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БАЯНДАМАЛАРЫ

ДОКЛАДЫ

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РЕСПУБЛИКИ КАЗАХСТАН

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THE POSSIBILITY OF USING GREEN ALGAE AS FERTILIZER IN AGRICULTURE

Abstract. The article presents the results of algological studies of the Koshkar-ata river and the influence of green microalgae on the physiological development of various agricultural crops.

Modern technologies for the production of agricultural products, based on the widespread use of pesticides and mineral fertilizers, made it possible to largely solve the problem of providing the population with food, and at the same time gave rise to multiple environmental, medical and environmental problems, problems of ecologically clean and biologically valuable food products, land rehabilitation, restoration their fertility, etc. Therefore, the emergence of new classes of pesticides with different mechanisms of action, high selectivity and low toxicity for warm-blooded animals is very modern. Currently, the development and application of new plant protection products that are not toxic to humans and animals is of global importance. Priority is given to research aimed at creating plant protection products based on microorganisms and their metabolites, as well as searching for plant substances with potential pesticidal activity. In this regard, the question arose of finding new safe fertilizers that could also be economically viable for production on an industrial scale. One of the current trends in this industry is the use of green microalgae.

It was found that the use of a suspension of microalgae on various agricultural crops increased the yield of winter wheat by 30%, beans by 28%, mung bean by 15%.

Thus, the use of a suspension of green algae in agriculture saves on the use of fertilizers, due to a one-time application of the crop to the soil. Moreover, seed treatment with a suspension of green microalgae protects against decay. The main economic effect is achieved by increasing the yield by 20-25%.

Key words: green algae, fertilizers, plant physiology, ecological fertilization, increased productivity.

Introduction. The ubiquitous distribution of algae in nature determines their great importance both in everyday life of a person and in his economic activity. And yet, the available possibilities for the practical use of algae are far from being exhausted [1]. The practical importance of indirect algae is manifested to the greatest extent in fish, agriculture and communal services, as well as in the operation of water transport and hydraulic structures, partly in medicine, while their direct use is most significant as a food product and raw material for a number of industries. Most often in the food industry, seaweeds are used, such as kelp, porphyry, etc.

The possibilities of industrial use of algae of continental water bodies are much more limited in comparison with algae, and the attempts in this direction have not yet gone beyond the framework of laboratory studies or individual production problems that have not received wide development.

Modern technologies for the production of agricultural products, based on the widespread use of pesticides and mineral fertilizers, made it possible to largely solve the problem of providing the population with food, and, at the same time, gave rise to multiple environmental, medical and environmental problems, problems of ecologically pure and biologically valuable food, rehabilitation land, restoration of their fertility, etc [2]. Therefore, the arrival of new classes of pesticides with different mechanisms of action, high selectivity and low toxicity for warm-blooded animals is very modern.

Currently, the development and application of new plant protection products that are non-toxic to humans and animals is of global importance. Research aimed at creating plant protection products based

on microorganisms and their metabolites, as well as the search for plant substances with potential pesticidal activity, is a priority [3].

Among freshwater algae, the single-celled green algay *Chlorella* [4] has received the greatest application in the national economy, which turned out to be a convenient model for laboratory research and use in industrial conditions. Chlorella is a unicellular green alga, mononuclear vegetative cells of which usually do not exceed 15 microns in diameter, the protoplast has one cupped chloroplast with one pyrenoid in the thickened part. Chlorella reproduces exclusively by autospores, which usually occur 4-8 in one cell [5-6]. It is known that in terms of the content of vitamins, chlorella surpasses all plant feed and agricultural crops, it contains all the necessary amino acids, including essential ones. On the other hand, these algae can be used in agriculture as fertilizers, since in addition to biogenic elements, they include phytohormones that affect plant development [7]. However, data on the use of green algae in soil fertilization are very scarce. Studies show that when green algae biomass is added to the soil, the nutritional value of grain increases by 1.5 times. At the same time, there is an increase in biomass, an increase in the fixation of atmospheric nitrogen, oxygen, and a decrease in the growth of pathogenic bacteria that affect the development of agricultural crops [9]. Many of the substances contained in chlorella accumulate in its culture media.

Thus, the use of *Chlorella vulgaris* suspension as fertilizer in the agro-industrial complex is relevant [8].

Objects and methods of research. The study used microalgae isolated from the local reservoir of the city of Shymkent - the Koshkar ata river. Water samples were collected at various points in the river, such as the source of the river, the construction market area, residential areas. The samples were cultured in Petri dishes on Myers solid nutrient medium. The cultivation of algae took place on light racks at a room temperature of 250C. Microscopic examination of algae was carried out on a biological and scanning electron microscopes Jeol JSM-2890.

Myers medium for the cultivation of algae of the following composition, g:

- KNO_3-1.213;
- $MgSO_4x7H_2O$-1.204;
- KH_2PO_4 -1.224;
- $Fe_2(SO_4)_3$ - 0.0747;
- agar-20

When studying the effect of algae introduction on the growth and development of plants, agricultural and wild crops of plants, families of cereals, legumes, pumpkin, buckwheat, etc. were used as test objects. In laboratory studies, plastic glasses with sterile sand added to them were used, which were filled with various solutions (distilled water, zero nutrient solution, microalgae suspension, humate solution). After sowing the seeds of the samples into glasses, the glasses were tightly closed with plastic bags, the glasses were put on light racks at room temperature 250C. In addition, plot experiments were laid, where plots of 1.0 mx 2.0 m were used, where corn and garden strawberries were planted. Watering was carried out every 2 days with zero nutrient solution and microalgae suspension.

Study of the influence of a suspension of green algae on the development of *Triticum avestum*. To study the effect of a suspension of microalgal salts on germination, seeds of *Triticum avestum* were used, which germinated under conditions close to natural. Distilled water was taken as the control option. The second and third options included the use of a nutrient solution and a suspension of green algae, respectively. Repetition of all variants is 5-fold. In a special dish, 10 grains were placed on sterilized soil. The temperature of the plant cultivation room was 22-250C, sunlight came from lamps. The experiment was carried out for 10 days.

Statistical processing of the results was performed by calculating the arithmetic mean and the standard deviation. All determinations were carried out in 3-and 5-fold repetitions. The data was processed using an IBM Pentium personal computer based on Excel application software packages.

Research results and discussion

Algological study of the Koshkar-Ata river revealed the structure of algocenoses, consisting of such classes as:

-Zygnematales (20%)
-Chlorococcus (7%)
-Ulotricales (3%)
-Diatomophyta (70%).

Microscopic examination of water samples showed the predominance of monadic forms in flowing waters and filamentary forms in places with a low water flow rate (figure 1). It was found that the dominant role in biofouling on hard surfaces: stones, concrete piles, aquatic plants, from green monad algae belongs to *Chlorella sp.*

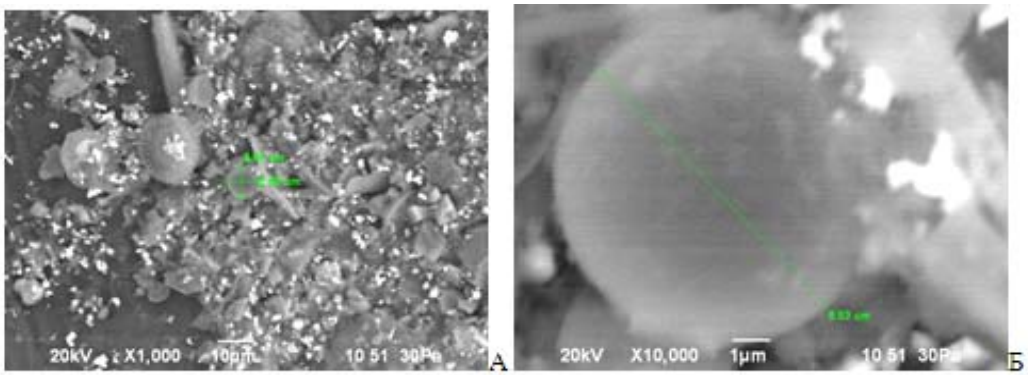

Figure 1 – Green microalgae, A-magnification x10000; B-magnification x100000

As a result of studying the effect of a suspension of green algae on the development of *Triticum avestum*, it was found that the germination of grains as a result of irrigation with distilled water averaged 60%, with a solution of a nutrient medium - 70%, when treated with a suspension - 90%. According to the results of the table, it can be seen that the germination of grains treated with a suspension of green algae exceeds the control group by 30%.

It was found that the use of a suspension of algae as a nutrient material also affects the morphometric parameters of the experimental plants. For example, in the control group, the length of the wheat seedling averaged 10 ± 0.2 mm, and in the group with a nutrient solution of 14.7 ± 0.3 mm on the 10th day of the experiment. In the variant with a suspension of green algae, the length of the seedlings varied from 15 mm to 39 mm. That is, in the group with the suspension, the development of seedlings exceeds the control and the group with the nutrient medium by 61% and 49%, respectively. Thus, the positive effect of the community of green algae and their exometabolites on the germination and development of wheat seeds has been proven.

In addition, in laboratory and greenhouse conditions, experiments were carried out on the effect of chlorella phytohormones on the development of agricultural seeds (genus Vigna - mung bean, genus Tríticum - wheat, genus Phaséolus - beans). In the first variant, the selected wheat grains were inoculated in a zero nutrient solution, in a solution of humates (source Lenger brown coals) and chlorella suspension for two hours (table 1).

Table 1 – Results of germination of wheat grains

No.	Zero nutrient solution, grains pcs.		A solution of humates, grains pcs.		Suspension of microalgae, grains pcs.	
	Sowing	Germination	Sowing	Germination	Sowing	Germination
1	10	8	10	8	10	10
2	10	7	10	9	10	10
3	10	6	10	7	10	9
4	10	6	10	7	10	10
5	10	8	10	8	10	9

The table shows that the germination of grains in a zero solution and in a solution of humates is similar, and is approximately 70-78%, while the germination of grains with a suspension was 98%.

In the second variant, using mung bean, the results were obtained, in the variant with the zero solution the germination rate was about 80%, and the variant with the suspension was about 90-95%.

In the third variant, beans were planted in a greenhouse covered ground. Preliminarily, beans were kept in zero solution and algae suspension for 24 hours. The room temperature was 25-30^{0}C, the soil temperature was 20-25^{0}C. The studies were carried out for 4 weeks, irrigation was carried out once a week with ordinary artesian water. As a result of studies, the germination rate of seeds with a suspension of algae was 100%, while the germination rate of seeds with zero nutrient solution was 85%.

Thus, the use of a suspension of green algae in agriculture can save the use of fertilizers, as well as the overrun of seed, thereby increasing the final yield by 20-25%.

Conclusion. Thus, the use of a suspension of green algae in agriculture can save the use of fertilizers, due to a one-time introduction of the crop into the soil. Moreover, the treatment of the seed with a suspension of green microalgae protects against decay. The main economic effect is achieved by the fact that the yield increases by 20-25%.

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АУЫЛШАРУАШЫЛЫҒЫНДА ЖАСЫЛ БАЛДЫРЛАРДЫ ТЫҢАЙТҚЫШ РЕТІНДЕ ҚОЛДАНУ МҮМКІНДІГІ

Аннотация. Мақалада Қошқар ата өзенінің альгологиялық зерттеу нәтижелері мен жасыл микробалдырларды түрлі ауылшаруашылығы дақылдарының физиологиялық дамуына әсері туралы баяндалған.

Пестицидтер мен минералды тыңайтқыштарды кеңінен қолдануға негізделген ауылшаруашылығы өнімдерін өндіретін заманауи технологиялар халықты азық-түлікпен қамтамасыз ету мәселесін шешуге мүмкіндік берді, сонымен бірге көптеген экологиялық, медициналық және экологиялық мәселелерді, экологиялық таза және биологиялық құнды азық-түлік өнімдері, жер және құнарлылығын қалпына келтіру және т.б. мәселелерін тудырды. Сондықтан түрлі әсер ету механизмдері, жоғары селективті және жылы қанды жануарларға уыттылығы төмен пестицидтердің жаңа кластарының пайда болуы да заманауилығын көрсетеді. Қазіргі уақытта өсімдіктерден қорғанудың адам мен жануарларға улы емес жаңа құралдарды жасау және қолданудың әлемдік маңызы бар. Микроорганизмдер мен олардың метаболиттері негізінде өсімдіктерді қорғау құралдарын құруға, сондай-ақ пестицидті белсенді өсімдік заттарын іздестіруге бағытталған зерттеулерге басымдық беріледі. Осыған байланысты жаңа қауіпсіз тыңайтқыштарды табу мәселесі туындады әрі бұл өнеркәсіптік ауқымда өндіріске экономикалық тұрғыда тиімді саналады. Осы саладағы қазіргі тенденциялардың бірі – жасыл микробалдырларды қолдану.

Микробалдырлар суспензиясын түрлі ауылшаруашылығы дақылына қолдану арқылы күздік бидайдың шығымы 30%-ға, бұршақтың 28%-ға, маштың 15% -ға жоғарылағаны анықталды.

Ауылшаруашылығында жасыл балдырлар суспензиясын қолдану дақылдың топыраққа бірреттік енуіне байланысты тыңайтқыштарды пайдалануды үнемдейді. Сонымен қатар, жасыл микробалдырлар суспензиясымен тұқым өңдегенде оны шіріп кетуден сақтайды. Негізгі экономикалық тиімділік кірісті 20-25% арттыру арқылы жүзеге асырылады.

Түйін сөздер: жасыл балдырлар, тыңайтқыштар, өсімдіктер физиологиясы, экологиялық тыңайтқыштар, өнімділікті арттыру.

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ВОЗМОЖНОСТЬ ИСПОЛЬЗОВАНИЯ ЗЕЛЕНЫХ ВОДОРОСЛЕЙ В КАЧЕСТВЕ УДОБРЕНИЙ В СЕЛЬСКОМ ХОЗЯЙСТВЕ

Аннотация. В статье представлены результаты альгологических исследований реки Кошкар-ата и влияние зеленых микроводорослей на физиологическое развитие различных сельскохозяйственных культур.

Современные технологии производства сельскохозяйственной продукции, основанные на широком применении пестицидов и минеральных удобрений, позволили в значительной степени решить проблему обеспечения населения продуктами питания и одновременно породили множественные экологические,

медицинские и экологические проблемы, проблемы экологически чистых и биологически ценных продуктов питания, реабилитации земель, восстановления их плодородия и др. Поэтому появление новых классов пестицидов с различными механизмами действия, высокой селективностью и низкой токсичностью для теплокровных животных является очень современным. В настоящее время разработка и применение новых средств защиты растений, нетоксичных для человека и животных, имеет глобальное значение. Приоритетными являются исследования, направленные на создание средств защиты растений на основе микроорганизмов и их метаболитов, а также поиск растительных веществ с потенциальной пестицидной активностью. В связи с этим возник вопрос по поиску новых безопасных удобрений, которые могут быть также экономически выгодным для производства в промышленных масштабах. Одним из актуальных направлений в этой отрасли является применение зеленых микроводорослей.

Установлено, что использование суспензии микроводорослей на различных сельскохозяйственных культурах повысило урожайность пшеницы озимой на 30%, фасоли – на 28%, маша – на 15%.

Таким образом, использование суспензии зеленых водорослей в сельском хозяйстве позволяет сэкономить на использовании удобрений за счет разового внесения урожая в почву. Более того, обработка семян взвесью зеленых микроводорослей защищает от гниения. Основной экономический эффект достигается за счет увеличения урожайности на 20-25%.

Ключевые слова: зеленые водоросли, удобрения, физиология растений, экологические удобрения, повышение урожайности.

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REFERENCES

[1] Garni Bharat, Patel J.P., Kothari I.L. Cultivation of Chlorella protothecoides (ISIBES-101) under autotrophic and heterotrophic conditions for biofuel production / Bharat Garni, J.P. Patel, I.L. Kothari // J. Algal Biomass Utilization. 2014. V. 5 (2). P. 20-29.

[2] Nabors, Murray W. Introduction to Botany / Nabors, Murray W. // San Francisco, CA: Pearson Education, Inc. 2000. ISBN 0-8053-4416-0.

[3] Madireddi N. Effect of dioxide on the rheological behavior of submerged cultures of Chlorella minutissima in stirred tank reactors / N. Madireddi, D.K. Daniel, V. Sankar, A. Krastanov // Eng. Life Sci. 2012. №. 5. P. 529-533.

[4] Makhan A.Zh., Anarbekova A.I., Abildaeva R.A., Dauilbai A.D., Rysbayeva G.S. Cyanobacteria Spirulina: biological

[5] characteristics and the role in biotechnology, Reports of the Academy of sciences of the republic of Kazakhstan Satbayev university. Series of geology and technical sciences, 2017,№1, ISSN 2518-1483, http://doi.org/10.32014/2020.2518-1483.000

[6] Olivieri G. Advances in photobioreactors for intensive microalgal production: configurations, operating strategies and applications / G. Olivieri, P. Salatino, A. Marzocchella A. // J. Chem. Technol. Biotechnol. 2014. Vol. 89. P. 1 7 8 - 195.

[7] Zayadan B.K. Isolation, mutagenesis and optimization of cultivation conditions for microalgae strains for the production of biodiesel / B.K. Zayadan, S. Purton, A.K. Sadvakasova, A.A. Userbaeva, K. Bolatkhan // Plant Physiology. 2014. T. 61. No. 1. P. 135 - 142.

[8] Ale M.T. Assessing effects and interactions among key variables affecting the growth of mixotrophic microalgae: ph, inoculum volume, and growth medium composition / M.T. Ale, M. Pinelo, A.S. Meyer // Preparative Biochemistry and Biotechnology. 2014. Vol. 44. P. 242 - 256.

[9] Tleukeyeva A.E. The influence of a suspension of green microalgae on the germination of seeds of agricultural crops / A.E. Tleukeeva and others // Feng-Science. 2013. No. 10 (25).

[10] Safi C. Morphology, composition, production, processing and applications of Chlorella vulgaris: A review / C. Safi, B. Zebib, O. Merah, P.Y. Pontalier, C.Vaca- Garcia // Renewable and Sustainable Energy Reviews. 2014. Vol. 35. P. 265 - 278.

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