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EFFECT OF SEAWEED LIQUID FERTILIZER (SLF) OF *PADINA* ON THE GROWTH AND BIOCHEMICAL ATTRIBUTES OF TOMATO (*SOLANUM LYCOPERSICUM* L.)

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ABSTRACT

A nursery experiment was conducted to study the Beneficial effect of seaweed Liquid Fertilizer (SLF) of *Padina* on the growth and biochemical characters of tomato (*Solanum lycopersicum* L.). The nursery soil was treated with SLF of *Padina* at different concentrations (1.0%, 2.0%, 3.0%, 4.0% and 5.0%) and had a positive effect on the growth and biochemical characters of *Solanum lycopersicum*. The positive effect was differed with reference to the concentration of SLF of *Padina*. Among different concentration tested, 3.0% of SLF was superior to other concentrations. Hence, the SLF from *Padina* is best suit for tomato plants especially at 3.0% concentration of SLF.

KEYWORDS: Seaweed, *Padina*, SLF, growth, biochemical, tomato.

INTRODUCTION

The continuous use of synthetic fertilizers are causing severe health and environmental hazards to the agricultural lands such as soil erosion, water contamination, pesticide poisoning, water logging, salinization, depletion of biodiversity *etc*. Thus, farmers are switching over to organic fertilizers for sustainable agriculture. Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health including biodiversity, biological cycles and soil biological activity.[1] Unlike synthetic fertilizer, manure derived from living resources is biodegradable, non-toxic, non-polluting and non-hazardous to soil ecosystem. Consequently, farmers began to shift from chemical-based conventional farming methods towards organic, alternative, or low input sustainable agriculture. With increasing demand, availability of organic fertilizers from one or two sources was not adequate. To meet the increasing demand many viable options have to be explored and one such option is the use of seaweed extracts as fertilizer.[2] In recent years, the use of natural fertilizer has allowed for substitution in place of conventional synthetic fertilizer.[3]

Seaweeds are important marine renewable resources and the extract obtained from the seaweeds is called as Seaweed Liquid Fertilizer (SLF). The extracts are marketed as bio-stimulant since they contain many growth regulators such as cytokinins.[4] Seaweed Liquid Fertilizer (SLF) contained macro nutrients, trace elements, organic substances like amino acids and plant growth regulators such as auxins, cytokinins and gibberellins. Seaweed extracts are known to enhance seed germination, improve plant growth and induce resistance to frost, fungal and insect attack and increase nutrient uptake from soil.[5] Seaweed fertilizers are preferred not only due to their nitrogen, phosphorus and potash content but also because of the presence of trace elements and metabolite similar to plant growth regulators. The seaweed suspensions can be an alternative treatment especially for organic farming.[6] The application of seaweed fertilizers for different crop plants is of great importance to substitute/supplementary to the inorganic fertilizers and to reduce the cost of production.[7,8]

A number of commercial seaweed extract products are available for use in agriculture and horticulture and can be used as liquid extracts applied as foliar spray, soil drench, or in granular/powder form as soil conditioners and manure.[9] These extracts are marketed as liquid biostimulants because a chemical analysis of seaweeds and their extracts has revealed the presence of a wide variety of plant growth-promoting substances such as auxins, cytokinins and betaines. These substances can influence shoot and root system development [10] and promote the growth of various vegetables, fruits and other crops. Many beneficial effects have been reported on the use of seaweed extracts. Positive responses include improved germination, root development, leaf quality, general plant vigour and resistance to pathogens.[11] More than 15 million metric tons of seaweeds are produced annually, a considerable portion

of which is used as biofertilizers in agriculture and horticulture.[12]

MATERIAL AND METHODS

Collection of seaweed

The marine algae *Padina* was freshly collected from the Rameshwaram coastal region. The collected sea weeds were washed thoroughly with seawater to remove all the unwanted impurities, adhering sand particles and epiphytes. Then, the samples were washed thoroughly using fresh water to remove the surface salt and then blotted to remove excess water. The shade dried seaweeds were cut into small pieces and powdered in a mixer grinder and stored in a air tight container for further use.

Preparation and treatment of Seaweed Liquid Fertilizer (SLF)

Seaweeds were shade-dried for four days, followed by oven-drying for 24 hours at 60°C. The dried seaweeds were used for the preparation of Seaweed Liquid Fertilizer (SLF) following the standard method.[13] The filtrate thus obtained was considered as 100% SLF, from which different concentrations (1% to 5%) were prepared by distilled water. Five treatments were given to the nursery plants by the soil application of 1%, 2%, 3%, 4%, and 5% of SLF. In each treatment, 100mL aqueous extract was applied. The first treatment was given to 10-days-old seedlings. Thereafter, three treatments at the intervals of 10 days each were given up to 30 days. The control set was treated only with normal water.

Nursery experiment

A nursery experiment was conducted to study the nursery performance SLF of *Padina* with tomato (*Solanum lycopersicum* L.). The seeds with uniform size, colour and weight were chosen for the experimental purpose and surface sterilized with 0.1% $HgCl_2$ for 1 minute and thoroughly washed with distilled water 3-5 times. Seeds were pre-soaked for 12 hours in distilled water and were sown in sterilized soil mixture. The soil mixture was prepared by mixing of black soil, red soil and sand in the ratio of 1:1:1. To study the nursery performance of SLF of *Padina*, the growth characters such as shoot length, root length, fresh weight and dry weight were studied. The biochemical characters such as total chlorophyll,[14] glucose and aminoacids,[15] protein,[16] and NR activity[17] were studied.

RESULTS AND DISCUSSION

Effect of SLF of *Padina* on the growth attributes

Effect of different concentration of SLF of *Padina* on the growth characters were studied in the untreated control and treated seedlings of *Solanum lycopersicum.* The results revealed that the treatment of SLF of *Padina* improved the shoot length of tomato compared to untreated control. The shoot length of treated plants showed that the maximum length of 28.9cm in 3% concentration of SLF, while the control plants showed only 15.4cm. Plants treated with different concentration of SLF (1.0%, 2.0%, 3.0%, 4.0% and 5.0%) significantly increased the root length than control plants. The maximum length of root observed was 14.2cm in 3% concentration of SLF, whereas, it was decreased as 11.7cm and 10.5cm in 4% and 5% SLF concentration respectively. But the control plant showed very less value of 8.3cm. The results clearly indicated that the application of SLF significantly increased the plant fresh weight over the control plants. The maximum plant fresh weight was noted in 3% concentration of SLF (14.1g) whereas, the control plant showed only 6.7g. The plant dry weight was increased with increasing concentration of SLF up to 3% and then there was a gradual decrease with the concentration of 4% and 5%. Among treated plants, the maximum plant dry weight of 3.92g was observed in plants treated with SLF at the concentration of 3% (Table 1).

Table 1: Effect of SLF of *Padina* on the growth attributes of *Solanum lycopersicum*.

S. No.	Treatment	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)
1.	Control	15.4±0.08 (100)	8.3±0.05 (100)	6.77±0.02 (100)	1.30±0.02 (100)
2.	SLF - 1%	20.3±0.09 (131)	11.3±0.09 (136)	8.73±0.03 (128)	1.75±0.01 (134)
3.	SLF - 2%	24.0±0.03 (155)	12.7±0.03 (153)	11.83±0.01 (174)	2.76±0.02 (212)
4.	SLF - 3%	28.9±0.04 (187)	14.2±0.05 (171)	14.11±0.03 (208)	3.92±0.03 (301)
5.	SLF - 4%	27.5±0.01 (178)	11.7±0.01 (140)	12.94±0.02 (191)	2.81±0.01 (216)
6.	SLF - 5%	26.2±0.06 (170)	10.5±0.03 (126)	10.72±0.02 (158)	1.97±0.01 (152)

Table 2: Effect of SLF of *Padina* on the biochemical attributes of *Solanum lycopersicum*.

S. No.	Treatment	Total Chlorophyll (mg/g LFW)	Glucose content (mg/g LFW)	Protein Content (mg/g LFW)	Aminoacid Content (mg/g LFW)	NRA (µmol NO_2 formed/g LFW/h)
1.	Control	1.28 ±0.01 (100)	10.86±0.08 (100)	1.95±0.05 (100)	1.63±0.02 (100)	0.93±0.05 (100)
2.	SLF - 1%	1.84±0.02 (143)	13.65±0.09 (125)	3.66±0.09 (187)	2.26±0.01 (138)	1.24±0.02 (133)
3.	SLF - 2%	2.57±0.01 (200)	18.97±0.03 (174)	5.52±0.03 (283)	3.97±0.01 (243)	1.86±0.01 (200)
4.	SLF - 3%	3.25±0.02 (253)	22.02±0.04 (202)	7.39±0.05 (378)	5.12±0.03 (314)	2.98±0.04 (320)
5.	SLF - 4%	3.10±0.08 (242)	21.55±0.01 (198)	6.72±0.01 (344)	4.56±0.01 (279)	2.47±0.04 (265)
6.	SLF - 5%	2.47±0.05 (192)	18.69±0.06 (172)	5.63±0.03 (288)	3.82±0.01 (234)	1.72±0.02 (184)

The application of SLF of *Padina* significantly increased the growth characters of tomato such as shoot length, root length, fresh weight and dry weight. The increased seedling growth may be due to the presence of phenyl acetic acid and other micro nutrients and trace elements in the seaweed liquid fertilizers and also presence of other growth promoting substances in *Sargassum wightii*, *Padina boergesenii* and *Ulva fasciata.* Among these three seaweeds, the maximum effect was found in *Sargassum wightii* in all the experimental studies. The increase in plant height with seaweed liquid fertilizer may be due to its stimulation effect on growth and development resulting in good health of plants, while deliberating the effect of seaweed liquid fertilizer on crops the aspects of root development and shoot growth of the plant system.[18,19]

Liquid extracts of marine algae as soil drench to cluster bean plant and noticed maximum influence on growth parameters such as shoot length, root length, total fresh and dry weight and leaf area.[20] The growth enhancing potential of seaweed might be attributed to the presence of carbohydrate, micro and macro elements. The highest shoot length, root length, fresh weight of shoot, dry weight of root, number of lateral root, leaf area index, number of leaf and number of flowers were recorded in the plants with SLF. The SLF treatment increased the growth parameters significantly when compared to the control. Liquid extract obtained from seaweeds has recently gained much interest as foliar spray for inducing growth and yield in cereal crops, vegetables, fruits, orchards and horticultural plants. Seaweeds provide an excellent source of bioactive compounds such as essential fatty acids, vitamins, amino acids, minerals and growth promoting substances.[21,22]

Effect of SLF of *Padina* on the biochemical attributes

The biochemical constituents of *S. lycopersicum* when grown with different concentration of *Padina* SLF showed better results over the control plants. To find out the positive response of SLF of *Padina*, the biochemical parameters such as total chlorophyll content, glucose content, protein content, aminoacid and nitrate reductase activity were analyzed. In *S. lycopersicum*, at 3% concentration of SLF showed the maximum pigment production (Total chlorophyll) (3.25mg/g LFW) over the control plants (1.28mg/g LFW). But, slight reduction was observed in 4.0% (3.10mg/g LFW) and 5.0% (2.47mg/g LFW) concentration of SLF. In plants treated with SLF of *Padina* significantly increased the glucose content of *S. lycopersicum* and it was higher in plants treated with 3.0% concentration of SLF (123%). The least glucose content was noticed in plants treated with control plants. The application of SLF of *Padina* significantly increased the protein content and the higher protein content was observed in 3% of SLF (7.39mg/g LFW) when compared to the untreated control plants and then gradual decrease in 4% (6.72mg/g LFW) and 5% (5.63mg/g LFW) of SLF. The aminoacid content was estimated in plants treated with 1% to 5% of SLF of *Padina*. The aminoacid content was higher in plants treated with 3.0% of SLF (5.12mg/g LFW) than other treatments. The aminoacid content was only 1.63mg/g LFW in control plants. The treatment of SLF significantly increased the NR activity in tomato plants over the control plants. The activity was higher in plants treated with SLF of 3% .With increase the concentration of SLF of *Padina*, there was a gradual increase in the NRA up to 3% and then gradual decrease was observed in 4% and 5% concentration of SLF (Table 2).

Seaweed extract application in bean plant by foliar spray increased the leaf pigment (particularly chlorophyll a) and protein content. But at high proportion of seaweed extract decreased these parameters.[23] SLF applied at low concentration of *Ascophyllum nodosum* extract to soil or on foliage of tomatoes produced leaves with higher chlorophyll content than those of untreated controls. This increase in chlorophyll content was a result of reduction in chlorophyll degradation, which might be caused in part by betaines in the seaweed extract.[24]. The analysis for protein in SLF treated plant of *Vigna radiata* showed increase protein content in both leaves and seeds.[25]

The increase in protein content at lower concentrations of liquid extract may be due to absorption of most of the necessary elements by the seedling.[26,27] In *Vigna sinensis*, the sugar content increased up to 20% with *Sargassum wightii* liquid extract but showed a decline at higher concentrations.[28] With respect to nitrate reductase activity, the foliar application of seaweed extract increased the enzymatic activity. *Ulva rigida* extract was found more effective than *Fucus spiralis*. The incorporation of *Fucus spiralis* extract showed a remarkable increased of nitrate reductase activity particularly at proportion (50% and 75% of *Fucus spiralis* extract) while a high proportion of this extract (100% of *Fucus spiralis* extract) decrease the nitrate reductase activity. SLF of *Turbinaria decurrens* seaweed extract up to 1.5% showed more *in vivo* NR activity of *Cicer arietinum*. Leaf nitrate reductase activity decreased correspondingly with increase in the seaweed extract concentration. It has also been reported that the enzyme activity was in association with photosynthesis of carbohydrates and proteins reported that the enzyme activity was in association with photosynthesis of carbohydrates and proteins.[29,30]

CONCLUSION

Now-a-days, the synthetic fertilizers were mostly used in agriculture when compared with organic fertilizers. Prolonged usage results in diminishing soil fertility, soil erosion, health threads to human, livestock and also microbial community present in the soil. To overcome this problem and to increase the efficiency of plant cultivation, seaweed extracts can be used as fertilizers in sustainable agriculture. By considering the above important findings, the seaweed extracts derived from *Padina* act as an effective Seaweed Liquid Fertilizer (SLF) in increasing the growth as well as biochemical characters. Hence, this simple practice of application of eco-friendly seaweed liquid fertilizers to economically important plants like tomato of South India is recommended to the growers for attaining better growth, development and yield of the plant.

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