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REGULAR ARTICLE

EFFECT OF SEAWEED LIQUID FERTILIZER ON THE GROWTH, BIOCHEMICAL CONSTITUENTS AND YIELD OF *TAGETES ERECTA*, UNDER FIELD TRIAL

S. Sridhar[1*] and R. Rengasamy[2]

[1]*Department of Botany, Govt. Arts College, Thiruvannamalai- 606 603, Tamil Nadu, India*
[2]*Centre for Advanced Studies in Botany, University of Madras, Chennai-600 025*
Tamil Nadu, India

SUMMARY

The efficacy of Seaweed Liquid Fertilizer of different concentrations obtained from green seaweed *Ulva lactuca* was assessed on the growth, pigments, total chlorophyll, total protein, total carbohydrate and total lipid and the yield of a flowering plant *Tagetes erecta*. The combined effect of 1.0% SLF of *U. lactuca* with different proportions of recommended rate of chemical fertilizers was also made on the test plant. Among the concentrations, plants that received with 1.0% SLF and 50% recommended rate of chemical fertilizers showed a maximum growth characteristic, number and fresh weight of flowers.

Key words: Seaweed liquid fertilizer, Chemical fertilizers, *Ulva lactuca*, *Tagetes erecta*, Yield

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*Corresponding Author, Email: sekarsridhar@rediffmail.com

1. Introduction

Seaweeds as manure dates back to fourth century as a partial substitute for manure (Chapman, 1950). Seaweed extracts are being used as fertilizer to enhance the growth and yield of certain commercial crops (Bockett and Van Staden, 1990; Crouch and Van Staden, 1993; Jeanin *et al*., 1991 and Rama Rao, 1991). The value of seaweed as fertilizers was not only due to nitrogen, phosphorus and potash content but also because of the presence of trace elements and metabolites, similar to plant growth regulators (Booth, 1969). In recent years the use of natural seaweed products as substitutes to the conventional inorganic fertilizers assumed importance (Crouch and Van Staden, 1993 and Gangatharan, 1998). On the basis of these qualities, the seaweed has been tried in the form of concentrated extracts, which are being marketed under different trade names in Western countries (Stephenson, 1965). Improved mineral nutrition leads to healthier plants to withstand better against detrimental attacks by pest. Heightened resistance to fungal, bacterial and insect attack has been observed for a variety of plants treated with seaweed preparations (Aitken and Senn, 1965; Aldwoth and Van Staden, 1987; Booth, 1969; Featonby-Smith and Van Staden, 1983; Featonby-Smith and Van Staden, 1984 and Stephenson, 1965).

2. Materials and Methods

Specimen of green seaweed *Ulva lactuca* was collected form Mandapam coast, Tamil Nadu, in 2002. They were washed thoroughly initially with seawater on the spot and finally with fresh water in the laboratory to remove sand particles and macroscopic epiphytes. They were shade dried for 4 days, followed by oven dry for 12 h at 60˚C. Then the material was hand crushed and made as coarse powder using a mixer grinder. Then the material was taken for the preparation of Seaweed Liquid Fertilizer (SLF) as following the method of Rama Rao (1990). The above algal sample was added with distilled water in a ratio of 1 : 20 (w/v) and autoclaved at 120°C, 15 lbs/sq.

inch for 30 minutes. The hot extract was filtered through double-layered cheesecloth and allowed to cool at room temperature the filtrate was centrifuged at 10,000 x g for 15 minutes. The supernatant was collected and considered as the SLF stock. Its concentration was determined by taking a known volume of the sample (100mL) and kept in a hot air oven at 60°C until it showed a constant weight. A sample SLF was taken for the estimation of macro and micro elements (Humphries, 1956) and auxin (Gordon and Paleg, 1957) and cytokinin (Syono and Torrey, 1976).

Experimental trail was conducted at Panchalam near Tindivanam on *Tagetes erecta* seedlings were raised in 4m x 3m plot. Thirty days old seedlings were taken for transplantation. One or two seedlings were transplanted along a side of the ridges at 30 cm spacing. For each experiment ten plants per row was taken.

Application of different concentrations of SLF viz, 0.25, 0.5, 1.0 and 1.5% as well as different proportions of recommended rate of commercial fertilizers: 25%, 50%, 75% plus 1.0% SLF was made on the plants grown in rows. The plants were irrigated every week. Application of different concentrations of SLF was made 100ml/hill by soil drench on 0 day and 30th day after transplantation as corresponding days of chemical fertilizer application. The plants were also applied separately with different proportions of recommended rate of chemical fertilizers plus 1.0% of SLF on 0 day and 30th day. The 1.0% SLF was taken and mixed the respective proportions of chemical fertilizer thoroughly and distributed equally to 10 plants in a row (100 ml/hill). The plants without any application (SLF or chemical fertilizers) were treated as control I and the plants that received with 100% recommended rate of chemical fertilizers treated as control II.

100% recommended rate of chemical fertilizers

Days	Chemical fertilizers (per ha)	
0day	Urea	- 62.5Kg
	Super Phosphate	- 120Kg
	Potash	- 25Kg
30thday	Urea	- 62.5Kg

e.g. Urea 6.2g/row applied on 30th day.

Mature seeds of *Tagetes erecta* were obtained from the Agricultural depot Arakkonam.

Thirty day old plants were taken for the following parameters total plant height, shoot height, root height (cm), total fresh weight, shoot fresh weight, root fresh weight, total dry weight, shoot dry weight, root dry weight (g) and number of branches. The Chlorophyll, Chlorophyll *a*, Chlorophyll b (Mackinney, 1941), total protein (Bradford, 1976), total carbohydrate (Dubois *et al*., 1956) and total lipid (Folch *et al*., 1957) (mg/g fresh weight) were also recorded. At the end of 60th day the mature flowers of *T. erecta* were picked out and recorded their number and fresh weight (Kg).

3. Results and Discussion

Tagetes etecta treated with four different concentrations of *U. lactuca* SLF 0.25%, 0.5%, 1.0% and 1.5% showed enhanced values on different physical and biochemical features than the plant received only water. The crude extract obtained from *Cladophora* was found to be more effective in increasing the length of main root than *Ulva* extract on *Vicia faba* and appreciable increase in chlorophyll *a* and chlorophyll b (El-Sheekh and El-Saiedh, 1999). Among the treatments the plants that received 1.0% concentration showed a maximum plant height of 51.0cm, which was more than 54.0% when compared to control. Further, SLF treatment increased the number of branches (Table 1) and concentration of photosynthetic pigments. At 1.0 % concentration, the plants contained maximum concentrations of 2.476 mg/g fresh weight of total chlorophyll, 2.021 mg/g fresh weight of chlorophyll *a* and 0.455 mg/g fresh weight of chlorophyll b. their increments were more than 41.0%, 42.0% and 37.0% respectively, when compared to control (Fig.1a).

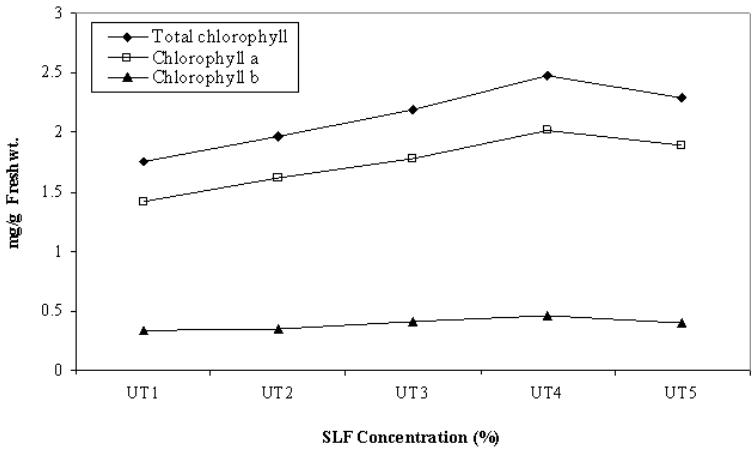
Table 1: Effect of *Ulva lactuca* SLF on growth of *Tagetes erecta* under field trial on 30th day

Parameters	F-value	P-value	Concentrations				
			UT1	UT2	UT3	UT4	UT5
Total plant height (cm)	41.87	0.00**	33.20 ± 0.83^{a}	35.40 ± 2.70^{a}	44.40 ± 4.33^{b}	51.00 ± 1.58^{c}	43.40 ± 1.34^{b}
Shoot height (cm)	34.53	0.00**	29.20 ± 1.48^{a}	30.80 ± 2.77^{a}	39.20 ± 3.70^{b}	43.80 ± 1.48^{c}	38.40 ± 1.14^{b}
Root height (cm)	13.51	0.00**	4.00 ± 0.70^{a}	4.60 ± 0.54^{a}	5.20 ± 0.83^{a}	7.20 ± 0.83^{b}	5.00 ± 0.70^{a}
Total fresh weight (g)	35.98	0.00**	70.42 ± 2.54^{a}	73.74 ± 5.80^{a}	92.82 ± 8.88^{b}	103.74 ± 3.03^{c}	90.68 ± 2.51^{b}
Shoot fresh weight (g)	23.02	0.00**	61.72 ± 3.44^{a}	64.60 ± 5.72^{a}	82.16 ± 7.71^{b}	92.18 ± 3.03^{b}	84.36 ± 8.72^{b}
Root fresh weight (g)	6.15	0.00**	8.70 ± 1.09^{a}	9.14 ± 0.84^{ab}	10.66 ± 1.71^{bc}	11.52 ± 0.46^{c}	10.32 ± 0.52^{abc}
Total dry weight (g)	35.95	0.00**	29.80 ± 2.10^{a}	31.21 ± 4.64^{a}	39.2 ± 7.10^{b}	43.90 ± 2.36^{c}	38.38 ± 1.72^{b}
Shoot dry weight (g)	33.86	0.00**	26.12 ± 2.82^{a}	27.34 ± 4.57^{a}	34.77 ± 6.17^{b}	39.01 ± 2.43^{c}	35.70 ± 1.84^{b}
Root dry weight	6.14	0.00**	3.68 ± 0.87^{a}	3.87 ± 0.67^{ab}	4.43 ± 1.37^{bc}	4.89 ± 0.36^{c}	2.68 ± 0.42^{abc}
Number of branches	6.63	0.00**	1.20 ± 0.83^{a}	2.00 ± 0.70^{a}	2.80 ± 1.30^{ab}	4.00 ± 0.70^{b}	2.80 ± 0.83^{ab}

Note: * denotes significant at 5% level
** denotes significant at 1% level
different alphabets between concentration denotes statistically significant based on multiple range test (Tukey -HSD test).

U - *Ulva lactuca* T - Treatment
UT1 - Control
UT2 - 0.25 % SLF
UT3 - 0.5% SLF
UT4 - 1.0% SLF
UT5 - 1.5% SLF

Fig. 1a: Effect of different concentrations of *Ulva lactuca* SLF on the pigments of *Tagetes erecta* on 30th day

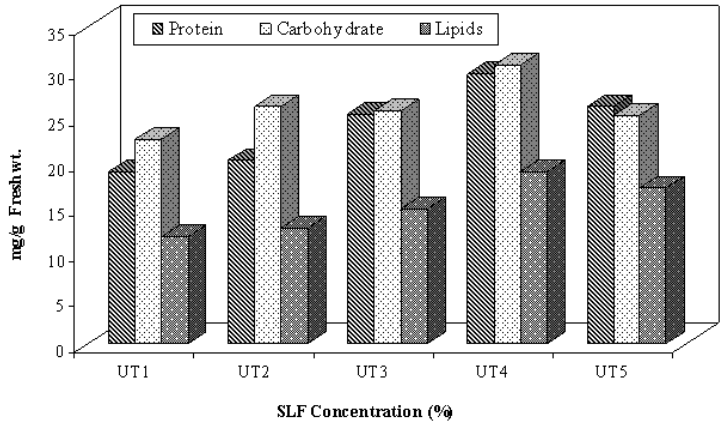


UT1 - Water only, UT2 - 0.25% SLF, UT3 - 0.5% SLF, UT4 - 1.0% SLF, UT5 - 1.5% SLF

Application of seaweed preparations has many beneficial effects on plants (Metting *et al*., 1990; Norrie and Hiltz, 1999). Observations in the present investigation confirm earlier reports showing that the *U. lactuca* SLF can improve the accumulation of

total carbohydrate, total protein and total lipid contents was also found maximum when the plants received with 1.0% SLF on marigold. At this condition their increments were more than 37.0%, 58.0% and 60.0% respectively (Fig. 1b). The plants that received with 1.0% *U. lactuca* SLF showed a maximum yield of 132 flowers with 1.76 Kg fresh weight per 10 plants per row when compared only 93 flowers with 1.24 Kg per 10 plants per row in control (Table 2).

Fig. 1b: Effect of different concentrations of *Ulva lactuca* SLF on the total protein, total carbohydrate, and total lipid content of *Tagetes erecta* on 30th day



UT1 - Water only, UT2 - 0.25% SLF, UT3 - 0.5% SLF, UT4 - 1.0% SLF, UT5 - 1.5% SLF

Table 2 : Effect of different concentrations of *Ulva lactuca* SLF on the yield of *Tagetes erecta*

Concentrations	Number of Flowers/10 plants/a row	Fresh weight of flowers/10 plants /a row (Kg)
Control	93	1.24
0.25% SLF	110	1.55
0.5% SLF	121	1.70
1.0% SLF	132	1.76
1.5% SLF	125	1.72

Among the treatments the plants that received with 50% recommended rate of chemical fertilizers plus 1.0% *U. lactuca* SLF showed maximum plants height, fresh weight, dry weight and number of branches (Table 3). At this condition accumulation of total carbohydrate, total lipid and total protein of the 3rd young leaf was also found maximum. Further, the concentration of total chlorophyll, chlorophyll *a* and chlorophyll b was increased by 34.0%, 33.0% and 38.0%, respectively when compared to 100% recommended rate of chemical fertilizers. The accumulation of total carbohydrate, total protein and total lipid content was also recorded a maximum of 30.9 mg/g fresh weight, 30.8 mg/g fresh weight and 20.1 mg/g fresh weight, respectively (Fig. 2a, b).

The number of pods per plant and seeds per pod the treatment with 2 gm of *Hypenea musciformis* plus chemical fertilizer yielded results to any other treatment (Norrie and Hiltz, 1999). However, in the present study the marigold plants received with 50% recommended rate of chemical fertilizers +1.0% *U. lactuca* SLF showed a maximum number and fresh weight of flowers at this condition, the plants had 142 flowers with 2.6kg fresh weight /10 plants/ row when compared to only 118 flowers with 1.95 kg fresh weight/10 plants/row recorded from

100% recommended rate of chemical fertilizers (Table 4).

Utilization of seaweed as seaweed liquid fertilizer is one of the excellent means to get the lost nutrients back to the land. Application of SLF plays a significant role in improving the yield of crop plants by about 20-30%. The value of seaweed as fertilizer is not from the nitrogen, phosphorous, potash an organic matter but from trace elements (Booth, 1965, 1969). The analysis of seaweed extract of *U. lactuca* revealed that amongst macronutrient the values of total nitrogen were maximum followed by potassium, sulphur, magnesium, calcium and phosphorus (Sekar *et al*., 1995). But in the present study among the macro elements the value of magnesium (384 mg/L) was highest followed by potassium (220 mg/L), calcium (208 Mg/L), nitrogen (24.2 mg/L) and phosphorus (20.9mg/L) and the micronutrients Fe- 7.9, mn – Nil, Cl 170.

Table 3: Effect of different proportions of recommended rate of chemical fertilizers + 1.0% *Ulva lactuca* SLF on *Tagetes erecta* under field trial on 30th day

Parameters	F-value	P-value	Concentrations					
			CUT1	CUT2	CUT3	CUT4	CUT5	CUT6
Total plant height (cm)	40.57	0.00**	34.84 ± 1.82^{ab}	37.28 ± 1.59^{b}	41.80 ± 0.60^{c}	35.38 ± 1.33^{ab}	34.22 ± 1.14^{b}	29.80 ± 1.45^{a}
Shoot height (cm)	35.99	0.00**	29.40 ± 1.49^{bc}	31.64 ± 1.31^{c}	34.86 ± 0.55^{c}	20.58 ± 1.20^{bc}	28.72 ± 1.30^{b}	24.90 ± 1.27^{a}
Root height (cm)	12.10	0.00**	5.44 ± 0.51^{ab}	5.64 ± 0.48^{ab}	6.94 ± 0.58^{c}	5.80 ± 0.40^{b}	5.50 ± 0.25^{ab}	4.90 ± 0.27^{a}
Total fresh weight (g)	39.91	0.00**	72.96 ± 3.84^{bc}	78.10 ± 3.35^{c}	87.60 ± 1.26^{d}	74.14 ± 2.85^{bc}	71.66 ± 2.43^{b}	62.40 ± 3.10^{a}
Shoot fresh weight (g)	35.81	0.00**	61.58 ± 3.14^{bc}	66.28 ± 2.76^{c}	73.02 ± 1.17^{d}	61.96 ± 2.51^{bc}	60.16 ± 2.75^{b}	52.16 ± 2.68^{a}
Root fresh weight (g)	11.79	0.00**	11.38 ± 1.10^{ab}	11.82 ± 1.01^{ab}	14.52 ± 1.21^{c}	12.18 ± 0.90^{b}	11.50 ± 0.51^{ab}	10.24 ± 0.59^{a}
Total dry weight (g)	40.05	0.00**	30.88 ± 3.05^{bc}	33.05 ± 2.67^{c}	37.07 ± 0.97^{d}	31.38 ± 2.27^{bc}	30.33 ± 1.95^{b}	26.41 ± 2.45^{a}
Shoot dry weight (g)	36.52	0.00**	26.06 ± 2.48^{b}	28.05 ± 2.19^{b}	30.90 ± 0.93^{c}	26.22 ± 1.99^{b}	25.46 ± 1.99^{b}	22.07 ± 2.13^{a}
Root dry weight	11.56	0.00**	4.82 ± 0.88^{ab}	5.00 ± 0.81^{ab}	6.17 ± 0.97^{c}	5.16 ± 0.73^{b}	4.87 ± 0.40^{ab}	4.34 ± 0.46^{a}
Number of branches	6.98	0.00**	3.40 ± 0.54^{abc}	4.20 ± 0.83^{c}	4.60 ± 0.54^{c}	3.80 ± 0.83^{bc}	2.80 ± 0.83^{ab}	2.40 ± 0.54^{a}

Note: * denotes significant at 5% level
** denotes significant at 1% level different alphabets between concentration denotes statistically significant based on multiple range test (Tukey -HSD test).

U - *Ulva lactuca* T - Treatment C - Chemical fertilizer
CUT1 - 100% recommended rate of chemical fertilizer
CUT2 - 75% recommended rate of chemical fertilizer + 1.0% SLF
CUT3 - 50% recommended rate of chemical fertilizer + 1.0% SLF
CUT4 - 25% recommended rate of chemical fertilizer + 1.0% SLF
CUT5 - 1.0% SLF only
CUT6 - Water only

Fig. 2a: Effect of different concentrations of recommended rate of chemical fertilizers + 1.0 *Ulva lactuca* SLF on the pigments of *Tagetes erecta* on 30th day

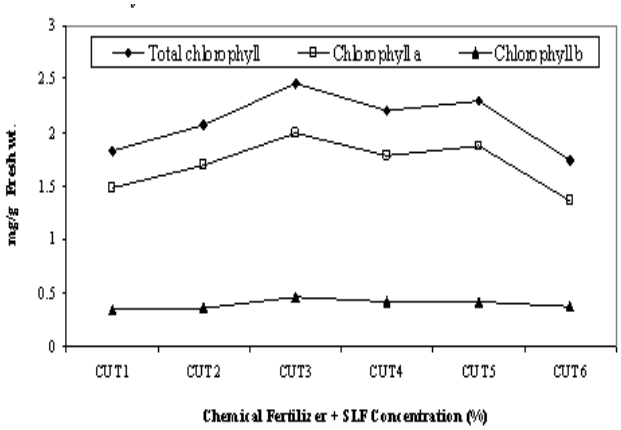
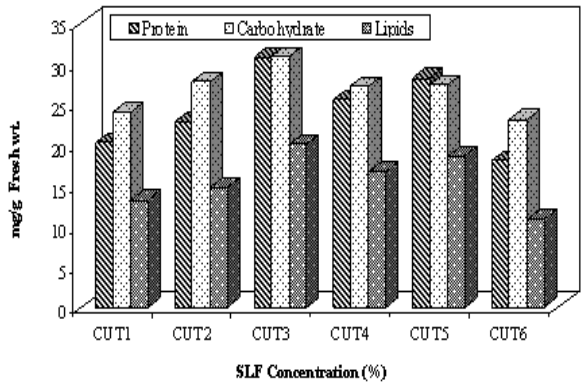


Fig. 2b: Effect of different concentrations of *Ulva lactuca* SLF on the total protein, total carbohydrate, and total lipid content of *Tagetes erecta* on 30th day



CUT1 - 100% recommended rate of chemical fertilizer
CUT2 - 75% recommended rate of chemical fertilizer + 1.0 % SLF
CUT3 - 50% recommended rate of chemical fertilizer + 1.0 % SLF
CUT4 - 25% recommended rate of chemical fertilizer + 1.0 % SLF
CUT5 - 1.0 % SLF only CUT6 - water only

Table 4 : Effect of different proportions of recommended rate of chemical fertilizers + 1.0% *Ulva lactuca* SLF on the yield of *Tagetes erecta*

Concentrations	Number of Flowers/10 plants a row	Fresh weight of flowers/10 plants/a row (Kg)
100% recommend rate of chemical fertilizers	118	1.95
75% recommend rate of chemical fertilizers + 1.0% SLF	125	1.76
50% recommend rate of chemical fertilizers + 1.0% SLF	142	2.60
25% recommend rate of chemical fertilizers + 1.0% SLF	137	1.93
SLF only	120	1.69
Water only	90	1.25

Fe-7.9, Mn-Nil, Cl-170 and F-0.45 mg/L and Auxin 157 µg/L and Cytokinin 200 µg/L were estimated

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Reference

Aitken, J. B. and Senn, T.L., 1965. Seaweed products as a fertilizer and soil conditioners for horticultural crops, *Bot. Mar*., 8 : 144-148.

Aldwoth, S. J. and Van Staden, J., 1987. The effect of seaweed concentrate on seedling transplants, *S. Afr. J. Bot*., 53 : 187-18.

Bockett, R. P. and Van Staden, J., 1990. The effect of seaweed concentrate on the yield of nutrient stressed wheat, *Bot. Mar*., 33 : 147-152.

Booth, E., 1965. The manorial value of seaweed, *Bot. Mar*., 8 : 138-143.

Booth, E., 1969. The manufacture and properties of liquid seaweed extracts, *Sixth international seaweed symposium,* Madrid.

Bradford, M. M., A., 1976. Rapid and sensitive method for the quantification of microgram quantities of protein utilizing the principle of protein-dye binding, *Anal. Biochem*., 72 : 248-254.

Chapman, V. J., 1950. *Seaweed and their uses*, (The Camelot press Ltd. Methuen and Co. Ltd., London and Southampton), pp.63.

Crouch, I. J. and Van Staden, J., 1993. Effect of seaweed concentrate from *Ecklonia maxima* (osbeck) papenfuss on *Melodogyne incoginta* infestation on tomato, *J. Appl. Phycol*., 5 : 37-43.

Dubois, M., Gillies, K. A., Hamilton, J. K., Robbers, P. A. and Smith, F., 1956. Calorimetric method for determination of sugar and related substances, *Anal. Chem*., 28 : 350-352.

El-Sheekh, M. M and El-Saiedh, A. E. F., 1999. Effect of seaweed extracts on seed germination, seedling growth and some metabolic processes of faba beans (*Vicia faba* L.), *Phykos*, 38 : 55-64.

Featonby-Smith, B. C. and Van Staden, J., 1983. The effect of seaweed concentrate on the growth of tomato plants in nematode-infested soil, *Sci. Hort*., 20 : 137-146.

Featonby-Smith, B. C. and Van Staden, J., 1984. The effect of seaweed concentrate and fertilizer on growth and the endogenous cytokines in *Phaseolus vulgaris*, *S. Afr. J. Bot*., 3 : 375-379.

Folch, J., Less, M. and Solune Stanley, G., 1957. A simple method for the isolation and purification of total lipids from animal tissues, *J. Biol. Chem*., 226 : 497-509.

Gangatharan, M., 1998. *Studies on the effect of photo organic compounds on growth and physiological activities of some crop plants*, M.Phil.Dissertation, Madurai Kamaraj University, India.

Gordon, S. A. and Paleg, L. G., 1957. Quantitative measurement of indole acetic acid, *Physiol. Plant*., 10 : 37-48.

Humphries, E. C., 1956. Mineral components and ash analysis, In: *Modern methods of plant analysis* edited by K. Peach and M.V. Tarcey (Springer-Verlag, Berlin). pp. 468-502.

Jeanin, I., Lescure, J. C. and Morot-Gaudry, J. F., 1991. The effects of aqueous seaweed sprays no the growth of maize, *Bot. Mar*., 34 : 469-473.

Mackinney, G., 1941. Absorption of light Chlorophyll solution, *J. Biol. chem*., 140 : 315-322.

Metting, B., Zimmerman, W. J., Crouch, I. and Van Staden, J., 1990. Agronomic uses of seaweed and microalgae, I: *Introduction to Applied phycology* edited by I. Akatsuka (SPB, Publishing, The Hague). pp: 590-627.

Norrie, J. and Hiltz, D. A., 1999. Seaweed extract research and applications in agriculture, *Agro. Food Ind. Hi-Tech*., 10 : 15-18.

Rama Rao, K., 1991. Effect of aqueous seaweed extract on *Zizyphus mauritiana* Lam, *J. Indian Bot. Soc*., 71 : 19-21.

Rama Rao, K., 1990. Preparation of liquid seaweed fertilizer from *Sargassum, Seaweed Research and utilization Association Workshop on algal products and Seminar on Phaeophyceae in India,* Madras, India, 4-7 June.

Sekar, R., Thangaraju, N. and Rengasamy, R., 1995. Effect of seaweed liquid fertilizers form *Ulva lactuca* on *Vigna unguiculata* L. (walp.), *Phykos*, 38 : 49-53.

Stephenson, W. A., 1965. The effect of hydrolyzed seaweed on certain pests and diseases, *Fifth international seaweed symposium*, Halifax.

Stephenson, W. A., *Seaweeds in agriculture and horticulture* (Faber and Faber, London) 1968, pp 231.

Syono, K. and Torrey, G., 1976. Identification of Cytokinins of root nodules of the garden pea, *Pisum sativum* L., *Plant Physiol*.,57:602-604.