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Growth promoting effect of two seaweed extract on chilly, Capsicum annuum L. var. PMK 01

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Abstract

In this study, growth promoting effects of extracts squeezed from the fresh thallus of two seaweeds (Red-*Gracilaria corticata* var.*corticata* and brown- seaweed *Sargassum wightii*) were evaluated on the seedling of chilly under polyhouse condition. The colour of dried sap of red seaweed was red and brown for brown seaweed. The pH was slightly alkaline in both extracts. Minimum difference in ash, total sugar and sodium contents was recorded in both extracts. Content of calcium and magnesium was high in the sap of *Gracilaria corticata* var. *corticata* and the sap of *Sargassum wightii* contained high amount of potassium and sulphate. Generally application of seaweed extracts significantly promoted the growth of chilly. Seedlings received full dose of both seaweed extracts and 50 % recommended dose of fertilizers + 50 % extracts showed more growth than plants applied with 50% *S. wightii* sap and 50% *G.corticata* sap compared to control (plants received recommended dose of fertilizer). This result showed that the application of seaweed extracts have the potential on reducing 50 % fertilizer application. From this study it was concluded that extracts obtained from the fresh thalli of both seaweeds have potential application on organic agriculture as organic fertilizer or biostimulant.

Key words: Seaweed, sap, organic fertilizer, biostimulant, growth promoter

Introduction

Seaweeds (marine macro algae) have long been used as fertilizers in the form of extract or compost to promote plant growth. People living along the coasts have been using seaweeds as mulch in the organic garden. The beneficial effects of seaweed products to promote the growth of plants are well documented. These seaweed products are improving seeds germination, seedlings development, increase plant tolerance to environmental stresses (Zhang and Ervin, 2004, 2008) and enhance plant growth and yield (Hong *et al*., 2007; Zodape *et al*., 2008; Khan *et al*., 2009; Kumari *et al*., 2011; Craigie, 2011). Seaweeds contain commercial cell wall polysaccharides (agar, carrageenan, alginate etc.,) protein, amino acids, lipids, alkaloids, phenols, terpenes, vitamins, hormones, minerals, trace elements**,** iodine and bromine. Hence seaweed are being utilized for the source of food and medicine (Verkleij, 1992).

Application of seaweed based organic matter and nutrients on agriculture crops as soil conditioners have been practiced for centuries. Foliar application of seaweed liquid concentrates give many beneficial effects on the growth of plants as they contain growth promoting hormones (IAA, IBA and cytokinins) trace elements (Fe,Cu, Zn, Co, Mo, Mn, and Ni), vitamins and amino acids (Bokil *et al*., 1974; Durand *et al*., 2003; Strik *et al*., 2004;Kalaivanan and Venkatesalu, 2012).Aqueous extract of *Sargassum wightii* when applied as foliar spray on *Zizyphus mauritiana* increased the yield and quality of fruits (Rama Rao, 1991). Extracts prepared from various seaweeds *Hypnea musciformis, Turbenaria decurrens, Sargassum myriocystum,Enteromorpha intestinalis* etc., (Gandhiyappan and Perumal, 2001; Sivasankari *et al*., 2006; Kalaivanan and Venkatesalu, 2012). Seaweed extracts available in the market as liquid fertilizers and biostimulants contain many growth regulating substances such as cytokinins (Durand *et al*., 2003), auxin (Strik *et al*., 2004), gibberellins (Wildgoose *et al*., 1978), betaines (Wu *et al*., 1997), macronutrients Ca, K and P and micronutrients Fe, Cu, Zn, B, Mn, Co and Mo (Khan *et al*., 2009). Presently demand for agricultural products has been increasing because of population explosion. If seaweeds diverted for preparing extract for crop improvements, there may be raw material shortage for traditional polysaccharides extraction because seaweed extracts were prepared through hot water extraction. In this study, extracts squeezed from the thallus of *Gracilaria corticata* var_*corticata* and *Sargassum wightii* were evaluated for the growth promoting potential of chilly seedling in order to utilize seaweed biomass not only for traditional polysaccharide extraction but also for fertilizer.

Materials and methods

Collection of seaweeds and preparation of seaweed sap: Seaweed sap was prepared from the red seaweed *Gracilaria corticata* var. *corticata* (J.Agardh) J.Agardh 1852(Plate Ia) and brown seaweed *Sargassum wightii* Greville ex J.Agardh 1848(Plate Ib). About 1 kg of fresh, healthy and disease free seaweeds were collected at Manapadu coast (8.3775° N, 78.0522° E Tamil Nadu, India) during November, 2013. The samples were washed thoroughly in seawater followed by tap water to remove the extraneous materials and sand particles. The samples were brought to the laboratory and water was drained immediately. Then the specimens were chopped using pulveriser and the sap was squeezed using muslin cloth. Then

the sap was concentrated using rotary evaporator (Evator, EV11) at 60°C and dried at 60°C in oven. This dried sap was powdered using mortar and pestle and it was treated as seaweed sap.

Plate I. Red seaweed *Gracilaria corticata* var. *corticata*(a) and brown seaweed *Sargassum wightii*(b) collected along the coast of Manapadu, Tamil Nadu, India

Physio-chemical properties of seaweed sap: The powder sap was stored at room temperature in desiccators until further study. Physio-chemical properties such as **c**olour, pH, total sugar (Dubois *et al*., 1956), ash content (Pise *et al*., 2010), sulphate (Krishna Pillai, 1957), calcium and magnesium (Barrows and Simpson 1962) and sodium and potassium (Varian spectra-220AA atomic absorption spectrophotometer) of seaweed sap were recorded. Colour noted based on observation and pH was measured using the pH meter(Hanna,HI98107). For atomic absorption spectrophotometer assay, 1 g of oven dried sample kept at 600°C for 6 hrs and the ash digested in 5 ml of concentrated hydrochloric acid diluted to 50ml in distilled H_2O was used.

Growth promoting effect of seaweed extracts on chilly seedlings

Treatments: Seeds of *Capsicum annuum* L**.** var. PMK were raised in the nursery bed for 20 days in polyhouse at 27-30°C with relative humidity of 75-80 %. Twenty days old seedlings with uniform size were transplanted in to the polythene bags [32x24cm] containing 5 kg of garden soil and compost (1:1 v/v). One seedling was maintained in each polythene bag and 6 replicates were maintained in each treatment under polyhouse (Plate II).Replicates were kept in randomized block design with uniform watering every day. Effect of seaweed extracts on the growth of chilly was evaluated using various treatments applied as soil drench mentioned below:

S. No	Treatment	Detail of treatment
1	T1	Recommended dose of commercial fertilizer (RDF)-(54.67 mg of N:P:Kin 2:1:1 w/w per Kg soil)
2	T2	Full dose *Sargassum* sap(100 mg/Kg soil)
3	T3	Full dose *Gracilaria* sap(100 mg/Kg soil)
4	T4	50 % RDF + 50 % *Sargasum* sap
5	T5	50 % RDF +50 % *Gracilaria* sap
6	T6	50% *Sargassum* sap
7	T7	50% *Gracilaria* sap

The treatment dose was divided into two splits and given on 10th day and 20thday after transplantation. Sampling was done on 60 days old plants after 40 days of transplantation.

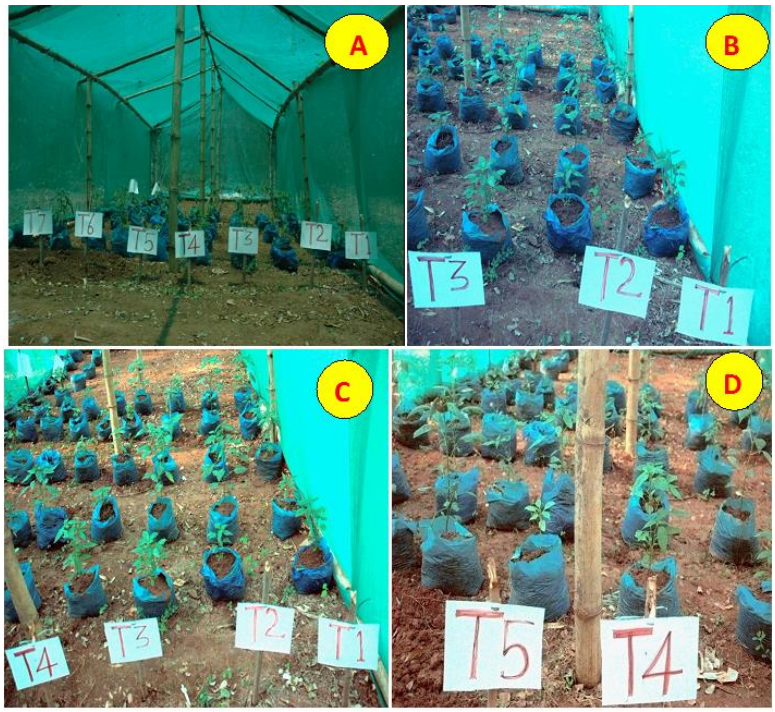

Plate II Seedling of *Capsicum annuum* L. (Family *Solanaceae*) applied with seaweed saps as various treatments raised under polyhouse condition .

Effect of seaweed sap on the growth of chilly: From the randomly selected three samples out of six replicates in each treatment**,** mean length of plant, mean length of shoot, mean length of root, number of leaves per plant, number of lateral roots per plant, number of flowers per plant, total chlorophyll (Arnon 1949), ash content (Pise *et al*., 2010), calcium and magnesium (Barrows and Simpson 1962) were recorded. Data were analyzed using SPSS 14 Statistical program.

Results and discussion

Physio-chemical properties of seaweed extracts

Most of the commercially available growth promoting extracts prepared from the seaweeds was based on the aqueous extraction of fresh or shade dried seaweed specimens. Such extracts contain organic matter, macro and microelements, vitamins, fatty acids and growth regulators such as auxin, cytokinins, gibberellins responsible for promoting the growth of different crops such as tomato (Crouch and Van Staden, 1994), horsegram (Anantharaj and Venkatesalu, 2002), wheat (Kumar and Sahoo, 2011), green gram (Pramanick *et al*., 2013) and soybean (Anisimov and Chaikina, 2014).Commercially valuable seaweeds for phycocolloid production also found as a source for extracting seaweed liquid fertilizer would divert the biomass from phycocolloid production (Verkleij, 1992). Method of extracting the seaweed liquid fertilizer in seaweeds was followed through aqueous heating (Arunkumar *et al*.,2002). In order to use seaweed biomass for more than one product, in this study, seaweed extracts squeezed from the fresh samples of two commercially important phycocolloid producing seaweeds were analysed for physiochemical properties in order to use as fertilizer for promoting agricultural crops (Table 1). The sap of red seaweed *Gracilaria corticata* var. *corticata* appear as red color and squeeze of brown seaweed *Sargassum wightii* was brown in color (Plate III). The pH was slightly alkaline in both extracts. Minimum difference in ash, total sugar and sodium contents was recorded in both extracts. Content of calcium and magnesium was high in the sap of *Gracilaria corticata* var. *corticata* and the sap of *Sargassum wightii* contained high amount of potassium and sulphate. This variation may be due to biochemical constituents of respective species (Arunkumar *et al*., 2014). It is known that seaweed liquid fertilizer obtained in aqueous extraction contain macro and micronutrients and growth hormones that can be used to promote the growth of agricultural crops (Pramanick *et al*., 2013; Anisimov and Chaikina, 2014). The result of this study shows that seaweed sap squeezed from the fresh thallus of both seaweeds contained organic and inorganic nutrients as source of natural fertilizer.

Plate III Dried saps of red seaweed *Gracilaria corticata* var. *corticata*(a) and brown seaweed *Sargassum wightii*(b)

Table 1. Physio-chemical properties of saps of two seaweeds.

S.No	Sap constituents (mg/g dry sap except pH and colour)	*Gracilaria corticata*	*Sargassum wightii*
1	P^H	07.60	07.70
2	Colour	Red	Brown
3.	Ash	50.84	48.60
4	Total Sugar	11.08	09.72
5	Sulphate	03.70	41.71
6	Calcium	74.00	32.00
7	Magnesium	48.00	38.00
8	Sodium	03.68	03.22
9	Potassium	11.11	16.15

Growth promoting effect of seaweed extracts on chilly seedlings

Most of investigations made earlier (Verkleij, 1992) on the seaweed liquid fertilizer as source of natural organic fertilizer were mainly prepared through aqueous extraction method that affects the potential phycocolloids production in seaweeds (Crouch and Van Staden, 1994). An integrated method to extract seaweed liquid fertilizer as well as phycocolloids from commercially important seaweeds such as *Kappaphycus alvarezii*, *Sargassum wightii* and *S. Tenerrimum* was developed (Eswaran *et al*., 2005). Since then, sap crushed from various seaweeds is being applied through soil drenching as well as foliar spry and assessed the growth and yield of various crop plants (Zodape *et al*., 2011; Pramanick *et al*., 2014). In the present study, seaweed extracts obtained from *Gracilaria corticata* var. *corticata* and *Sargassum wightii* and recommended dose of fertilizer as various treatments were applied through soil drench on chilly plants and evaluated the growth promoting effect by studying various growth characteristics (Plate II). Growth characteristics such as shoot height, root height, whole plant height, leaf fresh and dry weight, number of roots, number of leaves and number of flowers are presented in the Table 2. Total chlorophyll, ash content, calcium and magnesium content are presented in the Table 3. Generally significant increase in growth characteristics were recorded in plants received full dose of seaweed extracts T2 (*S. wightii* sap) T3 (*G.corticata* var. *corticata* sap) T4 (50 % recommended dose of fertilizers (RDF) + 50 % *S. wightii* sap) and T5 (50 % RDF +50 % *G.corticata* var. *corticata* sap) compared to plants received recommended dose of fertilizer (T1), T6 (50% *S. wightii* sap) and T7 (50% *G.corticata* var. *corticata* sap)(Table 2 and 3). Macro and micronutrients and growth hormones found in the cell crushed sap obtained in various seaweeds are supporting the plant growth (Eswaran *et al*., 2005; Zodape *et al*., 2011; Pramanick *et al*., 2014). The present study showed that extracts squeezed from the fresh thallus of *Gracilaria corticata* var. *corticata* and *Sargassum wightii* promoted the growth characteristics of chilly plants. This observation suggest that extracts of both seaweeds (*S.wightii* and *G.corticata* var. *corticata*) or 50 % sap with 50 % recommended dose of fertilizers can be applied on chilly plants as fertilizer of natural origin.

It is concluded that extracts of *Gracilaria corticata* var. *corticata* and *Sargassum wightii* can be used as organic fertilizer for the growth of plants in organic production system.

Table 3 Effect of seaweed saps on the biochemical charecteristics of chilly (*Capsicum annum* L.) under polyhouse conditions.

S.No	Treatment	Total Chlorophyll (mg/g fresh wt.)	Ash content (mg per plant)	Ca (mg/g dry wt.)	Mg (mg/g dry wt.)
1	T1	1.25±.15c	39.05±1.59ab	56.12±1.67b	37.20±1.88bc
2	T2	1.53±0.37d	41.05±0.90b	64.54± .40e	45.29±1.05e
3	T3	1.36±0.13cd	40.65±0.50b	62.04±1.22d	40.87±1.48d
4	T4	0.99±0.13b	38.21±2.09a	59.58±2.41c	36.62 ± 2.59b
5	T5	1.33±0.16cd	39.38±1.77ab	57.62±1.68bc	39.20±2.64cd
6	T6	0.77±0.13ab	39.25±0.88ab	52.91± 1.28a	34.25±1.33a
7	T7	0.59±0.12a	40.51±3.01b	51.58± 2.10a	32.25± 1.72a

Mean value with different letter in each column is significant as per DMRT at 0.05 % level.

Details of treatments- T1 -Recommended dose of commercial fertilizer(RDF)
T2- Full dose of *Sargassum wightii* sap; T3- Full dose of *Gracilaria corticata* var. *corticata* sap; T4 -50 % RDF + 50 % *Sargassum wightii* sap' T5 -50 % RDF +50 % *Gracilaria corticata* var. *corticata* sap; T6 -50% *Sargassum wightii* sap; T7 -50% *Gracilaria corticata* var. *corticata* sap

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Table 2 Effect of seaweed saps on growth charecteristics of chilly under polyhouse condition.

S.No.	Treatment	Shoot height(cm)	Root height(cm)	Plant height(cm)	Leaf fresh wt. (mg/plant)	Leaf dry wt. (mg/plant)	Number of lateral roots (per plant)	Number of leaves (per plant)	Number of Flowers(per plant)
1	T1	36.00±0.92a	7.58±0.30a	44.00±1.26a	36.38±2.46c	15.41±1.74b	16.88± .73a	63.16±1.72b	3.96±0.94c
2	T2	37.96±1.76b	8.38±0.53ab	46.35±1.18b	23.50±1.02a	12.71±0.77a	23.35±1.37b	49.76±1.41a	2.63±0.18a
3	T3	50.73±1.55f	8.16±0.75ab	57.90±0.67d	34.41±1.11b	18.16±1.32c	27.36±1.62c	71.66±1.86de	2.60±0.48a
4	T4	45.46±1.03d	9.71±0.77c	52.80±1.41c	45.00±1.41d	23.50±1.87e	27.28±1.57c	72.50±1.64e	3.66±0.81bc
5	T5	47.43±1.02e	11.16±1.16d	57.43±1.02d	33.28±1.18b	20.33±1.03d	31.70±1.04d	78.13±0.76f	3.66±0.98bc
6	T6	45.23±1.32d	8.73±1.07bc	52.73±2.21c	44.86±1.75d	21.33±1.21d	22.81±1.92b	70.43±1.35d	3.31±0.24abc
7	T7	43.00±1.26c	7.51±1.05a	51.33±1.21c	34.91±1.35bc	21.03±1.23d	18.38±.87a	67.16±1.32c	3.08±0.34ab

Mean value with different letter in each column is significant as per DMRT at 0.05 % level.

Details of treatments- T1 -Recommended dose of commercial fertilizer(RDF)
T2- Full dose of *Sargassum wightii* sap; T3- Full dose of *Gracilaria corticata* var. *corticata* sap ; T4 -50 % RDF + 50 % *Sargassum wightii* sap; T5 -50 % RDF +50 % *Gracilaria corticata* var. *corticata* sap; T6 -50% *Sargassum wightii* sap; T7 -50% *Gracilaria corticata* var. *corticata* sap