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Effect of Some Seaweed Extracts on Germination and Growth of Wheat (*Triticum aestivum* L.)

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Abstract:

The current study aims to investigate the effect of different concentrations (0.1, 0.5 and 1 %) of Cystoseira barbata (CBAE) and *Laurencia papillosa* (LPAE) aqueous extracts on seed germination, and some growth physiological parameters (germination percentage (GP), seed germination index (SGI), energy of germination (GE), plumule and radicle (PL and RL) lengths, and leaf area (LA) of *Triticum aestivum* (crop species). In general, there was a significant increase in GP, SGI and GE under the effect of both donor species as well as in PL, RL, was RL as increased by about 25.93 %, 19.78 % in 1 % CBAE, and LPAE respectively as compared to control. Furthermore, LA increased to 50 %, 30.35 % higher than the control.

Keywords: Biofertilizers, *Cystoseira barbata, Laurencia papillosa, Triticum aestivum*, growth, germination.

Introduction:

One of the most sustainable and green revolutionary approaches is the implementation of algae-based biofertilizers to control over the need for food supply. Chemical fertilizers have been applied for the last several decades. However, Chemical fertilizers are not ecologically and environmentally benign. Algae are one of the most promising outlets as potential biofertilizers which biologically transform the solar energy and various gases (i.e., carbon dioxide and nitrogen) into high value-added chemical products (i.e., biofertilizers) through large scale biomass generation. Therefore, algal biofertilizers can substitute the traditional chemical biofertilizers considering omnipresence, accelerated metabolic flux, short span of generation time, and constitutional capabilities to transform biologically benign nitrogen gas towards plant-accessible soluble nitrogenous derivatives through nitrogen fixation along with carbon dioxide sequestration and accessibilities of phosphorous-potassium. To this end, the aforementioned naive features of algae, economical feasibility, technical acceptability and environmental benefits defecate algal biomass as a most promising and demanding bioresource for sustainable green agricultural technology in the near future (Ghosh *et al*., 2022). Bread wheat (*Triticum aestivum* L.) is the world's most widely cultivated crop, with more than a billion people relying on it. Used by more than a third of the world's population as a Basic food (Curtis *et al*., 2002). The total global wheat output exceeded 749.3 million tons in 2016, according to FAOSTAT data (FAOSTAT, 2017). Wheat is further classified as winter or spring, hard or soft, red or white, and by protein content (Briggle and Curtis., 1987). Wheat is considered one of the main cereal crops in Libya. Wheat contains vitamins, minerals and essential amino acids, with useful metabolites and dietary fibers. With the high cost of inorganic fertilizers, the use of natural fertilizer resources for increasing crop production on a sustainable basis has become imperative. Hence, this study focused on the progress made in algae-based biofertilizers on the germination and growth of wheat.

Materials and Methods:

The study work was achieved during the year 2021-2022, Two species of algae *Cystoseira barbata*, C. Agardh (Sargassaceae), *Laurencia papillosa*, J. V. Lamouroux (Rhodomelaceae) (Donor species) were used in this investigation to study their biological activities on seed germination, some growth physiological parameters on *Triticum aestivum* (Poaceae) as (crop species).

Sample macro algae collection and preparation*:*

Manual harvesting of seaweed has been practised for centuries and it is still common for species naturally growing in coastal areas (van Poelgeest *et al*., 2013). Macro algae samples were collected *Cystoseira barbata*, C. Agardh, (Phaeophyta, Fam. Sargassaceae), *Laurencia papillosa*, J. V. Lamouroux, (Rhodophyta, Fam. Rhodomelaceae), from Al-Hamama coast located the northeastern Mediterranean coast of the north of the city of El-Beida, 25 km from the city of El-Beida - Libya, during June 2021. All samples were brought to the laboratory in plastic bags containing seawater to prevent evaporation. In the laboratory, seaweeds were cleaned from epiphytes and rock debris and given a quick freshwater rinse to remove surface salts. Seaweeds were then air dried in the shade at room temperature (25-30°C) on absorbent paper for estimation of moisture content. Then, they were pulverized in a cereal grinder for 5 min and sieved, using a 100 mesh sieve, to obtain a fine and homogeneous powder that was stored in hermetically sealed plastic bags and stored at -20°C until further chemical analysis. All seaweeds were identified taxonomically following the methods of (Taylor., 1960; Abbott and Hollenberg, 1976; Al-Ahmad and Aleem., 1993; Jha *et al*., 2009). The names of the species were used according to (Guiry *et al*., 2011) and were confirmed using an algae-based website. (The collected samples were identified in Botany Department, Faculty of Science, Omar Al-Mukhtar University.

Preparation of Donor Species Aqueous Extracts*:*

Stock aqueous extracts and subsequent dilutions were obtained by the following methods:

Dried powders of the two donor species (75 g for each) were extracted with 1000 ml distilled water. The extract was conducted in dark for 24 h at 25°C. The supernatant was taken and centrifuged at 3000 rpm for 15 minutes; this would be a full-strength concentration (100 %). The extracts were prepared no more than 48 h in advance and were kept in a refrigerator at 5°C until used, and the purified extract was adjusted to pH 6.8 with 1M HCl. Series of dilutions were prepared from the stock solutions (0.1, 0.5 and 1 % besides the control) for *Cystoseira barbata* (CBAE) and *Laurencia papillosa* (LPAE) were tested for their effects on germination parameters, and *Triticum aestivum* seeds were obtained from the Department of Plant Crops, College of Agriculture, Omar Al-Mukhtar University, Libya.

Germination Bioassay

Petri-dish experiment was applied to investigate the biofertilizer of the donor species aqueous extracts on germination percentage (GP), seed germination index (SGI), energy of germination (GE), plumule (PL), radicle (RL) lengths and leaf area, (LA) of *Triticum aestivum* (crop species).

To achieve this experiment, ten seeds were arranged in 9-cm diameter Petri-dishes lined with two discs of Whatman No.1 filter paper under normal laboratory conditions with day temperature ranging from 19-22°C and night temperature from 12-14°C. 10 ml of the respective donor species aqueous extracts (0.1, 0.5 and 1 %) or distilled water as control were added daily to two replicates in a randomized complete block design. Before sowing, the seeds were immersed in 2 % Chlorex for 2 minutes, then rinsed four times with distilled water. Finally, the seeds were soaked in aerated distilled water for 24 hours. Germination percentages (GP) and plumule (PL) and radicle (RL) lengths were recorded after seven days.

Calculations:

1. Germination percentage (GP) was calculated according to the following equation:

$$GP = Ni / S*100$$

Ni= is the number of seeds germinated on day i

S= is the total number of seeds planted

2. Seed germination index (SGI) was calculated according to the following equation (Scott *et al*., 1984).

$$SGI = \Sigma\ Ti\ Ni/S$$

Where,

Ti= is the number of days after sowing

Ni= is the number of seeds germinated on day i

S= is the total number of seeds planted

3. Energy of germination (GE) was recorded according to (Farooq *et al*., 2005) on the 4th day after sowing. It is the percentage of germinating seeds (GP) four days after sowing relative to the total number of seeds tested (TNST).

$$GE = GP\ (4^{th}\ day)/TNST$$

Statistical Analysis:

Statistical analysis was performed using a computer-run program (Minitab software). ANOVA followed by Turkey's test was performed to show the statistical significance among the means of the groups. Results were expressed as mean ± Standard Error Mean (SEM). P-value below 0.05 was considered to be statistically significant.

Results:

Germination parameters (Figures 1, 2 and 3)

Bioassays were carried out to test the fertilizer effects of *Cystoseira barbata* and *Laurencia papillosa* aqueous extract (CBAE and LPAE) on germination percentage (GP), seed germination index (SGI) and energy of germination (GE) of (*Triticum aestivum* L. Family: Poaceae). The germination percentage (GP) of *T. aestivum* seeds was effectively increasing with increasing concentrations of CBAE (Figure 1). The percentage increased from 90 % at the control to 100 % at 1 % concentration level after seven days from sowing. Furthermore, the percentage was increased with increasing the concentrations of LPAE (Figure 1). It increased from 90 % at the control to 100 % at 1 % concentration level after seven days from sowing. Data indicated that LPAE exerted the same significant effect on the germination of the seeds of the test species as compared to CBAE.

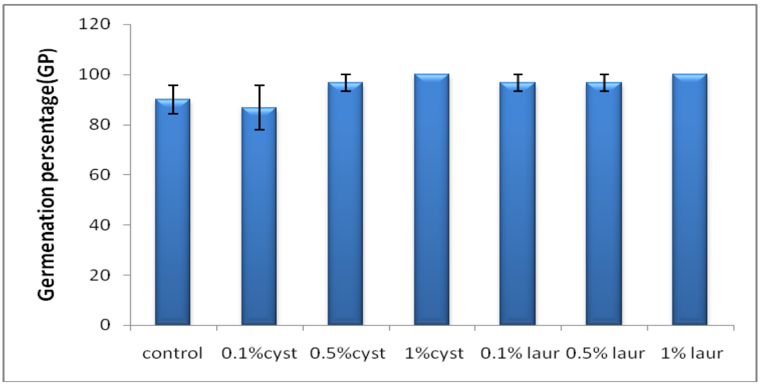

Figure 1: Fertilizer effect of different concentrations of *Cystoseira barbata* (CBAE) and *Laurencia papillosa* (LPAE) aqueous extract on germination percentage of *Triticum aestivum*

Seed germination index (SGI) and Energy of germination (GE) of *T. aestivum* are illustrated in figures 2, 3. With regard to SGI, the value significantly increased as CBAE concentration increased in samples. In control level, a value of about 3.5 was increased to 4.5 at 1 % concentration level of extracts while in LPAE a value of about 6.3 was increased to 7 at 1 % concentration level of extracts. Concerning GE, the value increased moderately as the extract concentration increased. GE started with a value of about 9 at control level which increased to 10 at 1 % concentration level for both extracts.

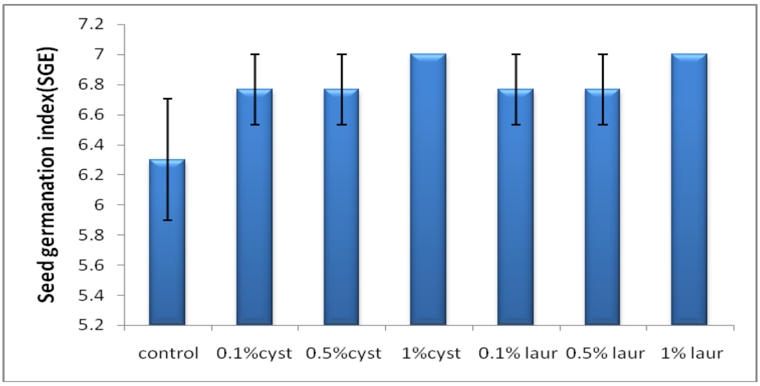

Figure 2: Fertilizer effect of different concentrations of *Cystoseira barbata* (CBAE) and *Laurencia papillosa* (LPAE) aqueous extract on seed germination index of *Triticum aestivum*.

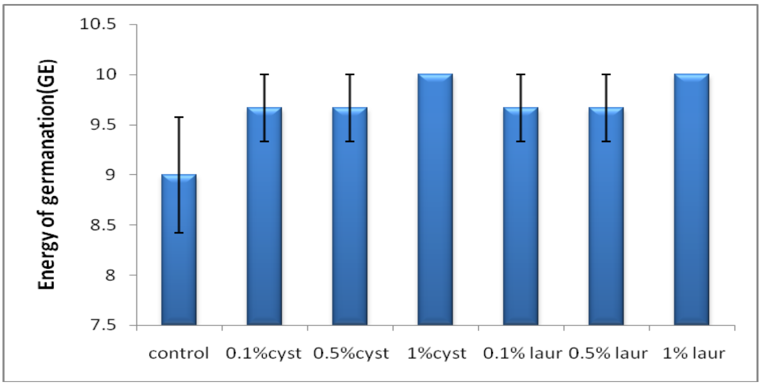

Figure3: Fertilizer effect of different concentrations of *Cystoseira barbata* (CBAE) and *Laurencia papillosa* (LPAE) aqueous extract on energy of germination of *Triticum aestivum*.

Plumule, radicle lengths and leaf area (Figures 4, 5 and 6)

The fertilizers of the different concentrations of CBAE and LPAE on plumule and radicle lengths (PL), (RL) are presented in figures 4 and 5 respectively. Generally, all concentrations of the applied extract increased PL. The length was visibly heightened at about 22 % and 19 % at 1 % concentration for CBAE and LPAE after seven days from the beginning of the experiment respectively, figure 4. While data demonstrated that in both extracts, the RL increased significantly upon applying different concentrations of the extract. In CBAE the length increased by about 25.93 % at 1 % concentration level.

Figure 5 confirmed the different effects of the extract on RL through the application of LPAE increasing comparatively, in LPAE the length increased by about 19.78 % at 1 % concentration level. As well as data demonstrated that in both extracts the LA increased upon applying different concentrations of the extract. In CBAE the length increased by about 50 % at 1 % concentration level. Figure 6 confirmed the different effects of the extract on LA through the application of LPAE increasing comparatively, in LPAE the length increased by about 30.08 % at 1 % concentration level.

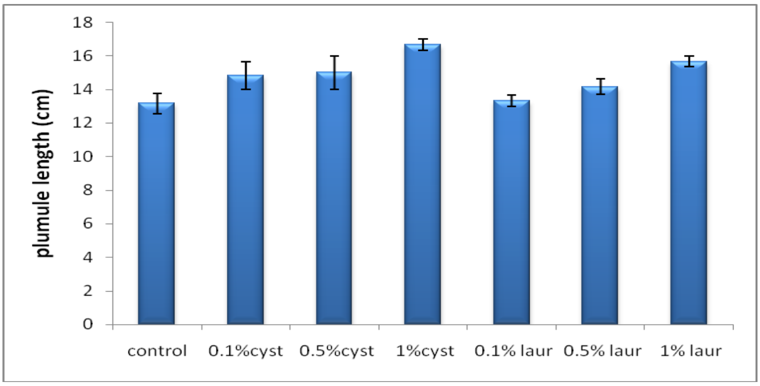

Figure 4: Fertilizer effect of different concentrations of *Cystoseira barbata* (CBAE) and *Laurencia papillosa* (LPAE) aqueous extract on plumule length of *Triticum aestivum*.

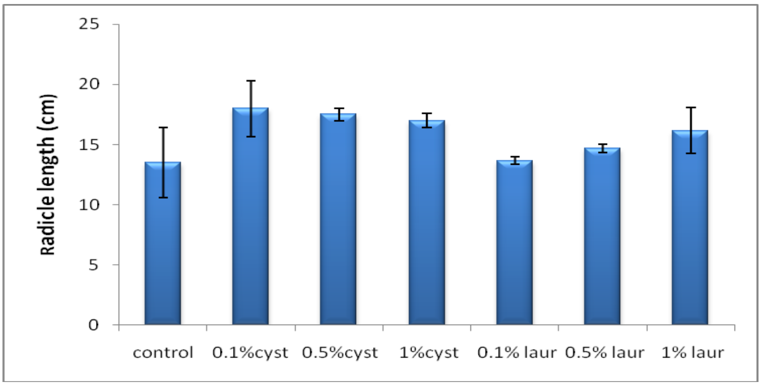

Figure 5: Fertilizer effect of different concentrations of *Cystoseira barbata* (CBAE) and *Laurencia papillosa* (LPAE) aqueous extract on radicle length of *Triticum aestivum*.

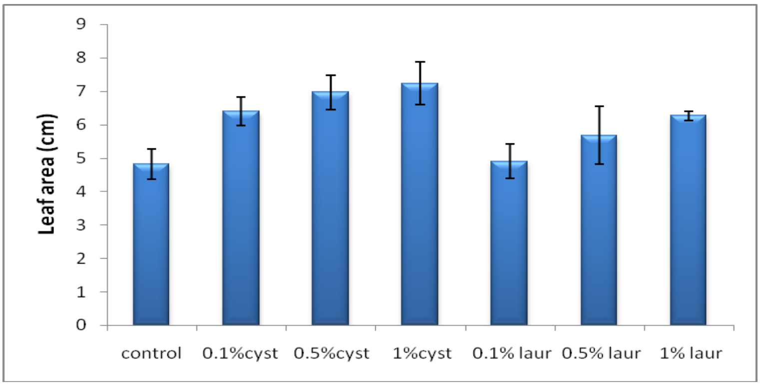

Figure 6: Fertilizer effect of different concentrations of *Cystoseira barbata* (CBAE) and *Laurencia* papillosa (LPAE) aqueous extract on leaf area of *Triticum aestivum*

Discussion:

Seaweeds are used in agriculture for ages and well-acknowledged for their plant growth enhancing properties. Extracts of seaweed are rich in phytohormones such as auxins, cytokinins, gibberellins, abscisic acid and ethylene as well as amino acids, vitamins, betaines, polyamines, carrageenans, polysaccharides and sterols which play a significant role as a biostimulant, elicitor for a biotic stress and increase the productivity of plants. Besides being stimulants for growth, seaweed saps are known for their antimicrobial potency and ability to provide protection to plants against their natural invaders. In general, extracts of seaweed can induce changes in the physiological/biochemical process associated with plant nutrient uptake and growth in agriculture (Chaturvedi *et al*., 2022) Thus, the application of *Cystoseira barbata*, *Laurencia papillosa*, increased the seed germination rate at lower concentrations. This enhanced growth effect is thought to be due to various organic compounds present in the seaweed extract. More specifically it is thought to be due to the presence of phytohormones, mainly, cytokinins in the seaweed extracts (Wightman *et al*., 1980). Our findings coincide with those of earlier studies in *Vigna catajung* (Anantharaj and Venkatesalu., 2001), *Dolichos biflorus* (Anantharaj and Venkatesalu., 2002), *Vigna sinensis* (Sivasankari *et al*., 2006), *Cajanus cajan* (Erulan *et al*., 2009), *Brassica nigra* (Kalidass *et al*., 2010), *Oryza sativa* (Sunarpi *et al*., 2020), *Abelmoscus esculentus* (Sasikumar *et al*., 2011), *Lycopersicon esculentum* (Zodape *et al*., 2011; Kumari *et al*., 2011) *Triticum aestivum* (Kumar *et al*., 2011) and *Hordeum vulgare* (Saudi, 2017). High levels of cytokinins and auxins amino acids, and a number of major mineral elements and the smaller ones that stimulate the division of the cell and its expansion rather than any leads to a balance in physiological and biological processes affecting root growth and increasing their ability to absorb water and nutrients soluble in it, which reflects positively on growth. The vegetative system, especially the leaves, this result agrees with what, Reported by Jabar-Abdul and others (Gollan and Wright 2006; AL-Ubeidi *et al*., 2012) who confirmed the increase in the leaf area of plants Wheat when sprinkled with seaweed extract. Marginatum at low concentration promoted the growth of the brown alga *Rosenvingea intricata*, applied to *Sorghum vulgare* (Ashok *et al*., 2004) and *Vigna sinensis* (Taylor and Wilkinson, 1977; Sivasankari *et al*., 2006) crop plant showed better results in all aspects of growth.

Conclusion:

The current study suggests, that the presence of various micro and macronutrients in *Cystoseira barbata* and *Laurencia papillosa* Seaweed Liquid Extract. The application practices have increased plant germination and growth, making Seaweed Liquid Extract an excellent choice of organic fertilizer. Ecofriendly seaweed liquid extracts to crops are recommended to the growers for attaining better yield.

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