ОБЩЕЕ ЗЕМЛЕДЕЛИЕ И РАСТЕНИЕВОДСТВО/GENERAL AGRICULTURE AND CROP PRODUCTION

DOI: https://doi.org/10.60797/JAE.2025.57.4

EFFECT OF FOLIAR APPLICATION OF TERRASAY FERTILIZER ON YIELD AND YIELD COMPONENTS OF SPRING WHEAT (*TRITICUM AESTIVUM L.*)

Research article

Kidane F.T.[1,] *, Okbagabir S.G.[2], Zargar M.[3]
[1] ORCID : 0009-0001-2069-5570;
[2] ORCID : 0009-0006-8937-9230;
[3] ORCID : 0000-0002-5208-0861;
[1, 2, 3] Peoples' Friendship University of Russia named after Patrice Lumumba, Moscow, Russian Federation

* Corresponding author (fitsumtekle43[at]gmail.com)

Abstract

The current study was conducted to examine the impacts of foliar fertilizer applications on yield and associated yield components of the spring wheat (*Triticum aestivum L.*). The experimental plots were 5 mx 2 m each arranged in a RCBD layout. The four treatment groups included NPK as the background along with varying levels of Terrsay fertilizer *i.e*. control (0 L ha $^{-1}$), Terrasay Fertilizer Micro Brand-1 (0.5 L ha $^{-1}$), Terrasay Fertilizer Micro Brand-2 (1 L ha $^{-1}$), and Terrasay Fertilizer Micro Brand-3(2 L ha $^{-1}$). The field experiment was conducted in 2024 at the Experimental Site of Research Institute of Agrochemistry in Barybino, Domodedovo Micro-district, Moscow Region, Russia. Foliar applications of Terrasay micro brand-3 at 2L ha $^{-1}$ (TMB3) and Terrasay micro brand-2 at 1L ha $^{-1}$ (TMB2) significantly increased grain yield of spring wheat, yielding 4348kg ha $^{-1}$ and 3523kg ha $^{-1}$, respectively, which represented a relative increases of 73.45% and 43.85% compared to the control. These fertilizer treatments also improved growth parameters and yield components of spring wheat such as number of leaves, Leaf Area Index (LAI), and spike weight. In addition, foliar application of trace elements (Terrasay) had a significant effect on fertile tillers number and a thousand grain weight of spring wheat compared to control.

Keywords: foliar application, Terrasay fertilizer, trace elements, fertilization.

ВЛИЯНИЕ ВНЕКОРНЕВОЙ ПОДКОРМКИ УДОБРЕНИЯ ТЕРРАСАЙ НА УРОЖАЙНОСТЬ И УРОЖАЙНОСТЬ КОМПОНЕНТЫ ЯРОВОЙ ПШЕНИЦЫ (TRITICUM AESTIVUM L.)

Научная статья

Кидане Ф.Т.[1,] *, Окбагабир Ш.Г.[2], Заргар М.[3]
[1] ORCID : 0009-0001-2069-5570;
[2] ORCID : 0009-0006-8937-9230;
[3] ORCID : 0000-0002-5208-0861;
[1, 2, 3] Российский университет дружбы народов имени Патриса Лумумбы, Москва, Российская Федерация

* Корреспондирующий автор (fitsumtekle43[at]gmail.com)

Аннотация

Настоящее исследование было проведено с целью изучения влияния внекорневых удобрений на урожайность и связанные с ней компоненты урожайности яровой пшеницы (Triticum aestivum L.). Экспериментальные участки имели размеры 5 х 2 м каждый и располагались по схеме RCBD. Четыре группы обработки включали NPK в качестве фона вместе с различными уровнями удобрений Terrsay, т.е. контроль (0 л/га), Terrasay Fertilizer Micro Brand-1 (0,5 л/га), Terrasay Fertilizer Micro Brand-2 (1 л/га) и Terrasay Fertilizer Micro Brand-3 (2 л/га). Полевой эксперимент проводился в 2024 году на Опытной площадке НИИ агрохимии в с. Барыбино, микрорайон Домодедово, Московская область, Россия. Внекорневая подкормка микромаркой Террасай-3 при норме 2 л га-1 (TMB3) и микромарке Террасай-2 при норме 1 л га-1 (TMB2) значительно увеличила урожайность зерна яровой пшеницы, дав 4348 кг га-1 и 3523 кг га-1 соответственно, что представляет собой относительное увеличение на 73,45% и 43,85% по сравнению с контролем. Эти обработки удобрениями также улучшили параметры роста и компоненты урожайности яровой пшеницы, такие как количество листьев, индекс площади листьев (LAI) и вес колоса. Кроме того, некорневая подкормка микроэлементов (Террасай) оказала достоверное влияние на количество фертильных побегов и массу тысяч зерен яровой пшеницы по сравнению с контролем.

Ключевые слова: внекорневая подкормка, удобрение Террасай, микроэлементы, подкормки.

Introduction

Triticum aestivum L., or wheat, is one of the major food crops in the world. It gives many people their main source of food and energy. Boosting wheat yield and quality has turned vital as global needs increase with changing diets and growing numbers of people [20]. Foliar fertilization, which is a smart way to control plant nutrients, is a common farming method [13]. Foliar fertilization is the act of spraying fertilizers straight on plant leaves. Earlier studies have linked foliar feeding to improved nutrient uptake and photosynthetic efficiency, both of which increase crop yield [5]. Utilizing foliar application instead of soil fertilization has the advantage of minimization of most (drawing) impairments such as leaching, precipitation of fertilizers, certain nutrients being antagonistic to each other, non-responsive soils structures to very low rates [8].

In spring wheat cultivation, main yield components — like the no. of spikes per plant, the no. of grains per spike, and weight of grains —are influenced directly by how many nutrients are available [18]. Traditional soil-applied fertilizers often

face problems because of leaching, volatilization, and immobilization, efficiency loss which causes low nutrient use efficiency [14]. Also, it causes Al contamination which not only contaminates agricultural products but also leads to nutrient imbalance, soil decomposition, decreased aggregate structural integrity, soil compaction, salinization, and disease aggravation [22]. Earlier studies have established that plants fed by leaves are able to assimilate more nitrogen and utilize sunlight more effectively for higher yields [1], [23]. For instance, Positive strong improvement in wheat grain yield attributed to the use of foliar spray micro nutrients as opposed to the common methods of soil fertilization has been documented [2], [3]. It is most crucial here in regions where soil infertility hinders plant growth. Also, leaf feeding lets for quick nutrient feedings, helping farmers to lessen nutrient lack at critical growth stages [6]. This method has shown to be very helpful in stress conditions like dry spells, where plants can have trouble using ground-fed fertilizers well [7], [16], [19], [21]. However, wheat farmers continue to use foliar fertilization techniques infrequently because they are unaware of and do not appreciate the possible benefits. The efficacy of leaf feeding techniques depending on various factors such as the weather, timing of application and the growth stage of the plant [9]. In spring wheat cultivation, it is especially important to adopt optimal foliar application treatment strategies, since optimal application strategies which take these factors into account are very important. However, while there is optimism for this and similar methods, more standardized protocols and field trials are needed to optimize the use of foliar applications for the several wheat varieties in question and their respective climates [11].

In consideration of all these factors, therefore, undertake this research to examine the influence of foliar application of Terrasay fertilizer on yield and yield components of spring wheat. Hence, it is important to equip farmers with information that will assist in improving their use of nutrients and this in turn will enhance the yields of crops and the sustainability of wheat production. This is likely to happen as well. Particularly so in cases where poor soil nutrition is the limiting factor for plant growth.

Research methods and principles

A field experiment was conducted from May 22, 2024 through September of the same year to examine the impact of foliar fertilizers on the yield and yield components of spring wheat (*Triticum aestivum L.*) at the Research Institute of Agrochemistry, located in the Barybino Domodedovo Microdistrict. Geographically, the mentioned research institute is placed in the Moscow Region, between 55° 15' 52.6248" northern latitude, a longitude of 37° 53' 13.1712" eastern longitude, and an altitude of 137 meters above sea level. The experimental plots were 5 mx 2 m each arranged in a RCBD layout. Plots were separated by 2m between blocks, 20cm between rows, 10cm between plants, and 0.5m wide between respective plots to minimize border effects. The experimental area was characterized by sod-podzolic heavy loamy soil. The spring wheat was used in the experiment at a rate of 220 kg ha $^{-1}$.

The experiment was applied with Background Complex mineral fertilizers with trace elements, namely Terrasay. The four treatment groups included NPK as the background along with varying levels of Terrsay fertilizer *i.e.* T1- control (0 L ha $^{-1}$), T2 - Terrasay Fertilizer Micro Brand-1(0.5 L ha $^{-1}$), T3- Terrasay Fertilizer Micro Brand-2 (1 L ha $^{-1}$), and T4 — Terrasay Fertilizer Micro Brand-3(2 L ha $^{-1}$). Terrasay Fertilizer has a set of essential vitamins for plant development, growth, and strength. It is a granular fertilizer with the following suggested composition, which makes it easier to use the nutrients that plants can use (%): Cu — 0.01, Zn — 0.02, Mg — 2.0, Fe — 0.15, Mn — 0.08, B — 0.02, N — 20, P — 9, and K — 10. It was applied first, during the tillering phase, and second, during the earing phase. After fertilizer applications, growth parameters were measured and recorded such as; the Leaf Area Index (LAI), Plant height and as the plants were approaching maturity, Number of tillers per unit square meter was counted. After harvesting, data were collected for the yield components such as; Number of spikes per spikelet, spike length, spike weight, and Biomass. Grain collected from each plot was weighed to determine 1000-grain weight, total yield per hectare.

2.1. Statistical Analysis

The data obtained from all the measured parameters of the experiment under various treatments were subjected to statistical analysis by using the GENSTAT software (4th ^{edn}) and IBM SPSS statistical package version 20 and the treatment means were compared with LSD at 5 per cent level of significance.

Main results

The analysis of the results indicated a substantial positive impact of foliar application of Terrasay fertilizers on the grain yield of spring wheat. The highest grain yield was recorded with the application of T4 and T3 containing Terrasay micro brand-3 at 2l ha^{-1} (TMB3) and Terrasay micro brand-2 at 1l ha^{-1} (TMB2), yielding 4.348t ha^{-1} and 3.523t ha^{-1},respectively, which represented a relative increases of 73.45% and 43.85% compared to the control. There was a noted trend of increased grain yield following the application of Terrasay fertilizers in all treatments compared to the control.

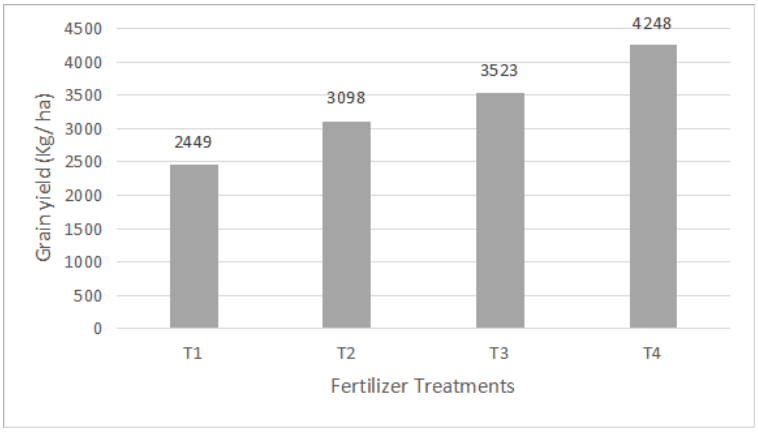

Figure 1 - Effect of Terrasay foliar fertilization on spring wheat in 2024
DOI: https://doi.org/10.60797/JAE.2025.57.4.1

The application of foliar fertilizer treatments had significant impact on the thousand grain weight (TGW) as shown in Table 1. The highest TGW was recorded with Terrasay Fertilizer Micro Brand-3 (TGMB3) and Terrasay fertilizer Micro Brand-2 (TFMB2) treatments (T4, T3), followed by the Terrasay Fertilizer Micro Brand-1; TFMB1 (T2). In contrast, T1 (control) resulted in the lowest TGW.

Table 1 - Foliar application effect of Terrasay fertilizer on growth parameters, yield and yield components of spring wheat

DOI: https://doi.org/10.60797/JAE.2025.57.4.2

Treatment	PH (cm)	NFT ($m^{-2)}$	LAI	LN	NSS	SL (cm)	SW (g)	TGW (g)	BY (Kg ha^{-1})	GY (Kg ha^{-1})
T1	64	190	0.313	3.3	14.9	8.16	1.82	28.03	10107	2449
T2	68.8	234	0.283	3.1	14.2	7.47	1.686	30.23	10024	3098
T3	63.6	278	0.321	3.2	15.1	8.54	1.946	31.80	14006	3523
T4	73	252	0.432	3.45	15	9.02	2.311	32.63	12956	4248
Mean	67.3	238.5	0.337	3.263	14.8	8.30	1.941	30.68	11773	3330
LSD 5%	n.s.	44.42	0.103	n.s.	n.s.	n.s.	0.375	2.804	n.s.	591.1

Note: PH – plant height in cm, NFT – number of fertile tillers per m^2, LAI – leaf area index, LN –leaf number, NSS – number of spikelets per spike, SL – spike length in cm, SW – spike weight in g, TGW – thousand grain weight, BY – biomass yield in kg per ha,, GY – grain yield in kg per hectare,LSD 5%- Least Significant Difference at 5%,and CV- coefficient of Variation in percentage

The Analysis of plant height revealed that there were no significant differences among the four foliar fertilizer treatments (T1, T2, T3, and T4) ($p > 0.05$). However, there was a slight increase in plant heights in the case of treatment T4 (Terrasay Fertilizer Micro Brand-3) with a 73-cm plant height compared to T1(control) and T3 (TFMB2), which were 64cm and 63.6 cm tall, respectively.

Analysis of the results showed a significant beneficial effect of foliar fertilizer application on the fertile tillers number of spring wheat (Table 1). The highest number of fertile tillers was stated under T3 and T4 fertilizer treatments as compared to control. Treatment 3; Terrasay Fertilizer Micro Brand-2 (TFMB2) and Terrasay Fertilizer Micro Brand-3 (TFMB3) showed a relative increase of 46.32% and 32.63% NFT respectively (273 NFT and 252 NFT per m^2).

Leaf Area Index (LAI) was significantly impacted by the foliar fertilizer application treatments (Table 1). Treatments with Terrasay Fertilizer Micro Brand-3 (T4) had the highest LAI, followed by applications of Terrasay Fertilizer Micro Brand-2 (T3), and Terrasay Fertilizer Micro Brand-1(T2) had the lowest LAI.

The different fertilizer treatments used in the present study showed no significant effect on the leaf number of spring wheat plants $p \geq 0.05$ (Table 1). It is, however, worthy of mention that the highest leaf number were increasingly recorded under the influence of T4 treatment (Terrasay Fertilizer Micro Brand-3), which produced 3.45 leaves per plant.

Regarding the number of spikelets per spike (NSS) and spike length (SL) the analysis of variance showed no significant differences ($p > 0.05$) among the four treatment groups (T1-T4). Although there was some variation in the observed values (Table 1), the means were quite similar. Specifically, NSS values ranged from 14.2 to 15.1, with T3 measuring at 15.1, and T4 at 15 recorded the highest. Meanwhile, SL ranged from 7.47 cm to 9.02 cm, with T4 measuring at 9.02 cm, and T3 at 8.54 cm.

The treatment Micro Brand-3 (T4) with Terrasay fertilizer had a notable impact on spike weight ($p < 0.05$). Specifically, microbrand-3 produced the heaviest spikes (2.31g), significantly surpassing treatments 2 (TMB1) and T1(control) (1.686g and 1.82g respectively). This indicates that the treatment 4 is especially effective in enhancing spike growth. Although treatment 3 exhibited an intermediate spike weight, it did not show a significant difference compared to treatments 1 or T2.

Discussion

The findings of this research indicate that foliar spray of Terrasay fertilizer has a significant impact on key spring wheat yield determinants such as yield, 1000-grain weight, spike weight, fertile tiller number, and leaf area index. This observation is consistent with the existing literature in favor of liquid fertilizers for boosting wheat productivity [15]. The improved yield parameters that were achieved in this research are due to the nutrient content of the Terrasay fertilizer, which is high in macro and micronutrients that are needed for wheat development.

The detected increase in 1000-grain weight makes it possible to conclude that foliar application is likely to go a long way in the grain-filling process, which is a crucial phase in wheat crop development. It is reasonable to suggest that the good nutrition resulted from Terrasay's nutrients led to a great development in the grains, as other authors have reported that properly nourished plants have a high allocation of biomass to grains [4], [10]. Additionally, the remarkable increase in spike weight and the fertility of tillers could be an indicator that the application of the Terrey is that it may positively influence the whole plant development and the reproductive structure, which is important in the case of higher yields.

Leaf Area Index was significantly impacted by the foliar fertilizer application treatments, which ius supported by a previous study which indicated that foliar application of boron increased the LAI index of wheat [17]. In contrast, another experimental research confirmed observed no significant effect of foliar application of different fertilizers on LAI [10].

The study found that Terrasay did not significantly affect plant height, biomass yield, spikelet count, leaf number, or spike length, suggesting that certain yield components were selectively improved. This suggests that nutrient ratios in Terrasay formulation favor growth factors that directly influence yield formation, leaving relatively other growth aspects unaffected.

The lack of influence on the number of spikelets per spike and the spike length raises questions regarding how foliar fertilizers have been aptly able to influence the mechanisms involved. Possibly, the application of Terrasay fertilizer favors metabolic activities related to grain filling rather than affecting the reproductive structures. The findings would require more experimental tests to verify nutrient application timing and concentrations that favor such stimulation.

Conclusion

The results of the present research revealed that different fertilizer treatments significantly affected grain yield and some of the yield components of spring wheat. The foliar applications of trace elements (Terrasay fertilizer) T 4 and T3 significantly improved grain yield and some yield components of spring wheat compared to the control. Additionally, foliar applications of Terrasay fertilizer, T 4 and T3, respectively, showed a significant effect on the thousand grain weight as compared to control T1. The findings have important implications for farmers and agricultural professionals aiming to enhance wheat yield. Using Terrasay could offer a cost-effective way to boost productivity. These results should be confirmed through additional field trials, and research should be done focusing on the long-term effects of foliar fertilization of Terrasay on other crops and the specific physiological processes by which Terrasay influences these outcomes.

Конфликт интересов

Не указан.

Рецензия

Минина Н.Н., Уфимский университет науки и технологий, Бирск Российская Федерация

DOI: https://doi.org/10.60797/JAE.2025.57.4.3

Conflict of Interest

None declared.

Review

Minina N.N., Ufa University of Science and Technology, Birsk Russian Federation

DOI: https://doi.org/10.60797/JAE.2025.57.4.3

Список литературы на английском языке / References in English

1. Bărdaş M. Effect of Foliar Fertilization on the Physiological Parameters, Yield and Quality Indices of the Winter Wheat / M. Bărdaş, T. Rusu, A. Popa [et al.] // Agronomy. — 2023. — Vol. 14, № 1. — Art. 73. — DOI: 10.3390/agronomy14010073.

2. Basrat K.M. Effect of foliar application of nutrients on growth and yield attributing characters of black gram / K.M. Basrat, R.P. Singh, D. Megha [et al.] // International Journal of Current Microbiology and Applied Sciences. — 2020. — Vol. 9, № 2. — P. 419–428. — DOI: 10.20546/ijcmas.2020.902.052.

3. Basvantrao M.C.O. Effect of foliar application of nutrients on growth, yield and quality of wheat (Triticum aestivum L.) : doctoral dissertation / M.C.O. Basvantrao. — Mahatma Phule Krishi Vidyapeeth, 2024.

4. Bobrecka-Jamro D. Response of some spring wheat cultivars to diverse mineral NPK fertilization / D. Bobrecka-Jamro, A. Jarecka, W. Jarecki // Acta Scientiarum Polonorum. Agricultura. — 2015. — Vol. 14, № 2. — P. 3–13. — DOI: 10.5601/jelem.2017.22.3.1435.

5. Dass A. Foliar application of macro-and micronutrients improves the productivity, economic returns, and resource-use efficiency of soybean in a semiarid climate / A. Dass, G.A. Rajanna, S. Babu [et al.] // Sustainability. — 2022. — Vol. 14, № 10. — Art. 5825. — DOI: 10.3390/su14105825.

6. Dobrinoiu R.V. Impact of foliar fertilization with completely soluble chemical fertilizers on winter wheat productivity and yields quality / R.V. Dobrinoiu, M. Dumbravă // Lucrări ştiinţifice USAMV. Seria A. — 2003. — Vol. 46. — P. 271–277.

7. Gangwar S. Effect of Foliar Application of Nano-Fertilizers on Growth and Yield of Wheat (Triticum Aestivum L.) / S. Gangwar, R.P. Singh, P.K. Mishra [et al.] // International Research Journal of Applied and Basic Sciences. — 2012. — Vol. 3, № 1. — P. 219–223. — DOI: 10.15515/abr.0976-4585.13.3.190193.

8. Hong J. Foliar application of nanoparticles: Mechanism of absorption, transfer, and multiple impacts / J. Hong, C. Wang, D.C. Wagner [et al.] // Environmental Science: Nano. — 2021. — Vol. 8, № 19. — P. 1196–1210. — DOI: 10.1039/D0EN01129K.

9. Hu Y. Editorial: Factors affecting the efficacy of foliar fertilizers and the uptake of atmospheric aerosols / Y. Hu, N. Bellaloui, Y. Kuang // Frontiers in Plant Science. — 2023. — Vol. 14. — Art. 1146853. — DOI: 10.3389/fpls.2023.1146853.

10. Jarecki W. Response of spring wheat to different soil and foliar fertilization / W. Jarecki, J. Buczek, D. Bobrecka-Jamro // Journal of Central European Agriculture. — 2017. — Vol. 18, № 2. — P. 460–476. — DOI: 10.5513/JCEA01/18.2.1919.

11. Jat L. Wheat Nutrient Management Strategies to Increase Productivity, Profitability and Quality on Sandy Loam Soils / L. Jat, R.K. Naresh, R. Bhatt [et al.] // Agronomy. — 2022. — Vol. 12, № 11. — Art. 2807. — DOI: 10.3390/agronomy12112807.

12. Javed M.S. Impact of foliar application of boron on productivity of different varieties of Triticum aestivum L. / M.S. Javed, Y. Saeed, S. Anwar [et al.] // Haya: Saudi Journal of Life Sciences. — 2023. — Vol. 8, № 6. — P. 84–88. — DOI: 10.36348/sjls.2023.v08i06.002.

13. Jaybhay S.A. Influence of foliar application of nutrient on growth, yield, economics, soil nutritional status and nutrient uptake of soybean / S.A. Jaybhay, P. Varghese, S.P. Taware // Legume Research. — 2021. — Vol. 44, № 11. — P. 1322–1327. — DOI: 10.18805/LR-4218.

14. Kaushal S. Foliar feeding of plant nutrients / S. Kaushal, R. Rana, S. Kumar // Popular Kheti. — 2014. — Vol. 2, № 2. — P. 76–81.

15. Mikos-Szymańska M. Effects of different fertilizer treatments on grain yield and yield components of spring wheat / M. Mikos-Szymańska, M. Borowik, M. Wyzińska [et al.] // Research for Rural Development. — 2018. — Vol. 2. — P. 100–106. — DOI: 10.22616/rrd.24.2018.058.

16. Mussarat M. Accentuating the Role of Nitrogen to Phosphorus Ratio on the Growth and Yield of Wheat Crop / M. Mussarat, M. Shair, D. Muhammad [et al.] // Sustainability. — 2021. — Vol. 13. — Art. 2253. — DOI: 10.3390/su13042253.

17. Nadim M.A. Micronutrient use efficiency in wheat as affected by different application methods / M.A. Nadim, I.U. Awan, M.S. Baloch [et al.] // Pakistan Journal of Botany. — 2013. — Vol. 45, № 3. — P. 887–892.

18. Narimani H. Study on the effects of foliar spray of micronutrient on yield and yield components of durum wheat / H. Narimani, M.M. Rahimi, A. Ahmadikhah [et al.] // Archives of Applied Science Research. — 2010. — Vol. 2, № 6. — P. 168–176.

19. Noreen S. Foliar application of micronutrients in mitigating abiotic stress in crop plants / S. Noreen, Z. Fatima, S. Ahmad [et al.] // Plant Nutrients and Abiotic Stress Tolerance. — Singapore : Springer, 2018. — P. 22. — DOI: 10.1007/978-981-10-9044-8_3.

20. Saeed F. Developing Future Heat-Resilient Vegetable Crops / F. Saeed, U.K. Chaudhry, A. Raza [et al.] // Functional & Integrative Genomics. — 2023. — Vol. 23, № 1. — Art. 47. — DOI: 10.1007/s10142-023-00967-8.

21. Saquee F.S. The Efficacy of Micro-nutrient Fertilizers on the Yield Formulation and Quality of Wheat Grains / F.S. Saquee, S. Diakite, N.J. Kavhiza [et al.] // Agronomy. — 2023. — Vol. 13, № 2. — Art. 566. — DOI: 10.3390/agronomy13020566.

22. Sarker A. Biological and green remediation of heavy metal contaminated water and soils / A. Sarker, M.A. Al Masud, D.M. Deepo [et al.] // Chemosphere. — 2023. — Vol. 332. — Art. 138861. — DOI: 10.1016/j.chemosphere.2023.138861.

23. Valente F. Growth, Photosynthesis and Yield Responses of Common Wheat to Foliar Application of Methylobacterium symbioticum under Decreasing Chemical Nitrogen Fertilization / F. Valente, A. Panozzo, F. Bozzolin [et al.] // Agriculture. — 2024. — Vol. 14, № 10. — Art. 1670. — DOI: 10.3390/agriculture14101670.