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Studies on Pharmacognostical and Biochemical Constituents of Selected Seaweeds and Their Effects as Liquid Fertilizers on Growth of Crop Plants

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Abstract

The effect of Seaweed Liquid Fertilizer (SLF) of three seaweeds was tested at different concentrations (10%, 20%, 40%, and 60%)on growth parameters of *Allium cepa* (onion), *Solanum melongena* (brinjal), *Eleusinecoracana* (ragi), *Oryza sativa* (paddy), *Solanum lycopersicum* (tomato).Seaweed extracts at different concentration were used to find out their efficiency on germination of seeds and plant growth inhibiting (toxic) concentration. This study revealed that the 40% level of SLF enhances the growth and yield than other concentrations. Thus in the present study, the effect of seaweed extract on plant germination is being discussed and the future perspective of its usage as a bio-fertilizer can be encouraged.

Keywords: Seaweed Liquid Fertilizer- Growth- yield-*Gracilariacorticata-Chaetomorpha antenna -Ulva fasciata.*

Introduction

The usage of seaweeds in agricultural land as a manure is very antique and common practice in several countries. Use of seaweeds as a fertilizer in the production of crop has an extended practice in coastal areas throughout the world. The seaweeds are known to possess several trace elements and growth hormones which are necessary for growth of plants. Seaweed manure was reported to comprise of nitrogen, potassium, and phosphorus.

Marine algal seaweed species are often regarded as an under-represented bio resource. The benefits of seaweeds as sources of organic matter and fertilizer nutrients have led to their use as soil conditioners for centuries [1,2]. Numerous studies have revealed a wide range of beneficial effects of seaweed extract applications on plants, such as early seed germination and establishment, improved performance and yield, elevated resistance to biotic and abiotic stress, and enhanced post-harvest shelf-life of perishable products [3,4]. Bokil et al. [5] has reported seaweed extracts are bioactive at low concentrations (diluted as 1:1000 or more). Liquid extracts obtained from seaweeds are successfully used as foliar sprays for several crops [6]. The growth enhancing potential of seaweeds might be attributed to the presence of macro and micronutrients [7].

Seaweed Liquid Fertilizer (SLF) is found to be highly potential compared to chemical fertilizers by current researches. Thus seaweed extracts as liquid fertilizers have come in market is established in recent years [8]. The favorable effect of seaweed extract application is a result of several components which works synergistically at various concentrations, even though the mode of action still remains indefinite. In this study, effect of three common seaweeds viz. *Gracilariacorticata, Chaetomorpha antenna* and *Ulva fasciataas* liquid fertilizer was established on crop plants.

Materials and methods

Collection of seaweeds

In the present study, effect of three common seaweeds viz. *Gracilariacorticata, Chaetomorpha antenna* and *Ulva fasciata* were handpicked in between intertidal rocks of Surathkal beach, Karnataka, India (13 00`34.1" N lat. & 74 47`16.1" E long). The collected seaweed was botanically identified by Dr. C.R.K Reddy, CSIR- Central Salt and Marine Chemicals Research Institute, Bhavnagar, Gujarat, India.

Preparation of seaweed liquid extract

Fresh seaweeds were washed thoroughly to remove all the epiphytes and sand particles with tap water. They were shade-dried for five to nine days. The dried seaweeds were powdered using kitchen type blender; further they were used

for the preparation of Seaweed Liquid Fertilizer (SLF). The coarse powder was mixed with distilled water in the ratio of 1:20 (w/v). Boiled for 60 minutes and filtered through four fold of white cloth. The filtrate was collected and stored. The filtrate thus obtained is considered as 100% [9]. Four different concentrations of solutions such as 10%, 20%, 40%, and 60% were prepared and used for the study.

Selection of crop plants

The crop plants, selected for the present study were onion, brinjal, ragi, paddy and tomato. The seeds were collected from the Indian Institute of Horticultural Research, Bangalore, Karnataka. The seeds with uniform size, color and weight were chosen for the experimental purpose and thoroughly washed with distilled water 3-5 times.

Effect of Seaweed Liquid Fertilizer on plant germination

Seeds of *Allium cepa* (onion), *Solanum melongena* (brinjal), *Eleusinecoracana* (ragi),*Oryza sativa* (paddy), *Solanum lycopersicum* (tomato) were treated with 3 different seaweed liquid fertilizers as described elsewhere [10]. Petri plates were sterilized to avoid spoilage of seeds, and then filter paper was placed to provide support and hold moisture for the germination of seeds. Each plate was placed with three seeds of *A.cepa, S. lycopersicum* respectively. Four different concentrations (10, 20, 40 and 60) of seaweed liquid fertilizer were poured on each plate with respect to the seaweed and seeds. The seeds were placed over filter paper and then, these were incubated at room temperature. The plates were kept separately with 12 hours of dark and 12 hours of light. Also field study was carried out using *A.cepa, S. melongena, E. coracana, O. sativa, S. lycopersicum.* The seeds were monitored for germination after three days and the growth of the seedlings were observed after a period of fourteen days from the day of treatment. After the observation of germination and growth of seedlings in the plate and the seedlings in field which were treated with different concentration of liquid fertilizers, various parameters such as number of leaves, height of the shoot, length of the root, number of lateral roots were measured. A plate with water instead of liquid fertilizer was kept as control.

Pharmacognostical studies

The powder of *G. corticata, C. antenna* and *U. fasciata* were mixed with different chemical substances for their identification purposes.

Sl. no Treatment

1. Seaweed powder + 50% H_2SO_4
2. Seaweed powder + concentrated H_2SO_4
3. Seaweed powder + 50% HCl
4. Seaweed powder + concentrated HCl
5. Seaweed powder + 50% HNO_3
6. Seaweed powder + concentrated HNO_3
7. Seaweed powder +10% NaOH
8. Seaweed powder +5% $FeCl_2$
9. Seaweed powder + 5% KOH
10. Seaweed powder + Ethanol
11. Seaweed powder +Acetic acid
12. Seaweed powder + 1N HCl
13. Seaweed powder + 1N NaOH +Ethanol

CHN analysis

The CHN Analyzer (Leco- TruSpec® CHN, USA) was used to determine total carbon, hydrogen and nitrogen content by combusting the dried samples and using a calibrated using EDTA as a reference standard.

Results and Discussion

Growth of shoot was influenced by all the concentrations of *G. corticata, C. antenna* and *U. fasciata* extracts and a maximum value was recorded for 20%, 40% and 60% respectively. Among the field study of three seaweed liquid fertilizers, *G. corticata* liquid fertilizer yielded better results compared to other two seaweeds. Temple has reported [11] increase in the harvest of bean by seaweed foliar applications, whose average yield was increased by 25%. Csizinszky has reported [12] staked tomato yields increase by 99%. The presence of macro and micronutrients and also some growth promoting substances might lead to enhancing the growth potential of seaweed extracts [13,14]. Whap ham et al. [15] has reported to increase in chlorophyll of cucumber seedlings and tomato plants with application of seaweed (*Ascophyllumnodosum*).

Pharmacognostical studies

In normal visible light, different colors were observed in the reaction of different chemical substances with fine powder of *G. corticata, C. antenna* and *U. fasciata* the results of which are tabulated (Table 1). The carbon, hydrogen and nitrogen content of three seaweeds were determined, out of which *C. antenna* showed highest carbon value, while hydrogen content was found to be highest in *G. corticata* and *U. fasciata* was found to have highest nitrogen content (Table 2).

Table 1: Pharmacognostical studies of three seaweeds.

Sl.No	Treatment	*G. corticata*	*C. antenna*	*U. fasciata*
1	50% H_2SO_4	Light yellow	Green	Light green
2	Conc.H_2SO_4	Brown	Yellowish green	Brownish yellow

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3	50% HCl	Yellowish green	Light green	Ash colour
4	Conc. HCl	Light yellow	Ash colour	Ash colour
5	50% HNO_3	Light yellow	Ash colour	Ash colour
6	Conc. HNO_3	Light yellow	Ash colour	Light yellow
7	10% NaOH	Light brown	Ash colour	Ash colour
8	5% $FeCl_3$	Yellow	Yellow	Yellow
9	5% KOH	Greenish yellow	Light green	Light green
10	Ethanol	Light green	Light green	Ash colour
11	Acetic acid	Light yellow	Yellowish green	Ash colour
12	1N HCl	Ash colour	Ash colour	Ash colour
13	1N NaOH + ethanol	Light green	Light green	Light green

Table 2: CHN Content of three seaweeds.

Seaweeds	Carbon%	Hydrogen%	Nitrogen%
G. corticata	36.5	6.46	5.04
C. antenna	43.9	5.11	5.55
U. fasciata	42.8	5.58	6.07

In this study 60% of *G. corticata*,60% of *C. antennina* and 60% of *U. fasciata* as liquid fertilizer have shown better yield for onion (Table 3).In this study 20% of *G. corticata*, 20% of *C. antennina* and 60% of *U. fasciata* as liquid fertilizer have shown better yield for tomato (Table 4). In this study 60% of *G. corticata,* 40% of C. antenna and20% of *U. fasciata* as liquid fertilizer have shown better yield for brinjal (Table 5).In this study, 20% of *G. corticata*, 40% of *C. antennina* and60% of *U. fasciata* as liquid fertilizer have shown better yield for paddy (Table 6).In this study, 20% of *G. corticata,* 40% of *C. antennina* and60% of *U. fasciata* as liquid fertilizer have shown better yield for ragi (Table 7).

Table 3: Shoot length of onion (in centimeters).

	Conc. of extract	10%	20%	40%	60%	Control
G. corticata	8th day	11.83	9.5	8.25	11.16	7.85
	20th day	16	11.5	10.83	18.33	9.1
	42nd day	21.5	16.35	18.25	26	15.16
	60th day	28.33	17.5	20.33	33.33	17
	70th day	35.33	24	24.25	44	23.5
C. antennina	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	12.6	10	11.66	11.66	7.85
	20th day	19.3	14.66	23.5	19.5	9.1
	42nd day	24.03	20.16	30.6	26.33	15.16
	60th day	20.33	21.66	36	34	17
	70th day	26	28.25	37.5	50	23.5
U. fasciata	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	13.33	21.73	14	25.16	7.85
	20th day	12.5	12.2	12	13.33	9.1
	42nd day	21.5	17.5	18.25	26	15.16
	60th day	24.66	34.25	21.66	39.93	17
	70th day	34.5	39.5	36.5	44.33	23.5

Table 4: Shoot length of Tomato(in centimeters).

	Conc. of extract	10%	20%	40%	60%	Control
G. corticata	8th day	10.66	10.6	9.33	11	5.66
	20th day	17.6	21.83	21.6	18	11.3
	42nd day	64	42.66	47	32.66	25
	60th day	69.5	65.33	70	64.5	39.66
	70th day	78.33	88.66	86.33	81	51.5

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C. antennina	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	8.4	11	10.5	7.33	5.66
	20th day	13.66	17	20.66	12	11.3
	42nd day	33.16	42.5	38.33	30.33	25
	60th day	40.33	51.33	41.33	41.66	39.66
	70th day	5550%	7850%	6350%	7350%	51.5
U. fasciata	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	6.8	10.33	10.33	13.5	5.66
	20th day	18.33	21.16	19.16	24.5	11.3
	42nd day	34	40.33	32	52.5	25
	60th day	48	53	53	73	39.66
	70th day	55.5	68.3	77	91.5	51.5

Table 5: Shoot length of Brinjal(in centimeters).

G. corticata	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	2.46	-----	6.5	5.2	2
	20th day	3.5	2.1	8	8.5	5.34
	42nd day	8.5	10	17	12.5	7
	60th day	15.33	16	25	25.33	13
	70th day	23	26.5	32	44.5	20
C. antennina	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	4.25	5	6	3.5	2
	20th day	4.7	7	9	5	5.34
	42nd day	8.7	12.75	13.83	10	7
	60th day	14	13.5	20.66	17	13
	70th day	26	16	37	18	20
U. fasciata	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	-----	4.83	3.5	7	2
	20th day	5	8	8	9.5	5.34
	42nd day	10.33	15.66	13.5	14.5	7
	60th day	16.66	23.33	20	25	13
	70th day	23.33	42.5	31.5	32.5	20

Table 6: Shoot length of Paddy(in centimeters).

G. corticata	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	6.5	7.5	6	6.66	5.33
	20th day	6.73	13.33	11.75	13.5	6.33
	42nd day	15.66	18.16	18.3	18.3	10
	60th day	16.66	25	27.33	24	12.66
	70th day	22	34.5	29.66	27.5	22
C. antennina	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	4.76	6	5.16	5.13	5.33
	20th day	6.33	7.66	6.5	6.5	6.33
	42nd day	13.5	13.83	15.66	14.83	10
	60th day	17	18	20.33	20.66	12.66
	70th day	22.5	20	29.5	24.5	22
U. fasciata	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	5.5	5.66	5	6.5	5.33
	20th day	9.83	10.16	9.83	10.66	6.33

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	42nd day	16.33	16.5	18.66	17.5	10
	60th day	20	20.66	23.66	25.66	12.66
	70th day	26.6	23.66	30.5	31.5	22

Table 7: Shoot length of Ragi (in centimeters).

	Conc. of extract	**10%**	**20%**	**40%**	**60%**	**Control**
G. corticata	8th day	7.12	7.4	7.16	13.5	4.95
	20th day	12.66	13.5	13.83	13.5	5.5
	42nd day	22	23	22	23.43	14.3
	60th day	32	41.66	39	40.66	16.66
	70th day	45.33	82.6	60	52.5	27.5
C. antennina	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	4.5	6	7	5.96	4.95
	20th day	8	8.83	10.33	9.16	5.5
	42nd day	15	16.73	16.1	16.83	14.3
	60th day	25.33	25.66	25.33	25.6	16.66
	70th day	39	33.5	39.5	28.5	27.5
U. fasciata	**Conc. of extract**	**10%**	**20%**	**40%**	**60%**	**Control**
	8th day	5.23	5	4.83	6.16	4.95
	20th day	8.83	11.66	11.33	17	5.5
	42nd day	17.66	16.33	15.83	21.5	14.3
	60th day	20.66	22.66	26.33	39	16.66
	70th day	26	44.33	34	56	27.5

Conclusion

This study also confirms that use of seaweed extracts as liquid fertilizer was found to be highly effective in promoting growth; it is a wise eco friendly technique to enhance crop production. In this study, concentration of *G. corticata* as liquid fertilizer showed best results. Seaweed extract which gave better results at lower concentration shall be utilized at very high dilution rate in agricultural field that can enhance the rate of germination of seeds. It will not affect native useful microorganisms present in soil and also seaweed as fertilizer is economical.

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