



Sargassum latifolium L. water extract as a bio-stimulant for wheat seedling growth and salt stress tolerance

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Abstract

The objective of this investigation is to examine the effect of *S. latifolium* extract on the seedling growth of wheat. The treatments included two experiments: the first one was that seeds were soaked in the extracts (0.5% and 1%) for 3 h before sowing, and the morphological parameters were measured, which illustrated that the soaking of seed not sufficient to give good effect on the plant; the second experiment included using of extracts (0.5% and 1%) as a foliar spray weekly for 4 weeks on control plants and plants growing under salinity stress (two concentrations of NaCl, 100 mM, 200 mM). Spraying the plant with 0.5% and 1% *Sargassum* concentration significantly increased the growth parameters (fresh, dry weight, root and shoot length). The two extract concentrations increase the growth parameters (root fresh and dry weight, shoot fresh weight also the shoot length), the concentration. 0.5% helps the plant to tolerate the effect of salinity and causes an increase in shoot length from 25.4 cm recorded in plants under salinity stress (100 mM NaCl) to 30.35 cm. The extracts also increasing the concentration of Chlorophyll a and b. The low concentration (0.5%) was more suitable for the Wheat plant than the 1.0% concentration, which also helped the plant mitigate the harmful effects of salt. The appropriate *Sargassum* concentration used to enhance growth and tolerate the effects of different stresses varies depending on the type of plant.

Keywords: Bio stimulator, brown algae, wheat, *Sargassum*, seaweed extract, salt stress

Introduction

Wheat (*Triticum aestivum* L.) is a grass family (Poaceae) member that is grown for cereal grain. It is the second most produced crop globally after corn. It is the most widely cultivated crop in terms of acreage and is grown extensively around the world. According to FAO, global wheat production in 2024/2025 was 793.24 million metric tons. Scientists are interested in how to increase wheat productivity using environmentally friendly biological sources, such as seaweed. Seaweed extracts have been widely used with many plants, either through algae extraction by researchers or through the use of commercial extracts. Seaweed acts as a growth stimulant. It affects the growth and productivity of different plants: Faba bean, Sunflower, wheat, Tomato, Calotropis and cowpea (Salah El Din *et al.*, 2008; Osman and Salem 2011; Shaddad *et al.*, 2014; Carrasco-gil *et al.*, 2021; Bahmani *et al.*, 2021; Hamouda *et al.*, 2022; Salem *et al.*, 2025) [5, 6, 8, 9, 10, 11, 12, 13] and also helps plants to withstand stress conditions, improving plant tolerance against different environmental disturbances. Uses of seaweed with plants under salinity stress take place in Rosemary, *Capsium annum*, wheat (Gharib *et al.*, 2014; Altundal, 2019; Vijayakumar *et al.*, 2019) [1, 4, 17], also nano-extract from *Ascophyllum nodosum* and nano-specific fertilizer used on wheat (Al-Taee *et al.*, 2020)

Brown seaweeds, especially *Sargassum*, gave good results, including an increase in growth parameters and yield per plant for different crops such as faba bean, Rosemary, wheat, and *Milkweed seeds* (Salah El Din *et al.*, 2008; Gharib *et al.*, 2014; El-Din, 2015) [1, 7, 10]. *Sargassum* extract balanced the adverse effects of salinity and stimulated almost all measured parameters in Rosemary. (Gharib *et al.*, 2014) [1] and barley (Sofy, 2017) [15], and in improving wheat tolerance to water stress. (Ali *et al.*, 2022) [3]

Material and methods

Seaweed collection

The seaweed samples were collected from the coastal region of Alsomirat (17°31'17.0"N, 42°13'37.4"E) in Aldarb College, Jazan. The harvested seaweed was thoroughly rinsed with fresh water and then dried in a hot air oven at 50 °C for 4 days.

Preparation of seaweed extract

The seaweed extract was prepared by putting 20 g in 2 L of distilled water overnight at 60 °C. The prepared extract was considered the 1% concentration, and the 0.5% concentrations were prepared by dilution.

Experimental design

For germination tests, the seeds were placed between two germination papers with 40 seeds in each of the Petri dishes with a 9 cm diameter, and the percentage of germination was calculated

1. Seed soaking experiment

Wheat grains of similar weight were selected were washed with distilled water, and divided into three groups. Each group was sown in plastic pots (20 cm diameter and 25 cm depth) containing 10 kg clay-sandy soil (2:1 w/w); 3 pots were used for each treatment, and 6 grains were sown in each pot. The first group of grains was pre-soaked in water for 3 h and considered as control. The second and third groups were pre-soaked for 3 h in *Sargassum latifolium* extract, 0.5% and 1%. The grains were left to germinate and grow at the normal environmental conditions of 16/8 h. light/dark, at 25/15 ± 2 °C day/night, respectively, and relative humidity of 65% and irrigated with tap water twice a week during the 4 weeks of experiment

2. Foliar application and salinity experiment

There are 9 treatments used in this experiment, as illustrated in Table 1. Spraying occurs each week, and irrigation with saline water takes place twice a week.

Table 1: Foliar application of *Sargassum* extract treatments on wheat plant

Treatment	
Control	Spraying the plant with distilled water
0.50%SE	Spraying the plant with <i>Sargassum</i> extract 0.5% concentration
1%SE	Spraying the plant with <i>Sargassum</i> extract 1.0% concentration
S1	Plants irrigated by 100mM NaCl
S2	Plants irrigated by 200mM NaCl
0.5%SE+S1	Plants irrigated by 100mM NaCl and sprayed with <i>Sargassum</i> extract 0.5%
0.5%SE+S2	Plants irrigated by 200mM NaCl and sprayed with <i>Sargassum</i> extract 0.5%
1%SE+S1	Plants irrigated by 100mM NaCl and sprayed with <i>Sargassum</i> extract 1.0%
1%SE+S2	Plants irrigated by 200mM NaCl and sprayed with <i>Sargassum</i> extract 1.0%

The plants grow in the normal environmental conditions of 16/8 h. light/dark, at 25/15 ± 2 °C day/night for four weeks, after that, the morphological characteristics were measured. Six plants were selected for each treatment 28 d after sowing. The different morphological characteristics, such as root length, shoot length, and plant fresh weight, were measured. The plants were then dried in an oven at 70 °C for 48 h until they reached a constant dry weight

Chlorophyll content (mg g-1 F.W)

Chlorophyll a, b, and total carotenoids in fresh leaves were determined according to (Shereen *et al.*, 2009)^[14]

Results

Table 2: Effects of two concentrations of *Sargassum* extract applied as seed soaking on the morphological parameters of the Wheat plant. Data are expressed as mean ± SD

Treatment	Root			Shoot			
	Fresh weight (gm)		Dry weight (gm)	Length (cm)	fresh weight (gm)	dry weight (gm)	length (cm)
control	0.36±0.02		0.046±0.005	6.55±0.29	0.32±0.02	0.048±0.002	18.13±0.38
Extract 0.50%	0.36±0.014	0.039±0.006	8.15±0.37	0.265±0.04	0.042±0.002	18.9±0.22	
Extract 1%	0.31±0.026	0.026±0.006	8.58±0.48	0.33±0.03	0.04±0.003	18.28±0.25	

The effect of *Sargassum* extract used as foliar spray is shown in Table 3 for root; the treatment of seedling with extracts increases the root length in case of 0.5% SE, while 1.0% decrease the root length. The two extract

The percentage of germination in case of grains treated with *Sargassum* extract of 0.5% resulted in the highest germination percentage (GP) 100% followed by 1% and control 95%. The effect of *Sargassum* extract is shown in Table 2 for root; the treatment of grains with extracts increases the root length, but the root weight is not significantly affected. On the other hand, the shoot is not significantly affected by the extract treatment. There are no significant differences between the treatments and control in all morphological parameters studied as a result of soaking the grains in the extract. Our finding differs from the results of Salem *et al* 2025^[11, 12] showing that shoot and root length gave the highest value in plants treated with *Sargassum* extracts.

concentrations increase the root fresh and dry weight, while the stressed plants can tolerate the effect of salt with the treatment by the two treatments 0.5 and 1%. The low concentration (0.5%) gave the best results

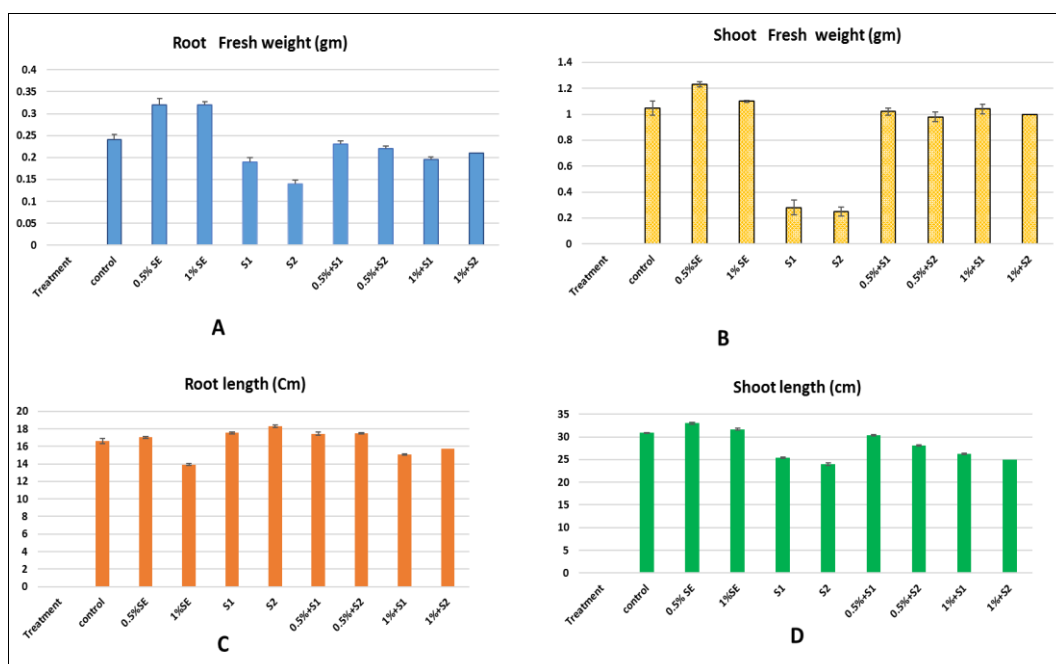


Fig 1: Growth parameters A: Root fresh weight, B: Shoot fresh weight, C:Root length, and D: Shoot length of wheat plants sprayed by *Sargassum* extracts (0.5% and 1%) in normal conditions and under salinity stress

The effect of *Sargassum* extract used as foliar spray is shown in Table 3 and figure 1 for root; the treatment of seedling with extracts increases the root length in case of 0.5% SE, while 1.0% decrease the root length. The two extract concentrations increase the root fresh and dry

weight, while the stressed plants can tolerate the effect of salt with the treatment by the two treatments 0.5 and 1%. 0.5% gave the best results. The shoot fresh weight showed an increase in the case of plants treated with 0.5 and 1%.

Table 3: Effects of *Sargassum* extract applied as foliar spray on the morphological parameters of Wheat plant. Data are expressed as mean ±SE

Treatment	Root fresh weight (g)	Root dry weight (g)	Root length (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Shoot length (cm)
Control	0.24±0.013	0.044	16.6±0.16	1.048±0.02	0.09	30.9±0.07
0.50%SE	0.32±0.012	0.045	17.03±0.28	1.23±0.056	0.14	33±0.08
1%SE	0.32±0.014	0.045	13.9±0.11	1.1±0.02	0.11	31.7±0.16
S1	0.19±0.007	0.03	17.55±0.11	0.28±0.007	0.04	25.4±0.27
S2	0.14±0.009	0.03	18.3±0.11	0.25±0.06	0.04	24±0.16
0.5%SE+S1	0.23±0.009	0.038	17.45±0.16	1.02±0.036	0.12	30.35±0.24
0.5%SE+S2	0.22±0.008	0.044	17.5±0.16	0.98±0.027	0.08	28.1±0.13
1%SE+S1	0.195±0.006	0.044	15.1±0.07	1.04±0.038	0.12	26.3±0.20
1%SE+S2	0.21±0.006	0.045	15.7±0.07	1±0.035	0.14	25±0.12

The salinity decreases the shoot weight from 1.04 g in control to 0.28 g in S1 treated plants and 0.25 g in S2 treated plants, but the plants tolerate this effect with the use of SE; the plants treated with the extract 0.5% recorded 1.04 g and gave 1.0 g in plants treated with 1%. The shoot length increased when plants were treated with SE concentrations, the concentration. 0.5% helps the plant to tolerate the effect of salinity and causes an increase in shoot length from 25.4 cm to 30.35 cm, so that the growth parameters increased by SE extracts, and using extracts with saline water helps the plants to tolerate the salinity effect.

The effect of the extracts is also evident in the pigment

content, as shown in Figure 2. Chlorophyll a increased from 8.4 mg/g in the control to 9.9 mg/g and 9.3mg/g in the case of treatment with 0.5% and 1% respectively, and chlorophyll b increased with also from 5.68 mg/g in the control to 6.08 mg/g and 5.98 mg/g in the case of treatment with 0.5% and 1% respectively, while carotenoids decreased. Salinity decreased Chlorophyll a and chlorophyll b, while increasing the concentration of carotenoids. *Sargassum* extract helps plants to tolerate the effects of salinity by increasing the Chla and b to control level depending on the concentration of salt and extract concentration.

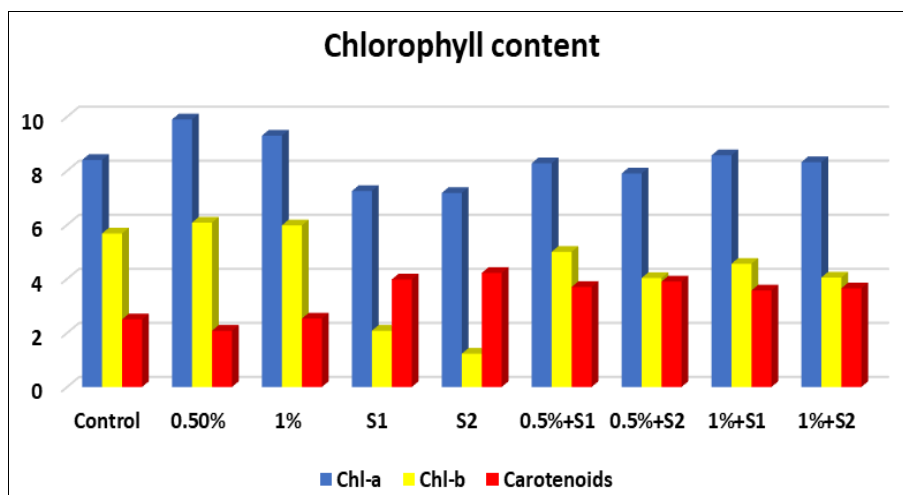


Fig 2: Pigment content of wheat plants sprayed by *Sargassum* extracts (0.5% and 1%) in normal conditions and under salinity stress

Discussion

The studied plants illustrated that there are no significant differences between the treatments and control in all morphological parameters studied as a result of soaking grains in the *Sargassum* extract. Our finding differs from the results of Salem *et al.* (2025) [11, 12], showing that Seeds of *Vigna* soaked in seaweed extract gave higher values for all measured traits than the control.

The low concentration of 0.5% yielded positive results compared to 1%, which is compatible with El-Din (2015) [7], who showed that relatively high concentrations of *Sargassum* exhibited a decreasing trend with respect to wheat seedling growth criteria.

The two extract concentrations increase the root and shoot fresh and dry weight as compared with the control. The same results obtained by Talaat *et al.* (2021) [16] showed that the application of some macroalgae on wheat plants influenced nutrient transformation and soil properties, leading to improved wheat growth. Also, Osman and Salem (2011) [9] showed the same effect on the pigment content of sunflower plants by using seaweed extracts.

The biochemical composition of seaweed extracts is very complex due to their high content of numerous compounds, including polysaccharides, minerals, vitamins, oils, lipids, acids, antioxidants, pigments, and hormones (Salem *et al.*, 2025) [11, 12]. Therefore, understanding their mechanism of action is extremely complex due to the multiple interactions

that occur between these biologically active compounds within the same extract.

According to the results obtained from the research, 25% SE application in the wheat grown under the salt stress had a positive effect on the dry weight, length of the shoot, and radicle (Altindal 2019) [4], also polysaccharides of seaweed also enhance salt stress adaptability of wheat seedlings and significantly enhance shoot and root lengths and dry and fresh matter of wheat under stress (Zou *et al* (2019) [18]. while the stressed plants can tolerate the effect of salt with the treatment by the two treatments, 0.5 and 1%. The low concentration (0.5%) gave the best results, which is in complete agreement with what Zou *et al* (2019) [18] found. Increase in plant growth and yield against salinity may be attributed to SE Cytokinen and plant growth-promoting substances contained in the used in saline conditions (Vijayakumar *et al.*, 2018), or seaweed water extracts increasing plant resistance by stimulating the antioxidant enzyme system (Shaddad *et al*, 2014) [13].

Conclusion

According to the current study, using low concentrations of seaweed water extract (0.5%) as a priming treatment improves plant growth parameters and pigment content of leaves in wheat plants, and also helps plants tolerate the salinity effect.

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