Potentiality of marine seaweeds to reduce soil salinity

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***Abstract*—The present study aimed to evaluate the potentiality of four seaweeds, which belong to different algal taxa like *Ulva lactuca* Linnaeus is green alga, *Sargassam spp.* and *Spatoglossum asperum* is brown alga and *Botryocladia leptopoda* is red alga all are used as soil amendment to reduce the soil salinity. Furthermore, the different concentrations of seaweeds i.e. 2gm, 4gm and 8gm were investigated for saline soil samples collected from Khambhat district, Gujarat. Amongst from the different concentration of the seaweeds species, the 2gms concentration of the seaweeds observed best soil conditioner and reduce the maximum salinity from the soil. Hence, the selected red seaweed has shown the negative effect against soil salinity. The brown seaweed spp. *Sargassam* gives the maximum positive effect against soil salinity in the 2gm of the concentration.**

***Key words* —Reduce salinity, Saline soil, Marine algae, Soil amendment**

INTRODUCTION

Seaweeds are thallophytic, macro- aquatic algae belonging to the plant kingdom [1]. Seaweeds have the ability to flourish within a large range of extreme environmental habitats. However, when adapting to new environmental surroundings, they produce a wide variety of hygienic primary and secondary metabolites [2]. Seaweeds are regarded as a gem of untapped natural biologically active compounds [3]. They have been used as renewable quality and quantitative bio-resources in sustainable botanical applications [4]. Chemical fertilizers, pesticides, fungicides, and herbicides give immediate results; however, their continuous use has an adverse impact on the quality of the soil, the beneficial soil microbial communities, the soil's fertility, and on the plants cultivated in these soils.

Seaweeds are effectively used as bio-fertilizers because they include high levels of organic matter, which leads to soil nutrient enrichment [5,6]. In addition, they were found to be a better and more suitable alternative to chemical and mineral fertilizers when used in adequate quantities [7]. Many recent studies have discovered wide applications of these marine macro algae (in the form of finely powdered or aqueous extracts) as eco-friendly fertilizers in modern agriculture and horticulture [8]. The application of seaweeds as a soil drench was found to be more effective on plant vigor than the foliar spray application [9].

Salinity stress is a major abiotic stress that has significant negative effects on plant growth and yield by causing osmotic and ionic stresses that affect various primary metabolic processes in plants [10]. These negative effects include interference with the root function in absorbing water, as well as detrimental effects on physiological and biochemical processes, such as nutrient uptake and assimilation [11]. Unfortunately, soil salinity is a current growing issue in a number of areas around the world. It is estimated that at least 0.3 million hectares of farmland are becoming unusable annually and another 20–46 million hectares are suffering decreases in production potential each year [12]. The development of strategies to alleviate the adverse effects of salinity stress on plants has received considerable attention.

The novelty of the current study is in the comparison between the efficiency of four different algal taxa not only as bio-fertilizers, but also as protective agents against environmental stress such as salinity.

MATERIAL AND METHODS:

Collection of soil samples:

Saline soil samples were collected from the Khambhat District, Gujarat. The details of the soil samples given below in table 1.

Table 1: Soil sample collection from Khambhat District, Gujarat

Soil sample collection	Sample ID	Location Details		Colour
		Latitude (N)	Longitude (E)	
Khambhat Beach	S1	22°17'36"	72°36'41"	white-grey
Akhol	S2	22°22'31"	72°32'2"	white-grey

Collection of Marine seaweeds:

In the current study seaweeds such as green alga *Ulva lactuca* Linnaeus, brown alga *Sargassam spp.* And *Spatoglossum asperum* and red alga *Botryocladia leptopoda* were collected from the Okha coast, Gujarat.

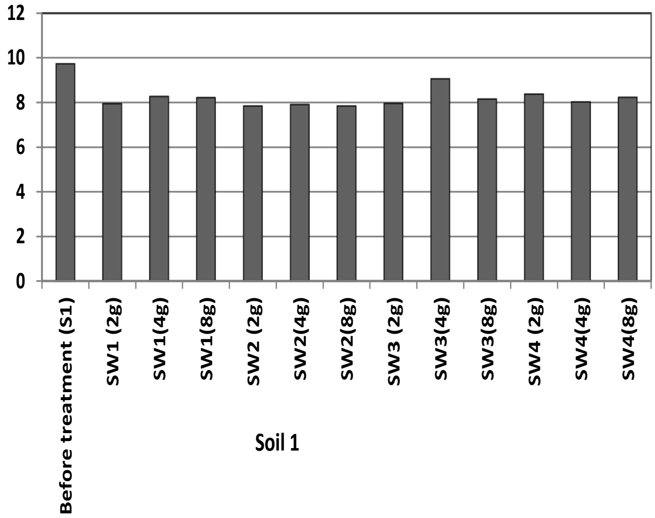
Preparation of collected saline soil samples:

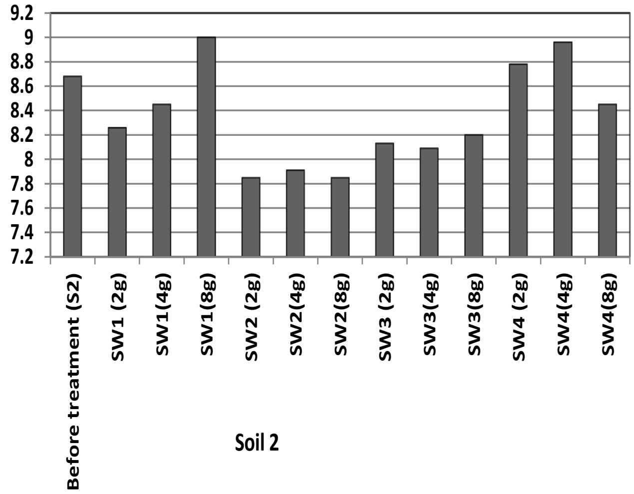
Take a 1-2 gm of oven dried soil sample in to beaker. Add 10 ml 1:1 Nitric acid and heat it to 95.5°C temperature. Then allow sample to cool down and add 5 ml of Conc. HNO_3 followed by 2ml of water and 3 ml of 30% H_2O_2. Heat it up to 5 ml. After cooling down sample, make up the volume up to 100 ml with distilled water. Filter the aliquot through wattman no 41 filter paper and use it for Atomic absorption spectrophotometric or colorimetric analysis.

Saline soil samples were treated with different concentrations of seaweed powder. Four species of marine seaweeds were taken for the saline soil treatment. Different concentrations of each species were taken for all the soil samples. Concentrations such as 2, 4 and 8 gms were taken. Observed these soil samples up to 21 days. pH, EC, water holding capacity, moisture content, soil texture, organic matter, organic carbon, Nitrogen, phosphorus, potassium, calcium, heavy metals such as Zn, Cu, Fe, Co, Pb, Ni etc. and minerals were analyzed for the soil characteristics.

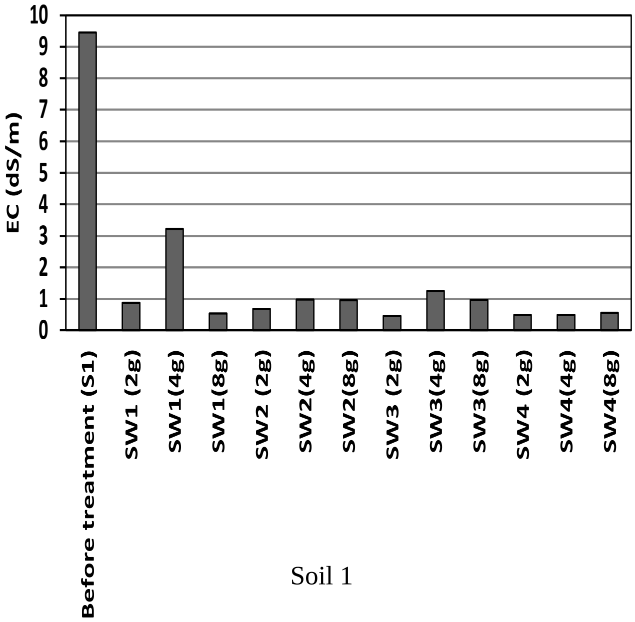
RESULTS AND DISCUSSION:

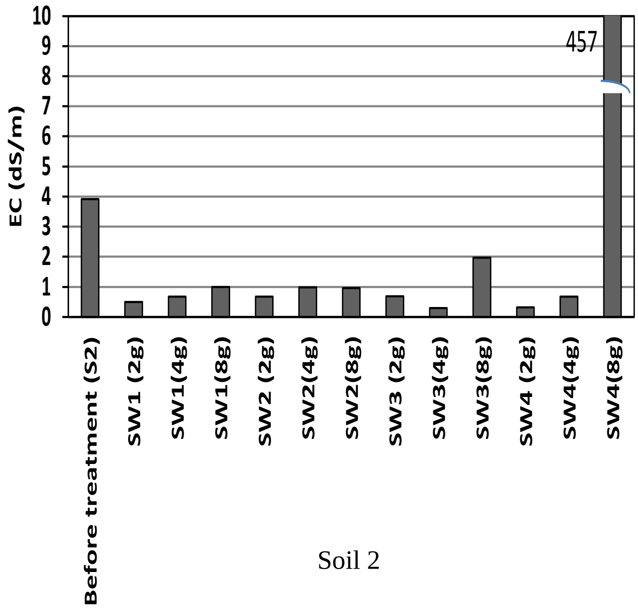
1. pH



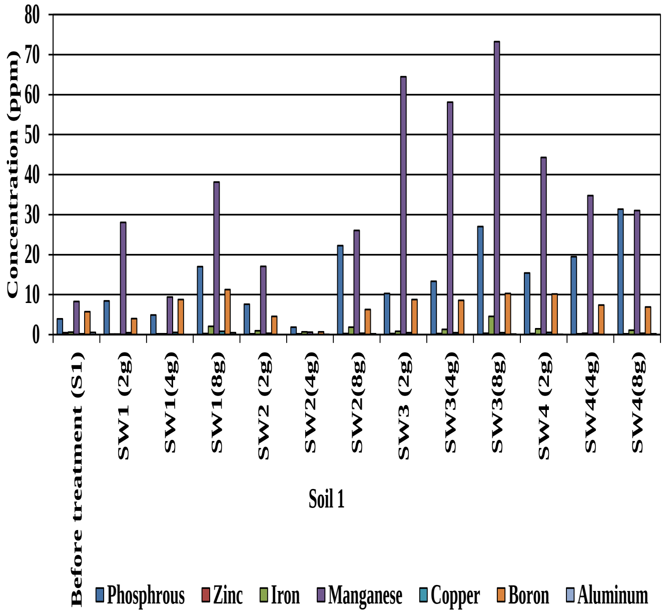


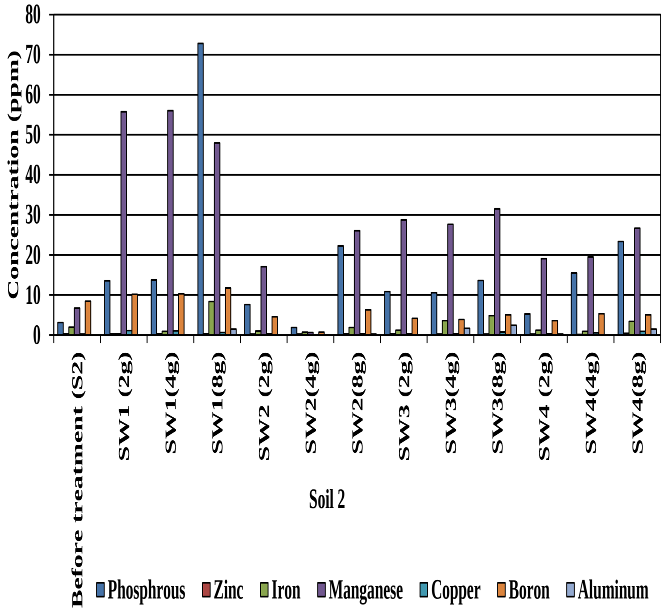
2. EC

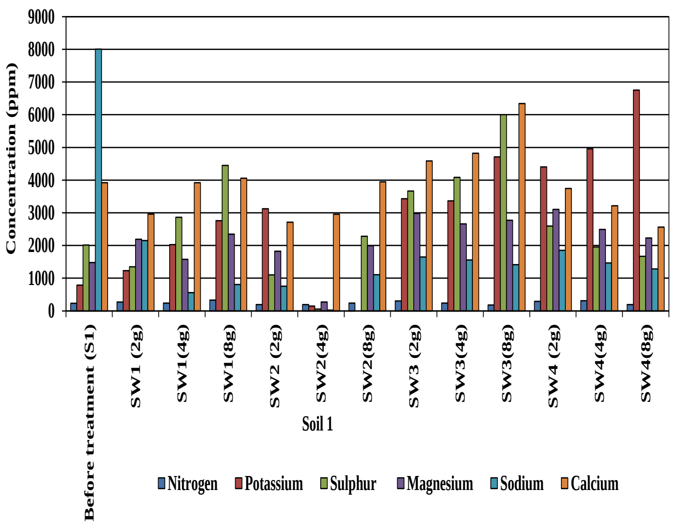




3. Nutrients in soil







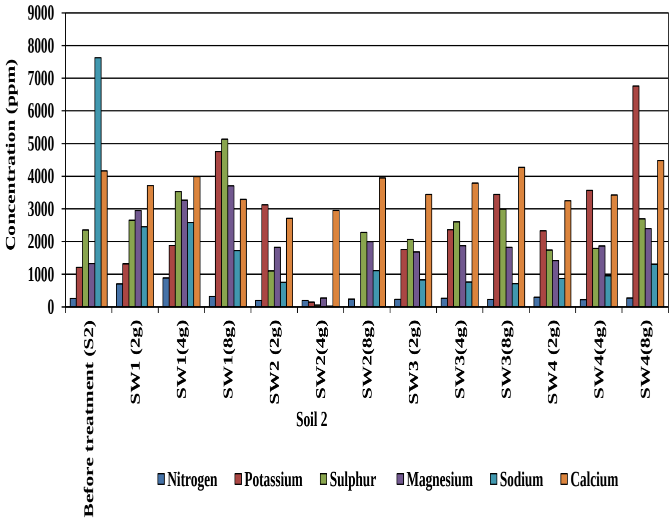


Table 2 Physico-chemical properties of soil -1 (Before and after seaweed application)

Sr. No.	pH	EC	Organic Carbon	Nitrogen	Phosphrous	Potassium	Sulphur	Zinc	Iron	Manganese	Copper	Boron	Magnesium	Aluminum	Sodium	Calcium
(Before treatment) S1	9.74	9.45	2.50	232.06	3.92	785.03	2013.17	0.49	0.64	8.27	0.21	5.77	1478.44	0.55	8008.250	3917.72
(SW1)2g	7.95	0.54	1.30	273.46	8.44	1233.01	1348.13	0.18	0.16	28.03	0.48	3.99	2189.75	0	2153.810	2958.62
(SW1)4g	8.27	2.88	1.20	235.83	4.92	2028.32	2864.14	0.23	0.23	9.41	0.54	8.77	1580.01	0	4559.986	3921.74
(SW1)8g	8.22	8.22	1.10	329.91	17	2761.40	4449.22	0.27	2.10	38.17	0.83	11.30	2348.47	0.49	9805.922	4057.58
(SW2)2g	9.07	1.12	0.9	252.13	13	486.16	57.36	0.24	0.61	8.93	0.42	1.69	461.03	0	1200.559	2091.47
(SW2)4g	8.80	1.10	1.0	292.28	12.62	5484	1743.80	0.21	1.38	16.57	0.44	10.14	1153.73	0.78	271.070	3418.31
(SW2)8g	8.01	3.94	1.30	235.83	20.99	0	1858.04	0.23	2.24	15.38	0.56	11.47	1205.56	0	302.556	3308.93
(SW3)2g	8.31	0.48	1.1	252.13	10.54	2756.84	2875.71	0.24	1.14	26.3	0.51	9.52	1362.57	0.57	329.59	4248.38
(SW3)4g	8.35	0.68	1.3	235.83	10.39	3392.85	3510.58	0.28	0.63	25.5	0.6	9.73	1414.25	0	333.886	4627.63

(SW3)8g	8.45	0.92	0.9	293.53	11.02	4469.25	4466.87	0.26	1.8	34.82	0.72	9.68	1540.8	0	369.237	4701.11
(SW4)2g	8.42	6.97	0.70	248.37	6.53	3352	1808.99	0.18	0.63	2.85	0.36	8.70	1098.89	0	913.788	3392.55
(SW4)4g	8.19	8.88	1.3	210.74	16.57	4530.61	2137.17	0.16	0.63	7.92	0.44	8.79	1239.95	0	455.484	3726.94
(SW4)8g	8.06	9.97	1.1	317.36	31.75	6571.92	2592.32	0.15	0.82	15.37	0.65	9.43	1441.49	0	698.065	4251

Table 3 Physico-chemical properties of soil -2 (Before and after seaweed application)

Sr. No.	pH	EC	Organic Carbon	Nitrogen	Phosphrous	Potassium	Sulphur	Zinc	Iron	Manganese	Copper	Boron	Magnesium	Aluminum	Sodium	Calcium
Before treatment (S2)	8.68	3.92	1.88	255.90	3.12	1210.98	2351.27	0.28	1.97	6.69	0.2	8.43	1320	0.00	7627.7	4163.65
SW1 (2g)	8.26	0.5	1.1	317.36	13.53	1315.42	2652.08	0.27	0.37	55.75	1.14	10.17	2947.94	0	2452.609	3710.32
SW1(4g)	8.45	0.68	1.1	699.96	13.76	1877	3531.69	0.33	0.88	56.02	1.03	10.3	3269.96	0.05	2580.616	3985.49
SW1(8g)	9	1	1.3	886.86	72.81	4755.28	5131.81	0.32	8.36	47.93	0.63	11.78	3704.66	1.48	4723.111	3293.97
SW2 (2g)	7.85	0.68	0.3	195.69	7.6	3121.75	1101.44	0.22	0.96	17.09	0.33	4.58	1823.24	0	754.456	2710.16
SW2(4g)	7.91	0.98	0.8	193.18	1.9	149.79	55.98	0.24	0.67	0.63	0.09	0.68	269.93	0.11	6721.094	2954.69
SW2(8g)	7.85	1.96	0.4	239.59	22.23	0	2284.29	0.26	1.87	26.08	0.34	6.27	1996.67	0.24	1104.032	3943.45
SW3 (2g)	7.96	0.46	2	303.56	10.31	3434.04	3668	0.28	0.83	64.48	0.49	8.81	2977.66	0	1649.808	4585.89
SW3(4g)	9.06	1.25	1.1	239.59	13.32	3366.64	4081.72	0.28	1.3	58.15	0.52	8.59	2658.16	0	1559.072	4820.9
SW3(8g)	8.15	1.97	0.9	180.63	27.03	4713.35	6003.72	0.34	4.56	73.27	0.52	10.29	2769.99	0.18	1414.132	6344.55
SW4 (2g)	8.37	2.49	1.2	291.02	15.41	4405.77	2598.58	0.25	1.44	44.27	0.58	10.14	3104.33	0.05	1853.48	3746.26
SW4(4g)	8.02	5.49	0.7	311.09	19.47	4959.38	1956.61	0.23	0.36	34.73	0.35	7.43	2493.27	0	1467.019	3213.15
SW4(8g)	8.23	7.56	0.6	193.18	31.4	6755.35	1667.53	0.2	1.09	31.06	0.32	6.89	2230.29	0.24	1283.738	2563.66

Table-1 and table -2 have been shown the physical properties of the collected soil samples with and without seaweed applications. Figure 1 shows pH of soil collected from Khambhat. The pH ranged between 7.8 to 10 in soil samples. Result of pH 9.74 and 8.68 for soil 1 and soil 2 before the treatment of seaweeds respectively. As per pH it is alkaline in nature before the treatment. Hence pH is very important physical properties of the soil.

Figure 2 shows Electric conductivity (EC) of soil. The EC was 9.45 and 3.92 ds/m in S1 and S2 respectively. S1 found higher in EC, which means that the soil is higher in salinity. But after the treatment of 2g, 4g and 8g of different seaweeds. In 2g and 4g treated soil samples salinity found reduced after 21 days and it is up to 0.8 ds/m. Higher salinity of soil may effects soil health and also effects to plant growth and sometimes this kind of places turns in to non-vegetative area. The electrical conductivity (EC) is one of the most important indicator of soil health. It is also affects crop production such as crop yields and crop suitability, plant nutrient availability and activity of soil microorganisms which influences key soil processes.

Analysed soil samples shows Organic carbon (%) ranged between 0.70 and 2.50%. Organic carbon is very important property which maintains the soil porosity, due to the porosity, the capacity of the soil is increasing its air and water holding capacity and also it is rich in nutrients for the plant growth [15].

Presence of nutrients in Soil

Presence of the nutrients in to the soil is very important because some nutrients in the toxic level may affect the soil physical and chemical properties. The growth of plants also depends on the nutrients present in to the soil which enhances the plant growth. Macro nutrients such as Nitrogen, Phosphorus and Potassium which is also known as major nutrients of the soil. Micro nutrients such as Zn, Cu, Mn, Fe etc. important for the soil chemical properties. The physic-chemical properties of the soil samples before and after the application of the seaweeds have been shown in to the table -2 and table-3.

Figure 3 and 4 shows nutrients availability in soil before treatment and after treatment. In nutrients especially Na salts found higher 8000 ppm in soil before the treatment. But after the treatment of seaweeds application, the concentration of Na reduced in 2g treatment in both soil. The reduction of the sodium from soil is ranges between 1255.90 to 2452.60 ppm. Among them, the brown seaweed spp. *sargassum* has been shown maximum reduction of sodium ion. Whereas, the treatment with red marine alga has been shown negative effect with sodium ion and it was increasing in soil with the increasing concentration of the spp. Additionally, other nutrients also as per limit in soil which is required for plant growth.

Based on the application of seaweed treatments, the best results reported for seed germination and root development. A marine algae is provides suitable solutions to overcome pollution problems caused by chemical fertilizers and industrialization. The correct way to treat a saline soil with marine seaweeds useful for restoration of plant growth under highly saline conditions (Nabti et. al. 2010). H. Chernane et. al. 2015 reported different doses of seaweed liquid extract applied to the wheat plant which reduces salt stress.

Marine algae have been historically used as a soil modification material and may have utility for modern agriculture as a low cost supply of nutrient-rich biomass and more beneficial for soil fertility [16, 17].

CONCLUSION

This experiment showed that there is significant effect of treatments with seaweed powder from *Sargassum* spp. followed by *Spathoglossum asperum* and *Ulva lactuca* improves the physico-chemical properties of soil and mainly it reduce the salinity from the saline soil and enrich it for the plant growth. These low cost, eco-friendly seaweeds are benefited and more useful as an organic farming in to the environment. It is also increases the soil fertility and crop productivity which may be economically beneficial.

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