



## РАЗЛОЖЕНИЕ ЦЕЛЛЮЛОЗЫ В ПРИКОРНЕВОЙ ЗОНЕ ЯРОВОЙ ПШЕНИЦЫ, ВОЗДЕЛЫВАЕМОЙ С ПРИМЕНЕНИЕМ ПРЕПАРАТОВ БИОВАЙС, ТУРМАКС И АЗОТНОГО УДОБРЕНИЯ

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Изучено влияние обработки семян препаратами БиоВайс Спринт и ТурМакс на целлюлозолитическую активность чернозема выщелоченного под посевом яровой пшеницы в лесостепной зоне Приобья. Эксперимент проведен в 2020, 2021 гг. в ризосферном слое почвы под посевом пшеницы сорта Новосибирская 31, которую размещали второй культурой после пара по зерновому предшественнику на двух фонах азотного питания –  $N_0$  и  $N_{60}$ . Целлюлозолитическую активность почвы определяли стандартным методом – по потере массы внесенного в почву целлюлозосодержащего полотна. Показано, что на данный показатель влияют условия вегетационного периода. В 2021 г. целлюлозолитическая активность почвы в ризосфере пшеницы была выше, чем в 2020 г., как на фоне без внесения удобрения – на 36,6%, так и при их применении – на 119,54%. Распад ткани усиливался в 1,3–1,4 раза, если высевали семена, обработанные БиоВайсом Спринт, и в 1,3 раза при использовании ТурМакса. На удобренном фоне в 2020 г. при применении ТурМакса целлюлозолитическая активность почвы усиливалась в 1,6 раза, БиоВайса – в 1,3 раза. В 2021 г. при обработке семян БиоВайсом показатель увеличивался в 2,8 раза, ТурМаксом – в 2,2 раза. Полученные результаты не позволяют выделить очевидное преимущество одного из двух изучаемых препаратов, но на их основании можно заключить, что обработка семян и ТурМаксом, и БиоВайсом Спринт способна усилить целлюлозолитическую активность почвы, особенно на фоне применения азотного удобрения.

**Ключевые слова:** целлюлозолитическая активность почвы, прикорневая зона пшеницы, БиоВайс, ТурМакс, азотное удобрение

## DECOMPOSITION OF CELLULOSE IN THE ROOT ZONE OF SPRING WHEAT CULTIVATED WITH THE USE OF BIOVAYS, TURMAX AND NITROGEN FERTILIZER

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The effect of BioVays Sprint and TurMax seed treatment on cellulolytic activity of leached chernozem under spring wheat in the forest-steppe zone of the Priob'ye region was studied. The experiment was conducted in 2020-2021 in the rhizosphere layer of soil under the Novosibirskaya

31 wheat, which was placed as the second crop after the fallow on the grain forecrop on two backgrounds of nitrogen nutrition -  $N_0$  and  $N_{60}$ . Cellulosolytic activity of soil was determined by the standard method - by the weight loss of cellulosic cloth introduced into the soil. It was shown that this indicator is influenced by the conditions of the growing season. In 2021, soil cellulosolytic activity in the wheat rhizosphere was higher than in 2020, both in the background without fertilizer application, by 36.6%, and with their application, by 119.54%. Tissue decay increased 1.3-1.4-fold if seeds treated with BioVays Sprint were sown, and 1.3-fold if TurMax was used. On the fertilized background in 2020, the application of TurMax increased the cellulosolytic activity of the soil by 1.6 times, BioVays by 1.3 times. In 2021, seed treatment with BioVays increased the indicator by 2.8 times and with TurMax by 2.2 times. The results obtained do not allow to identify an obvious advantage of one of the two preparations studied, but on their basis, it can be concluded that treatment of seeds with both TurMax and BioVays Sprint is able to increase the cellulosolytic activity of the soil, especially against the background of nitrogen fertilizer application.

**Keywords:** cellulosolytic activity of soil, wheat root zone, BioVays, TurMax, nitrogen fertilizer

**Для цитирования:** Власенко Н.Г., Теплякова О.И. Разложение целлюлозы в прикорневой зоне яровой пшеницы, возделываемой с применением препаратов БиоВайс, ТурМакс и азотного удобрения // Сибирский вестник сельскохозяйственной науки. 2022. Т. 52. № 2. С. 5–11. <https://doi.org/10.26898/0370-8799-2022-2-1>. EDN AIEBMD.

**For citation:** Vlasenko N.G., Teplyakova O.I. Decomposition of cellulose in the root zone of spring wheat cultivated with the use of BioVays, TurMax and nitrogen fertilizer. *Sibirskii vestnik sel'skokhozyaistvennoi nauki* = *Siberian Herald of Agricultural Science*, 2021, vol. 52, no. 2, pp. 5–11. <https://doi.org/10.26898/0370-8799-2022-2-1>. EDN AIEBMD.

#### Конфликт интересов

Авторы заявляют об отсутствии конфликта интересов.

#### Conflict of interest

The authors declare no conflict of interest.

## INTRODUCTION

The urgent task of modern agriculture is to obtain high crop yields by means of biologically based agricultural technologies in which energy-intensive agrochemicals are replaced by new-generation preparations [1, 2]. Biopreparation BioVays, which contains a consortium of highly effective strains isolated from the soil strains *Azotobacter chroococcum*, *Bacillus mucilaginosus*, *B. megaterium*, *B. subtilis*, *B. phosphaticum*, is a new bacterial fertilizer that improves the provision of nitrogen, phosphorus and silicon for plants. In addition, the drug has fungicidal properties [3]. This preparation showed its effectiveness on spring and winter wheat in the conditions of the south of the Russian Federation and in Siberia<sup>1,2</sup> [4]. The ac-

tive ingredient in the TurMax preparation is a natural mixture of oligosaccharides, amino acids, phytohormones and vitamins. BioVays was effective on spring wheat crops in Siberia [4], winter wheat in the Altai Territory<sup>3</sup> and in potato cultivation in Tomsk Oblast [5-7].

Inoculation of spring wheat seeds with biological preparations of associative nitrogen fixers, including BioVays, generally has a stimulating effect on the biological activity of the rhizosphere of cultivated wheat, promotes the development of nitrifying and phosphate-mobilizing bacteria useful for plant nutrition, and increases cellulosolytic activity of the soil [8].

The intensity of pulp decomposition in the soil is an integrated indicator of its biological activity, which depends on the established fer-

<sup>1</sup> Khamova O.F. From the history of the use of microbial preparations in agriculture of the Omsk Priirtyshye // Collection of scientific articles devoted to the 190th anniversary of experimental work in Siberia, the 100th anniversary of agricultural science in the Omsk Priirtyshye and the 85th anniversary of the Siberian Research Institute of Agriculture. Omsk, 2018. pp. 82-84.

<sup>2</sup> Khamova O.F. Effectiveness of biological preparations in spring wheat crops // Collection of scientific articles devoted to the 70th anniversary of RAS academician Ivan Khramtsov, the 95th anniversary of the department of agriculture FSBSI "Omsk ASC". Omsk, 2020. pp. 118-120.

<sup>3</sup> Usenko V.I., Litvintsev P.A., Litvintseva T.A. Effectiveness of mineral and bacterial fertilizers on winter wheat in the forest-steppe of the Altai territory // Scientific support of grain production in the Altai territory: collection of articles. Barnaul, Altai NIISKh, 2016. pp. 127-132.

tility, as well as on the weather conditions of the growing season. The cellulolytic capacity of the soil can serve as a characteristic of organic matter transformation, the involvement of hard-to-reach forms of carbon in the biological cycle, and ultimately determines the level of the soil fertility and biota productivity [9].

The purpose of the study was to study the effect of the treatment of seeds with BioVays and TurMax on the process of cellulose decomposition in the soil of the root layer of spring soft wheat in the forest-steppe of the Priob'ye region.

## MATERIAL AND METHODS

Studies were conducted in 2020, 2021 in the experimental field of the plant protection laboratory of the Siberian Federal Scientific Center of AgroBioTechnologies RAS. The Soil was leached chernozem, middle loamy, medium-powered. Wheat variety Novosibirskaya 31 was sown as the second crop after the fallow of spring wheat. The autumn tillage was deep loosening with SibIME tines. Sowing - May 14 and 21, by SZS-2,1 seeder with anchor coulters, the seeding rate of 6 million germinated grains/ha. Biovays Sprint and TurMax preparations were used for seed treatment, which was carried out with wetting (10 l/t), the application rate was 0.25 kg/t and 0.25 l/t, respectively. Experiments were placed on two backgrounds of nitrogen nutrition: without fertilizer application; with application of 60 kg d.w. N/ha. During the growing season a herbicide tank mixture treatment with Axial, SE (1.0 l/ha) + Primadonna, SE (0.4 l/ha) + Hextar, VDG (10 g/ha) against monocotyledonous and dicotyledonous weeds was performed in the phase of wheat tillering. Wheat was treated with Titul Duo fungicide, KKR (0.32 l/ha) in the ear formation phase. The intensity of cellulose decomposition was determined by a standard method - by the weight loss of the cellulose web introduced into the soil [10, 11]. Capron bags with the material fixed on a sterile glass (six repetitions) were introduced into the soil section of the rhizosphere layer (0-10 cm) in the phase of full sprouts, adjacent to

the plant roots formed at the depth of the seed embedding. The exposure time of the canvases was 90 days. Statistical data processing was performed using Statistica 7.0, Snedecor<sup>4</sup>.

The studies were conducted in the years contrasting in humification. The sum of precipitation for May, June, July and August in 2020 was 54.4; 23.8; 84.9 and 82.0 mm, respectively (245 mm total for the growing season 2020), average daily temperature was 16.5; 16.6; 19.7 and 18.6 °C; in 2021 - 34.0; 71.0; 36.0 and 44.0 mm (for the growing season 185.0 mm) and 15.1; 17.2; 21.0 and 19.1 °C respectively.

## RESULTS AND DISCUSSION

In 2021 the cellulolytic activity of the soil in the wheat rhizosphere was higher than in 2020 both against the background without fertilization - on average by 36,6% in the experiment, and with their application - by 119,54% ( the degree of influence of the factor year by Snedecor on N0 = 53,4, on N60 = 65,1%) (see the table).

The effect of seed treatment on cellulose decomposition was weaker (the degree of influence by Snedecor on N0 = 29.4, on N60 = 18.2%), but tissue utilization increased by 27.9-38.7 and 56.36-79.38% respectively to the levels of fertilizer application. In both seasons, the percentage of decomposed tissue in the experimental variants increased against the background of nitrogen fertilizer application (see Fig. 1).

In general, during 2 years in the soil, where no fertilizer was applied, the intensity of cellulose decomposition relative to N60 decreased by 1.6 times in the rhizosphere of wheat control variant, in the variant with the application of TurMax - by 1.97, with BioVays - by 2.2 times. Comparing the intensity of cellulose decomposition in the experimental variants it was found that a significant difference between them appeared in 2020 on the background without fertilizer application and in both years on the background of its application. The decomposition of tissue increased by 1.6 and 1.4 times if the seeds treated with BioVays Sprint on the

<sup>4</sup>Sorokin O.D. Applied statistics on the computer. 2nd ed. Novosibirsk, 2012. 282 p.

Разложение целлюлозы под яровой пшеницей, выращиваемой с применением препаратов Био-Вайс Спринт и ТурМакс

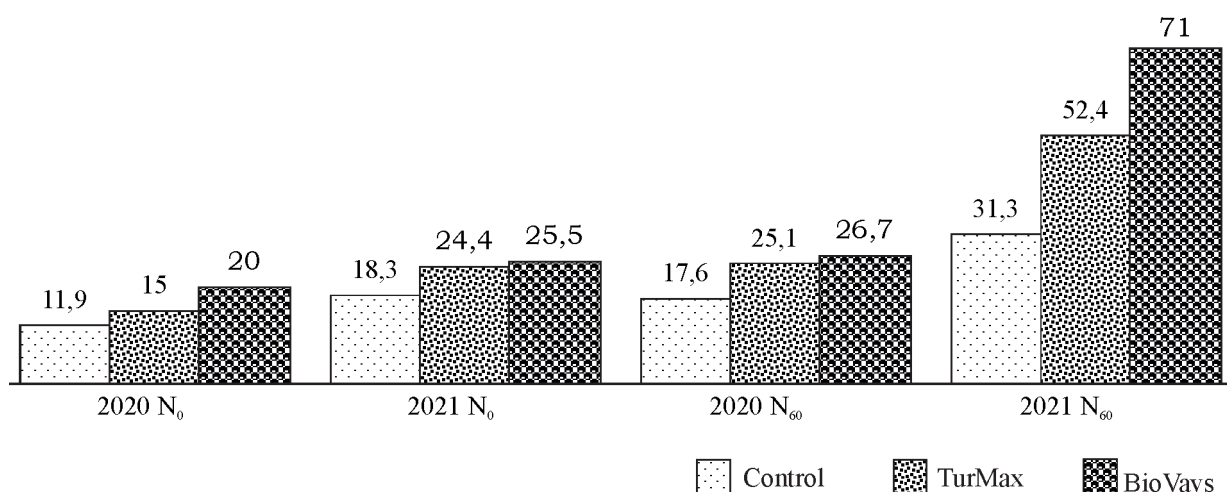
Cellulose decomposition under spring wheat grown with BioVays Sprint and TurMax

Nitrogen fertilizer dosage	Seed treatment	Loss of tissue weight, mg		
		2020	2021	Average
N <sub>0</sub>	No treatment (control)	83,33 ± 4,21	101,67 ± 4,77	92,50 ± 2,81
	TurMax	93,33 ± 3,33	143,33 ± 6,15	118,33 ± 4,01
	BioVays Sprint	110,00 ± 11,54	146,67 ± 7,15	128,34 ± 7,38
		95,55	130,56	
	LSD <sub>05</sub> for the factors: year = 6,25, seed treatment = 7,65, partial averages = 10,82			
N <sub>60</sub>	No treatment (control)	103,33 ± 9,54	171,67 ± 7,03	137,50 ± 3,59
	TurMax	121,67 ± 11,66	308,33 ± 27,74	215,00 ± 14,94
	BioVays Sprint	150,00 ± 11,54	343,30 ± 17,64	246,65 ± 9,46
		125,00	274,43	
	LSD <sub>05</sub> for the factors: year = 14,92, seed treatment = 18,27, partial averages = 25,84			

background without fertilizer application, and by 1.5 and 2.3 times against the background of N<sub>60</sub>. When using TurMax the corresponding figures were 1.3; 1.4 and 1.7 times.

During one day in the experimental variants 0,17-0,58% (TurMax) and 0,22-0,79% (Bio-Weiss Sprint) of the introduced fabric were utilized, which is on the average 1,5-2,0 times higher than in the control (see Fig. 2).

It is known that the application of nitrogen fertilizer to the chernozem soil can almost double the cellulolytic activity of its upper (0-10 cm) layer [12]. In our experiments, a similar increasing index was 1.5 times (2020) and 1.7 times (2021). As a result, according to Zvyagintsev's scale<sup>5</sup> (very weak - <10%, weak - 10-30, medium - 30-50, strong - 50-80, very strong - > 80%) high intensity of cellulose destruction

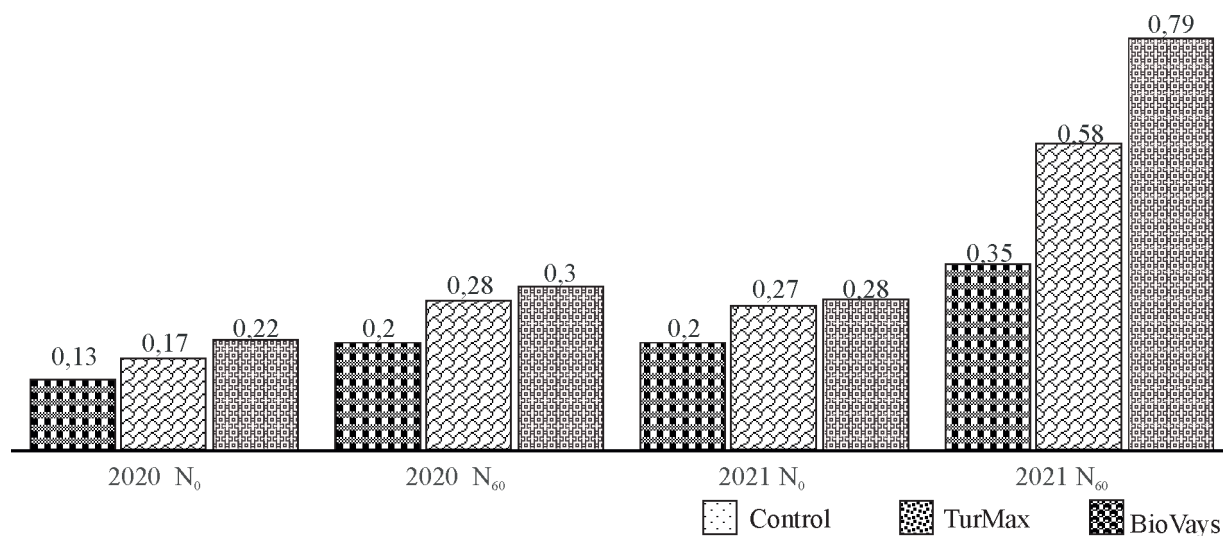


**Рис. 1.** Количество утилизированной целлюлозы под яровой пшеницей, выращиваемой на двух уровнях азотного питания с применением препаратов ТурМакс и БиоВайс, %

**Fig. 1.** Amount of utilized cellulose under spring wheat grown on two levels of nitrogen nutrition with application of TurMax and BioVays preparations, %

<sup>5</sup>Methods of soil microbiology and biochemistry: textbook / edited by D.G. Zvyagintsev. Moscow: Publishing house of Moscow State University. 1991. 304 p.





**Рис. 2.** Ежесуточный процент разложения целлюлозы под яровой пшеницей, выращиваемой на двух уровнях азотного питания с применением препаратов ТурМакс и БиоВайс Спринт, %

**Fig.2.** Daily percentage of cellulose decomposition in spring wheat grown on two levels of nitrogen nutrition with the use of TurMax and BioVays Sprint, %

was recorded only in one of two seasons - under wheat grown from BioVays Sprint and TurMax treated seeds, on nitrogen fertilized (N<sub>60</sub>) soil. In the first case, the level of cellulolytic activity can be characterized as strong, in the second - medium, in the control soil (tissue decay 11.88 and 18.3% of the initial weight of the web) - weak. Daily higher intensity of cellulose decomposition was traced in the variant with BioVays Sprint seed treatment.

## CONCLUSION

The study of cellulolytic activity of soil rhizosphere of spring wheat showed the effect of BioVays and TurMax on this process. The results obtained do not allow us to identify an obvious advantage of one of the two studied preparations, but on the basis of them we can conclude that the treatment of seeds with both TurMax and BioVays Sprint can cause the effect of increasing cellulolytic activity of the soil, especially against the background of nitrogen fertilizer application.

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*Дата поступления статьи / Received by the editors 24.12.2021*  
*Дата принятия к публикации / Accepted for publication 21.02.2022*  
*Дата публикации / Published 25.05.2022*