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International Journal of Current Research
Vol. 3, Issue, 7, pp.131-134, July, 2011

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

EFFECT OF SEAWEED LIQUID FERTILIZER ON GROWTH, PIGMENT CONCENTRATION AND YIELD OF *Amaranthus roxburghinus* AND *Amaranthus tricolor* UNDER FIELD TRIAL

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ARTICLE INFO

Article History:
Received 18th April, 2011
Received in revised form
12th May, 2011
Accepted 19th June, 2011
Published online 16th July 2011

Key words:
Ulva lactuca,
Seaweed Liquid Fertilizer,
Amaranthus roxburghinus,
Amaranthus tricolor,
Auxin, Cytokinin

ABSTRACT

The present study an attempt has been made to investigate the effect of Seaweed Liquid Fertilizer (SLF) of *Ulva lactuca* without chemical fertilizer on growth, pigment content and yield of *Amaranthus roxburghinus* and *Amaranthus tricolor* (greens) was analyzed. Among the different concentrations of SLF(s) investigated, the *A. roxburghinus* that received with 1.5 % SLF showed maximum fresh weight, dry weight, root and shoot length, leaf area and content of total chlorophyll, chlorophyll a and b, protein, carbohydrate, lipid and yield whereas, in *A. tricolor* maximum at 1.0% level. The SLF was also analyzed for micro and macro elements and the plant growth regulators like Auxin and Cytokinin.

INTRODUCTION

The importance of seaweeds as manure has been recognized for a long time in other countries. However, in India very little information is available on the beneficial effects of seaweeds to improve the crop growth Bhosle *et al.* (1975). Their use as manure is important in the present day world as the seaweed fertilizer is often found to be more successful than the chemical fertilizers (Bokil *et al*., 1972). Seaweeds are marine macro algae, which form an important component of the marine living resources of the world. They are available largely in shallow coastal waters of sea, estuaries and backwaters. The value of seaweed as fertilizer is not from the nitrogen, phosphorous, potash and organic matter but from trace elements and metabolites similar to plant growth regulators (Booth, 1969). The responses of plants to seaweed application are many and varied. These include higher yield, increased nutrient uptake, changes in plants tissue composition, increased resistance to frost, fungal diseases and insect attack, longer shelf life of fruit and better seed germination. It has been suggested that numerous benefits of seaweed are derived from the chelating properties of certain constituents Lynn (1972). The total standing crop of seaweeds from intertidal and shallow waters of all maritime states and Lakshadweep islands was estimated at 91,339 tons (wet weight). The quantity of seaweeds growing in deep waters of Tamil Nadu was estimated at 75,372 tons (wet weight) in an area of 1,863 sq. km. from Dhanushkodi to Kanyakumari (Kaliaperumal and Kalimuthu, 1997). Recent researches proved that seaweed fertilizers are better than other fertilizers since they are very economic and Eco-friendly.

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MATERIAL AND METHODS

The specimens of green seaweed *Ulva lactuca* L. were collected from Mandapam Coast, Tamil Nadu during November 2002. The collected seaweed was washed with seawater initially to remove macroscopic epiphytes and sand particles and finally with fresh water to remove adhering salt. They were shade dry for four days followed by oven dry at 60°C for 12h. Then the materials were hand crushed and made as coarse powder using a mixer grinder. This was added with distilled water in a ratio of 1: 20 (w/v) and autoclaved at 121°C, 15lbs/sq.inch for 30 minutes. The hot extract was filtered through cheese cloth and allowed to cool at room temperature Rama Rao (1990). Its concentration was calculated by keeping a known volume of (100 mL) in a hot air oven at 60º C until it showed a constant dry weight. The 1.0% seaweed liquid fertilizer was analyzed for different macro and microelements, Humphries (1956) as well as plant growth regulators namely auxin Gordon and Paleg (1957) and cytokinin, Syono and Torrey (1976).

The experiments on field of the green namely *A. roxburghinus* and *A. tricolor* were conducted at Vadamampakkam near Arakkonam, Tamil Nadu since the farmer in the above village are practicing the cultivation in the past years. Experiments were conducted in plots. Each plot covered an area of $12m^2$ (4m x 3m). Bunds were raised up to a half a feet. Three duplicates in randomized plots were maintained for each experiment. The greens were grown in sandy loam soil. The experimental area was added initially with Farm Yard Manure (FYM) (5kg / $12M^2$), ploughed thoroughly and removed the weeds. Twenty grams of seeds were uniformly sown separately on the plots and irrigated. Prior to application 1.2L of each SLF concentration was made up to 12L using the well water. Then it was applied uniformly to the respective plots their by receiving 1L of diluted SLF/m^2 (or) 100 ml of SLF conc./m^2. Application of SLFs was made on 10^{th} day after sowing. The experimental plots were irrigated every week. At end of 20^{th} day the greens were uprooted and the following parameters were recorded, total plant height, shoot height, root height (cm), total fresh and dry weight, shoot fresh and dry weight, root fresh and dry weight (g), number of branches, number of leaves and area of third young leaf (cm^2) were recorded. The biochemical parameters of the third young leaf namely total chlorophyll, chlorophyll a and b (Mackinney, 1941), total carbohydrate (Dubois *et al*., 1956), total protein (Bradford, 1976) and lipid content (Folch *et al*.,1957) (mg/g fresh weight) were recorded. Further, the plants were made bundles, (a harmful of stems = one bundle) and number of bundles was recorded.

RESULTS

A maximum total plant height of 30.5 cm was recorded when the plants applied with 1.5% of SLF. The maximum total fresh dry weight of 3.0g and 0.5g respectively, were recorded at 1.5% SLF concentration against 1.9g and 0.14g recorded in control. The number of leaves, branches and bundles and leaf area were increased due to the SLF treatments at all the concentration studied. A maximum number of 69 bundles per plot were recorded at 1.5% (Table 1). The plants applied with different concentrations of the SLF increased the concentration of photosynthetic pigments. Maximum concentration of 2.63mg/g fresh weight of chlorophyll *a* and 0.76 mg/g fresh weight of chlorophyll *b* was recorded at 1.5% of *U. lactuca* SLF treatment. Their increments were more than 90.0% and 105% respectively, when compared to control. The maximum accumulation of 32.2 mg/g fresh weight of total carbohydrate was recorded at 1.5% SLF which was more than 210% to that of control (Fig 1a & b). The plants *A. tricolor* received with different concentration of *U. lactuca* SLF revealed that a maximum fresh weight of 11.18 g recorded at 1.5% concentration was more than 3 ¼ folds when compared to control. The values recorded on the other physical parameters were also found maximum at 1.5% concentration (Table 2). The concentration of photosynthetic pigments namely chlorophyll, chlorophyll *a* and chlorophyll *b* was recorded maximum when the plants received with 1.5% *U. lactuca* SLF. The plants grown in 1.0% SLF showed a maximum of 32.2 mg/g fresh weight of total carbohydrate, which was more than

Table 1: Effect of *Ulva lactuca* SLF on the growth of *Amaranthus roxburghinus* under field trial

Parameters	F-value	P-value	SLF Concentrations					
			Control	0.25%	0.5%	1.0%	1.5%	2.0%
Total plant height (cm)	41.09	0.00**	21.70 ± 1.71^{a}	28.20 ± 2.43^{bc}	30.90 ± 1.81^{c}	41.60 ± 2.85^{d}	30.50 ± 1.65^{c}	25.86 ± 2.96^{ab}
Shoot height (cm)	48.94	0.00**	16.80 ± 1.09^{a}	21.30 ± 1.78^{bcd}	23.50 ± 1.73^{d}	32.40 ± 1.67^{e}	23.00 ± 1.22^{cd}	19.80 ± 2.16^{abc}
Root height (cm)	9.17	0.00**	4.90 ± 0.74^{a}	7.20 ± 0.97^{bc}	8.40 ± 0.82^{c}	9.20 ± 1.75^{c}	7.50 ± 1.00^{bc}	6.06 ± 0.90^{ab}
Total fresh weight (g)	21.16	0.00**	0.86 ± 0.15^{a}	2.08 ± 0.66^{b}	2.71 ± 0.75^{bc}	3.69 ± 0.53^{c}	3.00 ± 0.59^{bc}	2.19 ± 0.23^{b}
Shoot fresh weight (g)	24.01	0.00**	0.79 ± 0.14^{a}	1.90 ± 0.61^{b}	2.47 ± 0.66^{c}	3.44 ± 0.48^{d}	2.82 ± 0.41^{cd}	2.11 ± 0.26^{bc}
Root fresh weight (g)	14.34	0.00**	0.07 ± 0.01^{a}	0.13 ± 0.07^{ab}	0.24 ± 0.10^{bc}	0.24 ± 0.06^{b}	0.03 ± 0.009^{a}	0.02 ± 0.002^{a}
Total dry weight (g)	20.53	0.00**	0.14 ± 0.02^{a}	0.33 ± 0.10^{b}	0.42 ± 0.12^{b}	0.59 ± 0.08^{c}	0.48 ± 0.09^{bc}	0.35 ± 0.03^{b}
Shoot dry weight (g)	22.06	0.00**	0.12 ± 0.02^{a}	0.29 ± 0.09^{b}	0.38 ± 0.10^{bc}	0.52 ± 0.07^{d}	0.45 ± 0.09^{cd}	0.32 ± 0.03^{bc}
Root dry weight	17.52	0.00**	0.01 ± 0.003^{ab}	0.04 ± 0.01^{bc}	0.05 ± 0.02^{c}	0.06 ± 0.01^{c}	0.01 ± 0.002^{a}	0.006 ± 0.001^{a}
Number of leaves	28.40	0.00**	7.80 ± 1.48^{a}	17.40 ± 3.91^{b}	26.40 ± 5.72^{c}	32.00 ± 6.70^{c}	30.20 ± 4.43^{c}	14.40 ± 1.34^{ab}
Leaf area (cm^2)	30.79	0.00**	4.32 ± 0.13^{a}	8.00 ± 0.31^{de}	8.28 ± 0.37^{e}	7.78 ± 0.90^{de}	6.44 ± 0.76^{bc}	7.10 ± 0.73^{cd}
Number of branches	13.61	0.00**	0.00 ± 0.00^{a}	1.00 ± 1.00^{a}	3.80 ± 2.28^{b}	4.60 ± 1.14^{b}	4.60 ± 0.54^{b}	1.40 ± 0.89^{a}
Number of bundles			45	50	48	54	69	46

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).

Table 2: Effect of *Ulva lactuca* SLF on the growth of *Amaranthus tricolor* under field trial

Parameters	F-value	P-value	SLF Concentrations					
			Control	0.25%	0.5%	1.0%	1.5%	2.0%
Total plant height (cm)	68.71	0.0000**	18.60 ± 2.13^{a}	22.50 ± 1.27^{ab}	27.60 ± 1.74^{c}	32.20 ± 1.82^{d}	40.10 ± 3.17^{e}	28.40 ± 1.47^{cd}
Shoot height (cm)	91.41	0.0000**	13.70 ± 1.64^{a}	15.40 ± 1.34^{ab}	17.60 ± 0.41^{bc}	23.10 ± 1.14^{e}	29.60 ± 1.14^{h}	20.60 ± 1.51^{de}
Root height (cm)	26.53	0.0000**	5.04 ± 0.67^{a}	7.10 ± 0.65^{b}	10.00 ± 1.5^{d}	9.10 ± 0.96^{cd}	10.50 ± 0.79^{d}	7.80 ± 0.57^{bc}
Total fresh weight (g)	73.13	0.0000**	2.61 ± 0.60^{a}	3.35 ± 0.67^{a}	5.00 ± 0.91^{b}	8.03 ± 1.24^{c}	11.17 ± 1.14^{d}	3.97 ± 0.38^{ab}
Shoot fresh weight (g)	76.88	0.0000**	2.04 ± 0.54^{a}	3.04 ± 0.59^{a}	4.70 ± 0.81^{b}	7.25 ± 1.05^{c}	9.96 ± 0.96^{d}	3.59 ± 0.33^{ab}
Root fresh weight (g)	37.49	0.0000**	0.21 ± 0.06^{a}	0.31 ± 0.09^{ab}	0.51 ± 0.10^{b}	0.78 ± 0.20^{c}	1.21 ± 0.22^{d}	0.38 ± 0.07^{ab}
Total dry weight (g)	70.72	0.0000**	0.23 ± 0.05^{a}	0.30 ± 0.06^{a}	0.47 ± 0.08^{b}	0.72 ± 0.11^{c}	1.02 ± 0.10^{d}	0.36 ± 0.03^{ab}
Shoot dry weight (g)	76.89	0.0000**	0.20 ± 0.04^{a}	0.25 ± 0.05^{a}	0.40 ± 0.07^{b}	0.61 ± 0.08^{c}	0.84 ± 0.08^{d}	0.30 ± 0.02^{ab}
Root dry weight	37.47	0.0000**	0.03 ± 0.009^{a}	0.04 ± 0.01^{ab}	0.07 ± 0.01^{b}	0.11 ± 0.02^{c}	0.17 ± 0.03^{d}	0.05 ± 0.01^{ab}
Number of leaves	23.38	0.0000**	6.80 ± 0.83^{ab}	6.60 ± 0.89^{a}	0.80 ± 1.64^{ab}	9.80 ± 2.04^{b}	15.80 ± 2.49^{c}	8.00 ± 0.70^{ab}
Leaf area (cm^2)	287.85	0.0000**	16.20 ± 0.98^{a}	21.4 ± 0.73^{b}	28.40 ± 0.90^{c}	32.30 ± 1.44^{d}	37.30 ± 0.64^{e}	20.70 ± 0.70^{b}
Number of bundles			15	24	28	31	35	26

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)

Fig.1a Effect of *Ulva lactuca* SLF on the pigments of *Amaranthus roxburghinus*

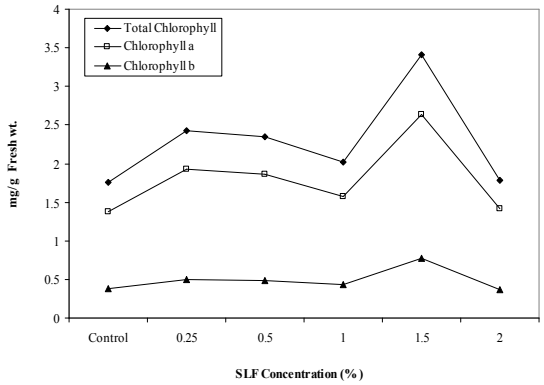


Fig.1b Effect of *Ulva lactuca* SLF on the total protein, total carbohydrate and total lipid content of *Amaranthus roxburghinus*

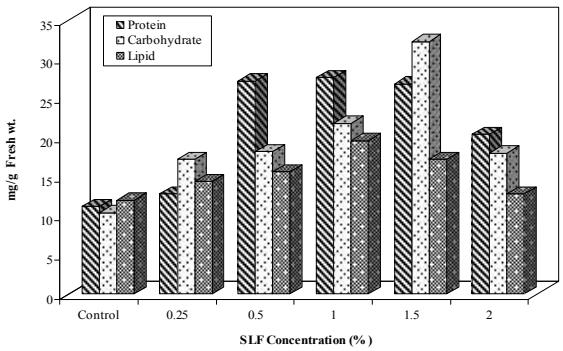


Fig.2a Effect of *Ulva lactuca* SLF on the pigments of *Amaranthus tricolor*

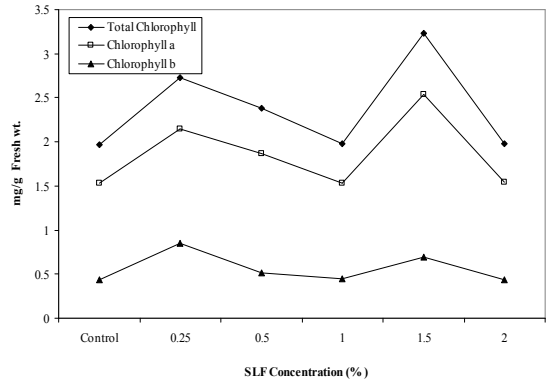
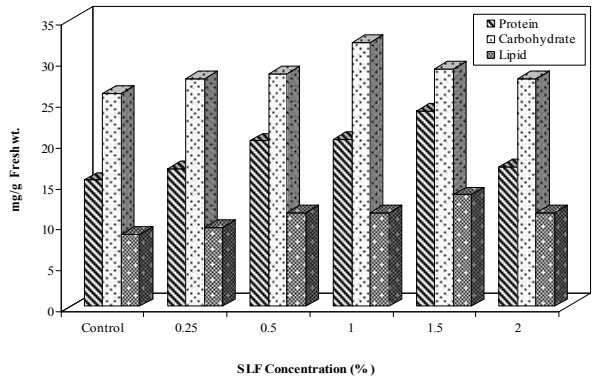


Fig.2b Effect of *Ulva lactuca* on the total protein, total carbohydrate and total lipid content of *Amaranthus tricolor*



24% to that of control. Whereas, the plants grown in 1.5% of SLF showed a maximum of 23.8 mg/g fresh weight of total protein and 13.6 mg/g fresh weight of total lipid content (Fig 2a & b). The seaweed extract of *U. lactuca* contained maximum content of Mg (398mg/L) followed by K (174mg/L), Ca (200mg/L), N (30.0mg/L) and P (16.78mg/L). Among the micronutrients Cl (99mg/L) was recorded a maximum followed by Fe (8.2mg/L) and F (0.30mg/L). The amount of plant growth regulators like auxin and cytokinin contents was recorded up to 166 µg/L and 240µg/L, respectively.

DISCUSSION

Seaweeds show great promise as a source of seaweed liquid fertilizer [SLF] for raising food crops. The present study highlights the efficiency of SLF obtained from the green seaweed, *Ulva lactuca*. The value of seaweed as fertilizer is not from the nitrogen, phosphorous, potash and organic matter but from trace elements and metabolites similar to plants growth regulators (Booth, 1969). Seaweed liquid fertilizer was found superior than chemical fertilizer because of the presence of high level of organic matter (Aitken and Senn, 1965). In present study, the amount of different macro and micro elements present in *U. lactuca* extract was found higher. The commercial seaweed extracts obtained from laminariaceae and fucaceae contained the plant growth regulators like cytokinin (Brain *et al.,* 1973). In this study, the concentration of PGRs namely, auxin and cytokinin were found greater in *U. lactuca.* The greater height and leaf area were observed on green gram when treated with 1.0, 2.0 and 3.0 g of *Chaetomorpha linum* and 2.0g of *Hypnea muscifoemis* plus recommended level of chemical fertilizer, indicating the synergistic influence of the seaweeds and chemical fertilizer (Kannan and Tamilselvan, 1990). The response of *A. roxburghinus* towards the enhancement of leaf growth was found similar. The green preferred a low concentration of 0.5% *U. lactuca* SLF for maximum leaf growth. Whereas, the preference of *A. tricolor* towards the concentration of SLF was found different and higher than that of *A. roxburghinus* treatment. This green preferred a high concentration of 1.5 % of SLF for its maximum leaf growth. *Vigna catajung* when treated with 10% Caulerpa *racemosa* extract contained highest protein and amino acid contents (Anantharaj and Venkatesalu, 2001). The amount of protein content was found highest the shoot system under the treatment of *Enteromorpha* and *Jania* extracts (El-Sheekh and El-Saied, 1999). The concentration of different pigments and total protein content of both the crops showed increased levels when treated with the SLF as in agreement with the findings of earlier workers.

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