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THE USE OF *CHLORELLA VULGARIS* SUSPENSION AS A BIOSTIMULATOR IN THE CULTIVATION OF WHEAT

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Abstract. *One of the priority directions of agriculture in the Republic of Moldova is the cultivation of plants, especially in the context of frequent droughts in recent years. The main crops that provide significant yields and economic benefits for farmers are winter crops, of which wheat (Triticum aestivum L.) is of major importance. The purpose of this research was to evaluate the effect of applying Chlorella vulgaris suspension on seed germination and quantitative and qualitative parameters of wheat. The application of the algal suspension to seed germination determined an increase in the generative faculty by 2%, a greater height of juvenile plants and the root system by 0.4 cm, as well as an increase in the number of roots. Following subsequent treatments of soil and plants with algal suspension, an increase in the yield by 0.55 t/ha, an increase in gluten content and a slight increase in the protein content of wheat seeds were recorded. The results obtained indicate that the use of Chlorella vulgaris suspension has positive effects on the development and performance of wheat under the conditions of the Republic of Moldova. Based on these results, we can conclude that the Chlorella vulgaris suspension presents premises for industrial application in the mass cultivation of wheat in the conditions of the Republic of Moldova.*

Keywords*: algae, biostimulator, wheat*

INTRODUCTION

The Republic of Moldova is an agrarian-industrial state, the main branch of the economy is agriculture (Stratanenco, 2022). Plant breeding has been, is and probably will remain an important pillar of national agriculture. Among the cereal crops cultivated in the Republic of Moldova, wheat has a major share, occupying quite large areas (ROTARU ET AL., 2022). To ensure economic progress, market competitiveness and demand for wheat, it is necessary for this crop to have a high yield and generate high-quality seeds. This can be achieved by using a variety of agricultural practices in crop cultivation, including the application of biostimulants, biofertilizers and other necessary substances (LYU ET AL., 2022).

For wheat cultivation, an important factor generating growth, quantitative and sometimes qualitative increase in crops is providing the crop with nutrients. In the vast majority of cases, mineral fertilizers are applied to wheat cultivation, which promote plant growth and development, as well as grain and straw production. The use of mineral fertilizers in combination with an organo-mineral substrate improves plant nutrition from ear lodging to the end of the milky phase and improves grain quality. To produce one hundred kilograms of grain and the corresponding amount of straw, this crop requires approximately 3.7 kg of nitrogen, 1.3 kg of phosphorus and 2.3 kg of potassium (BAUSHEVA ET AL., 2019, MILASHCHENKO, 2018; SHIRYAEVA, 2022). To ensure high-quality and sustainable harvests, it is recommended to apply biofertilizers and biostimulators to wheat cultivation. There is a wide range of biostimulators with different actions on stimulating plant growth, crop performance,

such as increasing tolerance to abiotic stresses or promoting nutrient absorption and mobilization (BHUPENCHANDRA ET AL., 2022). Quite accessible and effective are seaweed extracts, the application of which leads to improved root development, stimulation of flowering and grain filling in wheat under abiotic stress conditions, due to natural hormones and nutrients (SZCZEPANEK ET AL., 2018; TRIVEDI ET AL., 2018; ALHARBI, 2022). Liquid extracts obtained from seaweed have become more important as foliar sprays and applied to the soil in many agricultural crops, becoming one of the most promising biotechnological tools in agronomy. For example, foliar spraying and soil application of aqueous extracts of *Sargassum johnstonii* resulted in increased tomato plant height, shoot length, root length and branch number, as well as reproductive parameters (number of flowers, number of fruits and fresh weight). At the same time, application of the extract obtained from the combination of marine algae *Ulva lactuca*, *Cladophora dalmatica*, *Enteromorpha intestinalis*, *Corallina mediterranea*, *Pterocladia pinnate* and *Janiarubens* to *Vicia faba* L. cultivation resulted in increased seed germination, shoot and root length, and also led to increased protein, total soluble carbohydrates and chlorophyll in leaves, as well as in root and shoot systems, compared to the control group (KUMARI ET AL., 2011; EL-SHEEKH ET AL., 2000).

The main disadvantage of applying these treatments with algal biostimulators obtained through extraction is that they act, for the most part, over a short period of time, and do not ensure the creation of the premises for the development of native algal biota specific to agricultural ecosystems. To solve this shortcoming, it is recommended to use algal biostimulators consisting of live algal suspension, but for its application it is necessary that the species used possesses certain physiological traits (ability to withstand drought, temperature fluctuations and strong insolation, ability to easily and quickly pass between the vegetative and dormant stages, minimum cell volume, regeneration capacity of 8–12 hours, accelerated reproduction, proliferation on the soil surface and in depth, can be selected in culture and cultivated on an industrial scale) and specific ecological traits (dominance in the biocenosis, biological specificity and high tolerance to the environment, participation in the phenomenon of "soil flowering", etc.) (DOBROJAN ET AL., 2025).

In this sense, one of the most suitable species of green algae used as a biostimulator or biofertilizer is *Chlorella vulgaris*, *Chlorella vulgaris Beijerinck*, whose value is highlighted by its increased tolerance to variations in abiotic and biotic factors, its global spread, its high reproduction rate, the remarkable biochemical composition of its biomass, its ability to fix and consume atmospheric CO_2, its ability to neutralize numerous pollutants, the possibility of being cultivated industrially with relatively little effort and which generates positive effects upon application (DOBROJAN ET AL., 2026). In addition, the application of *Chlorella* suspension contributes to reducing the cost of traditional agricultural products, including fertilizers, by significantly reducing their leaching from the soil (BILYAVTSEVA, 2020). Based on these considerations, we aimed to apply the suspension of *Chlorella vulgaris Beijerinck* as a biostimulator of wheat seed germination and subsequently apply it to the soil and foliar when cultivating wheat (*Triticum aestivum* L.) under the conditions of the Republic of Moldova.

MATERIAL AND METHODS

The experiments used the *Chlorella vulgaris* strain obtained and stored in the collection of the Scientific Research Laboratory of Algology V, Șalaru of the State University of Moldova. The experiments used the algal suspension, in the exponential growth phase, with a concentration of 2.70 g/l of absolutely dry biomass,

The experiments were carried out in the agricultural year 2025, according to specific planning methods on the lands in the region of the village of Hîrtopul Mic, rn. Criuleni, on the plantations managed by SRL Schim Agromex, the soils being typical moderately humus-rich cermosiums. Initially, the effect of the algal suspension on the germination faculty of Triticum aestivum L. (Kuialnik variety) was tested, experiments carried out in field conditions by spraying seeds with the algal suspension, as a control the seeds sprayed with distilled water served. After treatment, the seeds were sown in the soil at a depth of 5 cm (DOSPEHOV, 1985).

Initially, the effect of treating seeds before sowing with the algal suspension was investigated in laboratory conditions, then it was expanded to field conditions on an area of 100 ha each experimental variant. After seed treatment, the algae was applied to the soil immediately after sowing the crop at a dose of 100 l/ha, followed by the application of three foliar treatments at a dose of 5 l/ha, in the key ontogenetic phases of the crop. Additionally, the soils in both experimental lots were fertilized by applying green manure (in the fall of 2024) consisting of peas, and in the spring of 2025, 2000 kg/ha of solid and liquid bioorganomineral fertilizer (5 l/ha) was applied to the soil surface, the chemical composition of which is indicated in specialized literature (JIGĂU ET AL., 2022).

During the experiments, the germination capacity of the seeds (FG) was determined, according to the formula: FG = Nsg/Nts * 100, where Nsg – number of germinated seeds; Nts – total number of seeds, the morphological changes of the crop based on measurements made directly in the field, the yield obtained and the quality of the seeds determined using the device (SpectraStar XT), The mathematical calculation was performed by determining the arithmetic mean (M), the standard error (m) using artificial intelligence (ChatGpt).

RESULTS AND DISCUSSIONS

It is well known that the application of *Chlorella vulgaris* suspension in the treatment of seeds of many crop plants has beneficial effects manifested by stimulating seed germination, accelerating crop growth and strengthening their health, because it contains phytohormones that have a positive action (BOGDANOV, 2007). Most of the research conducted recommends treating wheat seeds before sowing with *Chlorella vulgaris* suspension by soaking them for a period of 10-12 hours, which has the effect of increasing the germination capacity of seeds, stem height, root length and seedling mass (KRIVOSHEEV ET AL., 2022).

The main disadvantage of this process is that it is quite difficult to apply in wide production practice since it involves performing several operations, which makes the application difficult and attracts additional expenses that often cannot be borne by agricultural entrepreneurs specializing in wheat cultivation. This is why we set out to evaluate the effect of treating wheat seeds by stopping them with a suspension of *Ch. vulgaris* before sowing (Tab. 1).

Table 1

Influence of treating wheat seeds with a suspension of *Chlorella vulgaris* on germination and juvenile growth

Experimental variants	The analyzed parameters			
	Germination rate, % on the 3rd day	Seedling height (7th day), cm	Root length (7th day), cm	Number of roots (7th day), pieces
Control	96,00±3,50	10,70±0,42	11,40±0,40	3,50±0,11
Algae treatment	98,00±3,21	11,10±0,40	11,80±0,41	4,20±0,12

The results obtained allow us to conclude that the treatment of wheat seeds with the suspension of *Chlorella vulgaris* led to an increase in the germination capacity of wheat by 2%, in the height of plants and the length of roots by 0.40 cm and in the number of roots by 0.7 pieces. These results allow us to conclude that the use of the suspension of *Ch. vulgaris* generates a positive effect on the germination and initiation of the growth process of juvenile wheat seedlings.

Figure 1. The effect of treating wheat seeds before sowing with a suspension of *Chlorella vulgaris*

Similar results were obtained in the case of treating spring wheat seeds by soaking them for 24 hours in a suspension of *Chlorella vulgaris*, which led to an increase in germination capacity by 8%, plant height by 0.4 cm, root length by 0.60 cm and the number of roots by 0.3 pieces (Minicaev et al., 2022). Research conducted by Odgerel B., also demonstrated that a suspension of *Chlorella* sp. 56 at a dose of 0.06 g/l and 0.23 g/l increases the growth of wheat and barley seeds (Otgerel et al., 2016). Other research has highlighted that the application of *Chlorella* start suspension to treat seeds of several wheat varieties generated different results, with some varieties showing an increase in seed germination of up to 4.5%, while others showed no differences compared to control samples (Korhova et al., 2021).

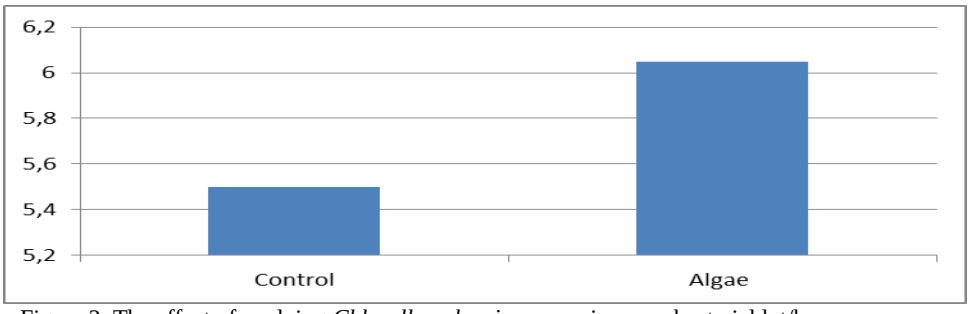

Figure 2. The effect of applying *Chlorella vulgaris* suspension on wheat yield, t/ha

The application of *Chlorella vulgaris* suspension also contributed to increasing the wheat yield obtained. Thus, in the variant with the application of algal treatment, the amount of

wheat increased by 0.55 t/ha, which allows us to conclude that there is a positive trend of quantitative increase in the wheat yields obtained. Similar results were also obtained in the research conducted by Korkhova M.M. which highlights the fact that the treatment of seeds of some wheat varieties before sowing with *Chlorella vulgaris* suspension had the effect of increasing the yields by 0.22-2.48 t/ha (Korkhova, 2024).

Table 2

The influence of applying *Chlorella vulgaris* suspension on the quality of wheat seeds, %

Experimental variants	Moisture	Protein	Gluten	Color index
Control	11,27	13,52	17,77	72,95
Algae	11,54	13,63	18,78	71,69

The application of *Ch. vulgaris* suspension generated less pronounced effects on the quality of wheat seeds. In the variant with algae application, the amount of protein increased by 0.11%, and that of gluten by 1.01%. The color index of the seeds had lower values in the group with algae administration (71.69%) compared to the control variant (72.95%). The results obtained allow us to conclude that there is a tendency to improve the quality of wheat seeds attested to the application of *Chlorella vulgaris* suspension.

Other research conducted has also highlighted the fact that the application of *Ch. vulgaris* suspension to treat seeds before sowing over several years of investigations has attested to the insignificant increase in the total protein content of the seeds of several wheat varieties by approx. 0.1% compared to the control variant (Korkhova, 2024).

CONCLUSIONS

The research conducted allows us to conclude that the application of *Chlorella vulgaris* suspension to the treatment of wheat seeds Triticum aestivum L. (Kuialnik variety) generated a positive effect manifested by increasing the germination capacity of wheat by 2%, plant height and root length, in the juvenile phase, by 0.40 cm and the number of roots by 0.7 pieces. Subsequent application of the algal suspension on the soil and foliar led to an increase in the crop yield by 0.55 t/ha and its quality manifested by increasing the protein content by 0.11%, gluten by 1.01% and reducing the color index values. Based on these results, we can conclude that the *Chlorella vulgaris* suspension presents premises for industrial application in the mass cultivation of wheat in the conditions of the Republic of Moldova.

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