 21:91-94.
24. Jeanin, I., J.C. Lescure and J.F. Morot Gaudry, 1991. The effects of aqueous seaweed sprays on the growth of maize. *Bot. Mar*. 34:469-473.
25. JebaAnanthi, K., V. Somalakshmi and Venkataraman Kumar, 2010. Comparative study on the effect of Ulva lactuca liquid fertilizer by different methods of extraction on Vigna radiata seedlings. *Seaweed Res. Utiln.*, 32(l&2):69-74.
26. Jothinayagi, N. and C. Anbazhagan2009. Effect of seaweed liquid fertilizer from Ulva lactuca on Abelmoschus esculentus. *Seaweed. Res. Utiln.*, 31(1&2):171-175
27. Kaliaperumal, N and S. Kalimuthu, 1999. Seaweed potential and its exploitation in India. *Seaweed. Res. Utlin* 19:33-40.
28. Kannan, L., and T. Thangaradjou 2005. Seagrass ecosystem: Importance and need for conservation. In: (N. Kaliaperumal, J. K. Paterson Edward, V. Edwin Joseph, A. Murugan, P. Chidambaram and J. R. Ramalingam, eds). Souvenir National symposium on marine plants, their chemistry and utilization. Seaweed Research Utilization Association and Suganthi Devadason Marine Research Institute, *Tuticorin. pp.* 76-78.
29. Lingakumar, K., D. Balasubramania , S.K.G.Sundar, R. Jeyaprakash, and M. Jeyakumar, 2006. Effect of Ulva lactuca crude extract on growth and biochemical characteristic in Cyamopsis tetragonoloba L. and Phaseolus mungo L. *Seaweed Res. Utiln*., 28:75-80.
30. Mehta, V.C, B.S.Trivedi, , K.K. Bokil and M.R. Narayana, 1967. Seaweed as manure: 1 - Studies on Nitrification. Proc. Semi. Sea, Salt and Plants. *CSMCRI, Bhavanagar. pp*.357-365.
31. Metting. B.W.J. Zimmerman, I. Crouch and J. Van Staden 1991. Agronomic uses and microalgae. In : Aktsuka I (ed) Introduction to applied Phycology. *The Hague, Netherlands. SPB Publishing pp*- 269-307.
32. Mohan, V.R. and Venkataraman Kumar 1993. Effect of seaweed extract Algifert on seed germination and seedling growth in black gram and green gram. *Seaweed Res. Utiln*., 16:53-55.
33. Mohan, V.R., Venkataraman Kumar, R. Murugeswari, and S. Muthusamy, 1994. Effect of crude and commercial seaweed extracts on seed germination and seedling growth in Cajanus cajan L. *Phykos*, 33:47-51.
34. Mooney, P.A. and J. Vanstaden, 1986. Tentative identification of cytokinins in Sargassum heterophyllum (Phaeophyceae). *Bot. Mar*., 30:323-325.
35. Oza, Rohit, S.H. Mand Zaidi, 2001. A revised checkHst of Indian marine algae, Central Salt and Marine Chemical Research Institute, *Bhavnagar*.
36. Rajeswari, M., K.K. Lakshmanan, and A.S. Chitra1983. Effect of seaweed on tomato. Proc. National Seminar on the Production Technology of Tomato and Chillies. TNAU, Coimbatore. *pp*.87-89.
37. Rama Rao, K. 1990. Preparation, properties and use of liquid seaweed fertilizer from Sargassum. Work shop on algal products and seminar on Phaeophyceae in India, Seaweed Research and Utilization Association, 4*-7* *June Madras. pp78*.

38. Ramamoorthy, K. and K. Sujatha2007a. Aqueous seaweed sprays on the growth and yield of pigeon pea Cajanus cajan L. Millsp. *Seaweed Res. Utiln*., 29 (1&2):111-117.
39. Ramamoorthy, K. and K. Sujatha, 2007b. Effect of seaweed extracts on the ageing of blackgram seeds. *Seaweed Res. Utiln*., 29 (1&2):119-123.
40. Ramamoorthy, K., K. Sujatha, and K. Sivasubramaniam, 2007. Utilisation of seaweed extracts for enhancing yield in blackgram Vigna mungo L. Hepper. *Seaweed Res. Utiln*., 29 {\&2):97-\00.
41. Ramamoorthy, K., K.Sujatha, , K. Sivasubramaniam, and K. Subburamu, 2006. Organic priming with Sargassum polycystum extract on vigour and viability in cowpea Vigna unguiculata L. Walp. *Seaweed Res. Utiln*., 28(l):85-88.
42. Renukabai, N., N.R. Laila Banu, S. Jaquilin Goldi, and J.W. Prakash, 2008. Effect of seaweed extracts (SLF) on the growth and yield of Phaseolus aureus L. *Indian HydrobioL*, n(\y.l\3-n9.
43. Sahaya Anthony Xavier, and L. Louis Jesudass, 2007. Effect of seaweed extracts on cluster bean. *Seaweed Res. Utiln.,* 29 (l&2):85-87.
44. Selvaraj, R., M. Selvi, and P. Shakila2004. Effect of seaweed liquid fertilizers on Abelmoschus esculentus L. Moench and Lycopersicon lycopersicum Mill. *Seaweed Res. Utiln.*, 26: 121-123.
45. Sethi, S.K. and S.P. Adhikary, 2009. Effect of region specific Rhizobium in combination with seaweed liquid fertilizer on vegetative growth and yield of Arachis hypogea and Vigna mungo. *Seaweed Res. Utiln*., 31(1&2):177-184.
46. Silas, E. G., V. S. K Chennubhotla,. And N Kaliaperumal,. 1986. Seaweed resources, products and utiHzation. *Seaweed Res. Utiln.*, 9:11-24.
47. Sivakumar, K. and A.Gandhi, 2010. Potentiality of Sargassum wightii as a fertilizer on black gram and their growth and yield by image analysis. *Seaweed Res. Utiln.,* 32(l&2):75-83.
48. Sivasankari, S., V. Venkatesalu. M. Anantharaj and M. Chandrasekaran2006. Effect of extracts on the growth and yield of Vigna sinensis. *Bioresources Technol*, 97:1745-1751.
49. Sobithabai, R. and R. Asir Selin Kumar2010. Effect of Laurencia papillosa extract on reducing and non-reducing sugar content in Zea mays L. *Seaweed Res. Utiln*., 32(l&2):53-56.
50. Sreenivasa Rao, P., H.H. Perekh, B.K. Ramavatand S.B. Bhat. 1979. Preparation and properties of liquid seaweed fertilizer. Proc. Int. Symp. Marine Algae of the Indian Ocean Region. CSMCRI, Bhavanagar, *India, pp.*57.
51. Stephenson, W.A. 1974. Seaweed in Agriculture and Horticulture. 3^^ ed. Rateaver, peumavalley, California. *241pp.*
52. Stirk, W.A., G. D.Arthur, A.F Lourens, O. Novok, M. Strand, and J. Van-Staden, 2004. Changes in cytokinin and auxin concentrations in seaweed concentrates when stores at an elevated temperatures *J. AppL Phycol.,* 16:31-39.
53. Sujatha, K., G Vethanayagi. and K. Ramamurthy 2011. Studies on the effect of seaweed extracts on storage potential in bhendi seeds. *Seaweed Res. Utilin 33* (1&2): 125-131.
54. Sylvia, S., M. Baluswami , M.D. Vijaya Parthasarathy and V. Krishnamurthy2005. Effect of liquid seaweed fertilizers extracted from Gracilaria edulis (Gmel.) Silva, Sargassum wightii Greville and Ulva lactuca Linn, on the growth and yield of Abelmoschus esculentus (L.) Moench. *Indian Hydrobiology, 7supplement:69-88.*
55. Tay, S. A. B., J. K., Mac Leod, L.M.S. Palni and D. S. Lethan 1985 Detection of cytokinin in a seaweed extract. *Phytochemistry 24: 2611-2614*.
56. Thirumal Thangam, R. and S. Maria Victorial Rani2006. Effect of seaweed liquid fertilizer on photosynthetic pigments of Sorghum bicolour (L.) Moench. *Seaweed Res. Utiln., 2S{l):S\-S4*.
57. Thivy, F. 1958. Economic seaweeds. ImFisheries of West coast of India. Jones (ed.*). ppl-8.*
58. Thivy, F. 1960. Seaweed utilization in India. Proc. Symp. Algology. ICAR, New Delhi, *pp.345-365*.
59. Veeragurunathan, V., V.Meenakshi Sundaram, and C. Balachandar2011. Comparative studies on fertilizing efficiency of LSF from three seaweeds on the growth oi Capsicum annum. *Seaweed Res, Utilin. 33 (1&2) 143- 149.*
60. Veeragurunathan, V.2009. Effect of commercial fertilizer and LSF of Enteromorpha intenstinalis on the growth of Capsicum annum L. *Seaweed Res. Utiln., 31(1&2):157-163*.
61. Venkataraman Kumar and V.R. Mohan, 1994.A comparative study on the effect of and commercial seaweed extracts on seed germination and early seedling growth of Cicer orietinum *L. Acta Botanica Indica 22:175-177.*
62. Venkataraman Kumar and, V.R. Mohan, 1997. The effect of seaweed liquid fertiHzer on black gram. *Phykos, 36 (l&2):43-47.*
63. Venkataraman Kumar, V.R. Mohan, R. Murugeswari and M. Muthusamy, 1993. Effect of crude and commercial seaweed extracts on seed germination and seedling growth in green gram and black gram. *Seaweed Res. Utiln., 16(l&2):23-27.*
64. Venkataraman Kumar. 2005. Recent trends in research and utilization of seaweeds. In : (N. Kalia perumal, J.K. Patterson Edward, V. Edwin Joseph, A. Murugan, P. Chidambaram, J.R. Ramalingam). Souvenir National Symposium on Marine Plants, Their Chemistry and Utilization. Seaweed Research and Utilization Association and Suganthi Devadason Marine Research Institute. Tuticorin. *pp. 44-47.*
65. Venkataraman Kumar. 2010. Application of seaweeds in Agriculture. In: (N. Kaliaperumal, T. Balasubramania, V. Edwin Joseph, P. Chidambarairi and P. Anantharaman, eds) National symposium on marine plants. Souvenir Seaweed Research and Utilization Association and CAS.
66. Vethanayagi, G., K. Sujat and K.Ramamoorthy, 2009a. Effect of soaking - drying with seaweed extracts on vigour and viability in bhendi (Abelmoschus esculentus L.). *Seaweed Res. Utiln.*, 31 (1&2):191-197.
67. Vijayalakshmi, A. and, K.K. Lakshmanan1988. Impact of seaweed extract SM3 on winged bean vegetative parts. *Ad. Plant. Sci.*, 1:229-239.
68. Williams, D.C. K.R. Brain, G. Blunden, P.B. Wildgoose and, S.K Jewe ,1974. Plant growth regulatory substances in commercial seaweed extracts New Zealand *J. Sci.* 19:213-214.