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Effect of Seaweed Liquid Fertilizer from *Gracilaria Textorii* and *Hypnea Musciformis* on Seed Germination and Productivity of Some Vegetable Crops

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Abstract The effect of Seaweed Liquid Fertilizer (SLF) of *Gracilaria textorii* and *Hypnea musciformis* on seed germination, growth and yield parameters such as number of leaves, weight of fruits in crop plants such as Brinjal, Tomato and Chilly were examined. The Seaweed Liquid Fertilizer was found to be effective in increasing the growth and yield in low doses (1:4 and 1:6 conc.) than the control, 1:2 and higher concentrations of seaweed Liquid fertilizer.

Keywords Seaweed Liquid Fertilizer, Vegetable Crops, Seed Germination, Productivity

1. Introduction

Seaweeds are marine macro algae which form an important component of the marine living resources of the world. The plant growth hormone's effect of seaweed is advantageous to stimulate germination and growth, thereby increasing the yield and resistance ability of many crops (Moller and Smith, 1998). Seaweeds represent an alternative to conventional chemical fertilizers. Commercial use of liquid extracts, obtained from seaweeds is successfully used as foliar sprays for several crops (Bokil *et al*., 1974). The use of marine macro algae as fertilizer in crop production has been a long tradition in coastal areas all over the world. In the recent years, the use of marine macro algae in modern agriculture has been investigated by many authors (Rama Rao, 1990; 1991; Manimala and Rengasamy, 1993; Whapham, *et al.,* 1993). Seaweed extracts are known to enhance seed germination and plant growth (Bhosle *et al.,* 1975; Venkataraman Kumar *et al.,* 1993; Mohan *et al.,* 1994). Seaweeds contain all the trace elements and plant growth hormones required by plants. It was also reported that seaweed manure is rich in potassium but poor in nitrogen and phosphorus than the farm manure (Kingman and Moore, 1982).

In the present day world, the seaweed fertilizers are often found to be more successful that the chemical fertilizers (Bokil *et al.,* 1974). In India, large quantity of macroscopic marine algae has been utilized directly as manure or in the form of compost by coastal peoples (Thivy, 1961). Besides their application as Farm Yard Manure (FYM) Liquid extract obtained from seaweeds popularly known as SLF/LSF has recently gained much interest as foliar spray for inducing faster growth and yield in cereal crops, vegetables, fruits, orchards and horticultural plants (Thivy, 1961; Metha *et al.,* 1967; Hansra, 1993). The present study intends to investigate the effect of Seaweed Liquid Fertilizer (SLF) prepared from *G. textorii* and *H. musciformis* on the seed germination and growth and fruit development of various vegetable crops such as Brinjal, Tomato and Chilly.

2. Material and Methods

Visakhapatnam lies on the East coast of India between latitudes $17^{0}\ 14^{1}\ 30^{11}$ and $17^{0}\ 45^{1}$ and longitudes $83^{0}\ 16^{1}\ 25^{11}$ and 83^{0}

$21^{1}\ 30^{11}$ E with vast resources of marine algal species. Marine red algae such as *Gracilaria textorii* J. Agardh and *Hypnea musciformis* (Turner) Montagne were collected from the Tennate park region of the Visakhapatnam Coast. The seaweeds were washed thoroughly with seawater to remove all the unwanted impurities, epiphytes and adhering sand particles.

3. Extraction of Liquid Fertilizer from Seaweeds

Plant materials of *G. textorii* and *H. musciformis* were collected and washed with tap water to eliminate epiphytes found on the alga. The samples were shade dried for 8-10 days, then powdered and stored in polythene bags.

Extraction: .There are two simple methods of extracting the algae

A. By boiling: 100g of shade dried and powdered seaweed suspended in one liter of deionized water was heated to 100^0

C in water bath for one hour. The extract was to be filtered through a muslin cloth and measured and stored in a refrigerator.

B. By heating: 100g of seaweed was cut into small pieces; one liter of deionized water was added and heated to 50^0 C for 24h. It was filtered, measured, bottled and stored in a refrigerator. About 100ml of seaweed liquid extract was used to prepare 5%, 10%, 15% and 20% concentrations by diluting with deionized water. The diluted extract in different concentrations was sprayed on the crop every 5days interval after germination and every 10 days interval after 20^{th} day.

4. Application of Seaweed Liquid Fertilizer on Crop Plants

Three crop plants raised in the nursery such as Brinjal, Chilly and Tomato were selected in the present investigation to examine the effect of the seaweed liquid fertilizer on these crops. Seeds of these crop plants were obtained from Regional Pulses Research Station, Tamil Nadu Agricultural University, Coimbatore. Seaweed Liquid fertilizer was prepared with different ratios such as 1:2, 1:4, 1:6, 1:8, 1:10, 1:20 and 1:30 and the seeds were soaked in different ratios of the SLF for 12 hours. Seeds soaked in water served as control in these experiments. Rate of germination was observed in control as well as in various concentrations of SLF. Seedlings were planted in different rows for application of different concentrations of fertilizer through foliar method. At the end, crop productivity was estimated.

Table 1. Effect of liquid fertilizer on seed germination of different vegetables:

Concentration of SLF of *G. textorii*	Brinjal (% of germination)	Tomato (% of germination)	Chilly (% of germination)
Control	65 ± 2.0	67 ± 3.1	71
1:2	78 ± 2.5	81 ± 2.8	86 ± 2.7
1:4	92 ± 3.1	96 ± 2.6	98 ± 2.6
1:6	94 ± 2.6	96 ± 3.2	98 ± 2.1
1:8	91 ± 2.8	92 ± 3.4	94 ± 3.2
1:10	82 ± 1.9	86 ± 2.9	88 ± 3.6
1:20	68 ± 1.8	69 ± 1.9	70 ± 1.8
1:30	64 ± 1.4	65 ± 1.6	65 ± 1.6

Data represent three replicates; ± Standard deviation.

Table 2. Effect of liquid fertilizer on seed germination of different vegetables:

Concentration of SLF of *H. musciformis*	Brinjal (% of germination)	Tomato (% of germination)	Chilly (% of germination)
Control	66 ± 2.1	68 ± 2.3	68 ± 3.1
1:2	77 ± 2.6	80 ± 3.1	81 ± 3.5
1:4	91 ± 3.2	93 ± 3.4	96 ± 3.7
1:6	97 ± 2.9	97 ± 3.1	99 ± 3.2
1:8	91 ± 2.8	90 ± 2.9	91 ± 3.4
1:10	81 ± 2.7	85 ± 2.6	87 ± 3.4
1:20	66 ± 2.6	67 ± 2.2	67 ± 3.1
1:30	65 ± 2.1	64 ± 2.6	65 ± 2.8

5. Results

The rate of seed (Brinjal, Tomato and Chilly) germination in different concentrations of SLF from *Gracilaria textorii* was presented in Table 1. Maximum seed germination (94 %) of Brinjal was observed in 1:6 and 1:4 concentrations of SLF and minimum seed germination rate (65%) was observed in 1:30 and control respectively. In case of Tomato, maximum germination rate (96%) was observed in 1:4 and 1:6 concentrations of SLF and minimum was observed in 1:30 and control. Maximum germination rate (98%) for chilly seeds was observed in 1:4 and 1:6 concentrations and minimum germination (66%) was observed in 1:30 (Table. 1).

Table 2 shows the seed germination in different concentrations of SLF from *Hypnea musciformis.* Maximum seed germination (97 %) of Brinjal was observed in 1:6, 1:4 and 1:8 concentrations of SLF and minimum germination rate (66%) was reported in 1:30 concentrations of SLF. In case of Tomato, maximum germination (97%) was observed in 1:6 concentration of SLF and minimum was observed in 1:30 concentration. Maximum seed germination (99%) for Chilly seeds was observed in 1:6 and 1:4 concentrations and minimum germination (65 %) was observed in 1:30 concentration.(Table2)

Table 3 shows the effect of SLF of *Gracilaria textorii* on the growth of different vegetable crops such as Brinjal, Tomato and Chilly. In Brinjal, maximum number of leaves (10 and 9) were observed in 1:6, 1:8 and 1:4 ratios of SLF and minimum number of leaves (5 and 6) were observed in control and 1:30 concentrations of SLF. In Tomato at the time of flowering, 12 leaves were observed in the SLF concentrations of 1:6 and 1:4 and minimum number of leaves (6) was observed in the ratios of 1:30 concentration. In case of Chilly, similar trend was observed with maximum number of leaves (14) were reported in 1:6 and minimum number of leaves (7) was reported in the SLF concentrations of 1:30.

Table 4 shows the effect of SLF from *Hypnea musciformis* on the growth of different vegetables crops. Experiments conducted on Brinjal showed that maximum growth in terms of maximum number of leaves (12 and 10) were observed in SLF concentrations of 1:6 and 1:8 and minimum number of leaves (6 and 7) were observed in the concentration of 1:30 and control. In Tomato, at the time of flowering 14 and 12 leaves were reported in 1:6, 1:4 and 1:8, while minimum number of leaves (6) was observed in control and 1:30 concentrations of SLF. In case of Chilly also similar trend was observed with maximum number of leaves (16) were reported in 1:6 and minimum number of leaves (7 & 8) was reported in control and the SLF concentrations of 1:30.

Table 3. Total numbers of leaves in different crop plants at the time of flowering in different concentrations of SLF:

Concentration of SLF of *G. textorii*	Brinjal	Tomato	Chilly
Control	6 ± 0.2	7 ± 0.3	8 ± 0.3
1:2	8 ± 0.3	8 ± 0.3	12 ± 0.4
1:4	9 ± 0.2	12 ± 0.4	12 ± 0.5
1:6	10 ± 0.4	12 ± 0.4	14 ± 0.4
1:8	9 ± 0.3	10 ± 0.3	11 ± 0.5
1:10	8 ± 0.2	8 ± 0.4	10 ± 0.5
1:20	7 ± 0.3	7 ± 0.3	9 ± 0.4
1:30	5 ± 0.2	6 ± 0.2	7 ± 0.2

Table 4. Total numbers of leaves in different crop plants at the time of flowering in different concentrations of SLF:

Concentration of SLF of *H. musciformis*	Brinjal	Tomato	Chilly
Control	6 ± 0.2	6 ± 0.3	7 ± 0.1
1:2	7 ± 0.3	9 ± 0.2	10 ± 0.3
1:4	8 ± 0.3	12 ± 0.2	13 ± 0.3
1:6	12 ± 0.4	14 ± 0.1	16 ± 0.4
1:8	10 ± 0.4	12 ± 0.1	13 ± 0.3
1:10	8 ± 0.4	9 ± 0.1	10 ± 0.3
1:20	7 ± 0.3	9 ± 0.1	10 ± 0.3
1:30	5 ± 0.2	6 ± 0.1	8 ± 0.3

Table 5. Weight of various vegetables after application of SLF:

Concentration of SLF of *G. textorii*	Brinjal (grams)	Tomato (grams)	Chilly (grams)
Control	57 ± 2.1	34 ± 1.2	10 ± 1.1
1:2	69 ± 1.8	50 ± 1.3	13 ± 1.2
1:4	78 ± 2.2	63 ± 1.6	17 ± 0.8
1:6	77 ± 1.9	67 ± 1.5	19 ± 0.9
1:8	73 ± 1.8	64 ± 1.4	16 ± 0.8
1:10	69 ± 1.6	58 ± 1.5	14 ± 0.7
1:20	65 ± 1.7	48 ± 1.3	13 ± 0.8
1:30	59 ± 1.8	38 ± 1.1	11 ± 0.7

Table 6. Weight of various vegetables after application of SLF:

Concentration of SLF of *H. musciformis*	Brinjal (grams)	Tomato (grams)	Chilly (grams)
Control	57 ± 1.8	39 ± 1.0	14 ± 0.9
1:2	71 ± 1.9	42 ± 1.2	16 ± 0.8
1:4	77 ± 2.1	65 ± 1.3	17 ± 0.9
1:6	81 ± 2.0	68 ± 1.2	19 ± 0.7
1:8	76 ± 1.9	63 ± 1.3	15 ± 0.6
1:10	69 ± 1.7	57 ± 1.2	14 ± 0.8
1:20	64 ± 1.8	50 ± 1.2	13 ± 0.7
1:30	55 ± 1.0	42 ± 1.0	12 ± 0.6

Table 5 showed the productivity of different vegetables in various concentrations of SLF of *Gracilaria textorii* .In Brinjal, maximum weight (78 g) of the vegetable was reported in 1:4 concentrations of SLF and minimum weight (57g) was observed in control. Likewise experiments were conducted on Tomato and Chilly also showed that maximum weight (67g for Tomato and 19 g for Chilly) was reported in 1:6 concentrations of SLF and similarly minimum weight (34 g for Tomato and 10 g for Chilly) was recorded in control only.

Table 6 showed the productivity of different vegetables in various concentrations of SLF of *Hypnea musciformis.* In Brinjal, maximum weight (81 g) was reported in 1:6 concentrations of SLF and minimum weight (55g) was observed in 1:30 concentration. Experiments with Tomato and Chilly showed that maximum weight (68g for Tomato and 19 g for Chilly) was reported in 1:6 concentrations of SLF and similarly minimum weight (39 g for Tomato and 12 g for Chilly) was recorded in control and 1:30 concentrations

6. Discussion

In the developing world, the use of seaweed liquid fertilizer should be urged to avoid environmental pollution by heavy doses of chemical fertilizer in the soil. The growth enhancing potential of seaweeds might be attributed to the presence of carbohydrates , phenylacetic acid (Taylor and Wilkinson, 1997), macro and micro elements (Cahallen and Hemingway, 1965), vitamins and plant growth regulators like cytokinin and gibberellins (Mostafa *et al.,* 1999). Venkataraman Kumar *et al.,* (1993) obtained 100% seed germination at lowest concentrations of SLF in black gram. Anantharaj and Venkatesalu, (2002) reported that high concentration of *Gracilaria edulis* SLF reduced the seed germination in *Dolichos biflorus.* In the present study, maximum rate of seed germination rate was observed in 1:6 concentration of Seaweed Liquid fertilizer of *Gracilaria textorii.* Minimum rate of germination was observed in 1:30 concentration only. 94% of seed germination was reported in the seeds of Brinjal in the SLF concentration of 1:6 and minimum seed germination of 64% was reported in 1:30 concentration. . Similar trend was observed in the remaining two vegetables such as tomato and chilly (Table 1). Retarding effect at higher concentrations could be either due to excess level of growth hormones (Jennings and Tulloch, 1965). In the present study maximum seed germination (99%) for Chilly seeds was observed in 1:6 concentrations of Seaweed Liquid fertilizer of *Hypnea musciformis* and minimum germination (65 %) was observed in 1:30 SLF concentration. (Table 2). Similar trend was observed in the remaining two crops such as Brinjal and Tomato. These observations supported with the earlier studies on application of SLF as seed treatment and the growth of the plants (Mohan *et al.,*1994; Chellen and Hemigway, 1965; Ramamoorthy and Sujatha, 2007).

The growth rate (in all parameters) was increased at 40% of SLF from *Gracilaria verrucosa,* Similarly, the lower values were reported at 100% concentration of SLF (Gandhimaniyan et al., 2010). In the present study, productivity of the vegetable crops was high in 1:6 concentration of seaweed liquid fertilizer prepared from *G. textorii* and *H. musciformis* species. It is due to the presence of growth promoting hormones and nutrients in more quantities in the red algae than in other groups of algae. These findings are confirmed the earlier studies of Mohan *et al.,* (1994) and Rajkumar Immanuel and Subramanian, (1999). Based on the present study on effect of the SLF on crop plants it is evident that the SLF promote the seed germination and as well as yield of the vegetable crops.

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