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Research Of The Impact Of Growth Regulators Application On The Basic Biometric, Structural Indicators And Formation Of Sunflower Hybrids Seed Performance In The Southern Zones Of Ukraine Under The Conditions Of Global Climate Transformations.

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ABSTRACT

The results of research in a dark-brown soil on the effects of Helafit Combi®, Myr ® and Mifosat® plant growth regulators on the yield of sunflower hybrids in the conditions of insufficient moistening of the steppe zone of Ukraine conducted in 2015 – 2017 have been interpreted. It was established that the studied growth regulators for their one-time introduction during sunflower vegetation contributed to the improvement of plant development, increased the intensity of growth processes at all stages of organogenesis due to the activation of growth processes, and intensified the adaptive capacity of sunflower agrocenosis to adverse climatic conditions. The use of growth regulators had positive effect on formation of higher yield of sunflower seeds. Thus, the greatest increase in the yield of sunflower hybrid seeds was observed when treating plants with Helafit Combi ® growth stimulating fertilizer. The increase in comparison with a reference sample observed in Forward hybrid was +0.51 t / ha, and in Zaklyk hybrid +0.47 t / ha. Somewhat lower yields were observed after foliar introduction of Myr ® and Mifosat ® fertilizers.

Keywords: sunflower, growth regulators, Helafit Combi ®, Myr ®, Mifosat ®, yield, efficiency.

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INTRODUCTION

Directional climate change is one of the most important global challenges of the 21st century, which goes beyond scientific research and represents a complex interdisciplinary problem embracing the ecological, economic, and social aspects of sustainable development in the countries of the world [1]. Climate changes are diverse and manifest themselves, in particular, in the intensity, frequency of climatic abnormalities and extreme weather phenomena at different levels of the hierarchy in space and time. In the last 20 to 30 years, the quantity, frequency, and intensity of abnormal hazardous phenomena, which cause significant economic losses, threaten the stable functioning of ecosystems, as well as health and life of people, have increased excessively. Scientists around the world believe that in the future, more frequent climate changes may lead to even more unpredictable consequences, unless the humanity takes appropriate precautionary measures [1-4]. Scientists determine the following factors to be the main causes of global climate change: anthropogenic factor [1, 2]; increase in the carbon dioxide cycle [5], radiative forcing of the atmosphere due to the absorption of red radiation at the dominant influence of convective heat transfer [6], change of tide in the Arctic Ocean (cold Labrador Current in the Greenland region and the warm Gulf Stream), which leads to periodic catastrophic epochs of a steady decline and an increase in the temperature regime in the Northern Hemisphere [7,8]. The climate at the regional level is formed under the influence of three major factors: circulation of the atmosphere, solar insolation, and relief [9].

Changing climatic conditions is not a purely environmental problem. Such changes affect all aspects of human life, and agriculture is not an exception. Everywhere on the planet, it is getting hotter, and this is already an obvious fact for agrarians of the whole world, whose crops have suffered from abnormally high temperatures and prolonged droughts in recent years. Thus, according to the forecasts of FAO UN experts, in the unchanged scenario, about 650 million people will suffer from hunger already around 2030. Economic activities, including agriculture, significantly affect changes in climatic conditions [10, 11].

Over the past 20 years, rainfall in different regions of Ukraine has increased by 50-100 mm per year, but the significant increase in temperature and the decrease in relative humidity during the growing season did not improve but only complicated the vegetation conditions of plants of most agricultural crops. Estimates show that from 10 to 20% or more of rainwater from storm water leave the boundaries of arable land and flow into beams and rivers. Such precipitations are not productive: plants in the fields cannot benefit from it due to the fact that the soil surface has a damaged structure being broken up or overcompacted. The part of the moisture that penetrates into the soil cannot be saved due to the low absorption capacity of the arable layer and, accordingly, the subsoil. The long-term shortage of organic matter in the soil, as well as the imbalance of nutrients, leads to the rapid mineralization of the most valuable part of the soil - humus, which, besides the well-known multifaceted positive effect on agronomically valuable indicators: soil structure, its equilibrium density, capacity of the absorption complex, nutrient reserve, air and permeability, is capable of holding 5 to 10 times more moisture than the parent material [12]. This led to a decrease in the productive moisture reserves in the arable and metre-deep soil layer, the emergence of prolonged hydrothermal stresses in the critical phases of plant development, especially late spring crops, which include sunflower. Therefore, the production of sunflower seeds in many economies is characterized by a decrease in the indicators of the productivity of the crop and the increase in the cost of production.

Changes in the recent climatic conditions cause a decrease in the soil's ability to provide plants with the main factors of life in an optimal amount, which makes it necessary to make adjustments to the existing technology of growing field crops. Namely, it is necessary to attract new additional multifunctional combined drugs, which will enable to some extent balance the manifestation of stress conditions in the cultivation of crops. Such drugs are already on the market, and they appeared quite timely. The composition of such organ mineral combined agents includes, in addition to mineral compounds, a bacterial component, which also has prophylactic and therapeutic properties, which causes the resistance of plants to a complex of diseases, pathogens of which are pathogenic microorganisms. This shows the "multifunctionality" of such formulations. As a consequence of the positive action of the aforementioned agents, there is an increase in the immunity of plants, improvement of qualitative and structural indices of the yield, increase of plant resistance to adverse environmental factors, namely: a sharp fluctuation of the temperature regime, moisture deficit and phototoxic action of chemical plant protection products throughout the vegetative period of the agrocenoses [13- 15].

More than 90 plant growth regulators have been registered In Ukraine, of which 69 are authorized for use. These agents are based on various active low molecular weight ingredients, primarily on the basis of physiologically active substances, plant growth promoters such as auxins, gibberellins, cytokinins, succinic acid, aminofumaric acid, polysaccharides, amino acids, vitamins, microorganism metabolites [16]. The use of plant growth regulating agents is one of the most affordable and highly profitable agricultural measures to increase the productivity of major crops, including sunflower, and improve their quality.

MATERIALS AND METHODS

Experiments were conducted in 2015 - 2017 on experimental field of "Kherson State Agricultural University" SHEE in conditions of insufficient moistening of the steppe zone of Ukraine on dark chestnut soils. Their purpose was to study the influence of different plant growth regulators on the growth, development and yield of sunflower hybrids.

The experiment is based on a two-factor scheme. Thus, the factor A are Forward and Zaklyk sunflower hybrids, which are entered in the State Register of Varieties of Ukraine ; and factor B - foliar application of Helagit Combi ®, Myr ®and Mifosat ®, and the reference variant - the cultivation of plants with pure water.

Soils of experiment plots are characterized by insufficient content of basic nutrition elements in the plow layer to obtain high yields of crops. Presence of available nutrients in soil was at the level of: easy hydrolysable nitrogen - 2.8 - 4.3 mg; nitrate - 0.28 - 1.36 mg; absorbed ammonia - 0.38 - 0.42 mg; motile forms of phosphorus - 3, 6 - 4.0 mg, exchangeable potassium - 25.4 - 29.2mg / 100 g of soil.

Foliar treatment of sunflower with growth regulating agents was carried out with an on-ground sprayer in the phase of 8 - 10 leaves, which coincided with the onset of the phase of anthodium formation. The area of the experimental plot was 280 m^2, and the recording area was 112 m^2. There was a fourfold repetition in the experiment.

Harvesting from the recording area was carried out by the method of combine threshing. We used KLASAS harvester with a four-row accessory for sunflowes. In fact, the obtained yield was estimated taking into account the baseline humidity (8%) and the presence of impurities.

Experimental data was processed using the multi-factor dispersion analysis according to B.A. Dospiekhov [17]. Simulation of yield formation was carried out using "Statistica 8.0" license program.

RESULTS AND DISCUSSION

The use of any, including new, agrotechnical practice is aimed at increasing the productivity of the cultivated crop and increasing the yield per area unit. The implementation of this task is ensured by influencing the processes of plant life, their growth, development, especially the use of solar radiation, moisture, nutrition elements.

The density of stubble affects the architectonics of sunflower plants in the first place. The crop density in the flowering phase ranged from 42 to 46 thousand pcs / ha of plants, depending on the years of research. High yield of sunflower seeds, as well as of other crops, is formed on the basis of a well-developed vegetative matter. One of the indicators characterizing its development is the height of plants. Studies have found that one-time application of growth stimulating agents Helafit Combi®, Myr® and Mifosat® in the phase of 8 - 10 leaves to the crop contributed to intensification of growth processes and the formation of vegetative matter of plants. Also, the tested growth stimulators provided for better growth activity. Thus, on average, over the years of research, their use ensured 5 - 9 cm higher plants than the reference variant, where plants were treated with pure water only. There was a tendency of the increased number of leaves per plant, which resulted in an increase in the area of photosynthetic activity of sunflower agrocenosis (Table 1).

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Table 1: Influence of growth regulating agents on the height of sunflower plants and the number of leaves, the average for the years of research (2015-2017).

No.	Agents (factor A)	Sunflower hybrids (factor B)			
		Forward		Zaklyk	
		Plant height, see	Number of leafs, pcs	Plant height, cm	Number of leafs, pcs
1	Reference (pure water treatment)	161	18	146	22
2	Helafit Combi ®	168	22	157	27
3	Myr®	166	19	153	24
4	Mifosat ®	167	20	155	25
least significant difference $_{05}$		3.11	1.71	4.78	1.84

The results of field studies show that all of growth regulating agents had a positive effect on the studied hybrids of sunflower. Thus, on average, over the years of research, the height of sunflower plants was the largest at the time of their treatment with Helafit Combi ® as compared to the reference variant (treatment of plants with pure water). The increase of plant height was 7 cm, and in Zaklyk hybrid - 9 cm, respectively. Myr® and Mifosat® growth regulating agents also significantly affected the plant height, but somewhat inferior in intensity to the effects of Helafit Combi ® on plant.

Regarding the formation of the number of leaves per plant, the foliar treatments with the growth regulating agents had a clear tendency to increase the number of leaves on sunflower plants. Graphically, the results of studies on the height of plants and the number of leaves per plant, depending on foliar applications, were as follows (Fig. 1).

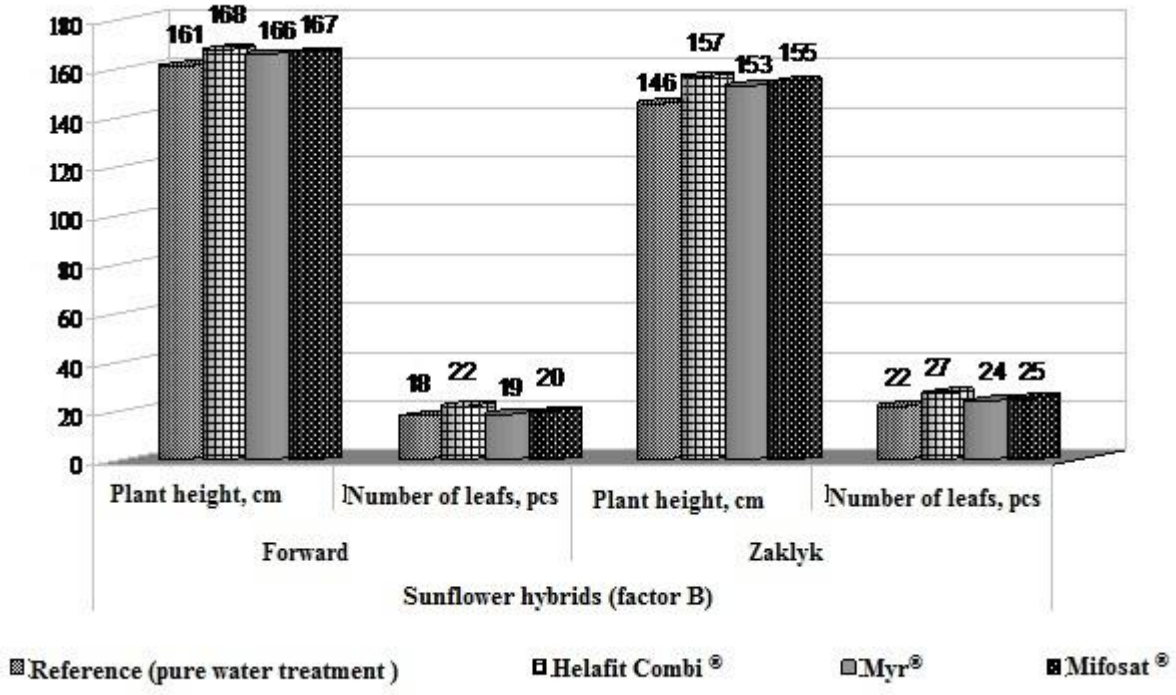

Figure 1: Influence of foliar application of growth regulating agents on plant height (cm) and number of leaves on these plants (pcs), the average for 2015- 2017 years of research

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Photosynthesis is a unique process of creating organic matter by means of the energy of the sun and biochemical reactions in plants. Biomass of plants is 75% composed of products of carbon dioxide photo fixation from the atmosphere and only 25% - of absorbed mineral substances. However, soil and air supply are very closely interconnected in plant metabolism, and one process does not occur without the other. As a result of their interaction in the plant organism, there occurs a series of successive reactions with the formation of such substances as: carbohydrates, amino acids, proteins, fats - which, in fact, form the yield of crops [18].

One of the main ways to increase productivity of photosynthetic performance of agrocenosis is increase of assimilating organs (leaf area) to a certain size and enhancement of their activities, which is determined by the amounts of incoming solar energy. It has been proved that growth regulators of plants stimulate the growth of the leaf apparatus, affect the biosynthesis of chlorophylls, formation of chloroplasts, transport of photoassimilants and the intensity of photosynthesis [19].

According to the results of field studies, not all growth stimulating agents had the same effect on the area of photosynthetic potential of sunflower agrocenosis (Table 2).

Table 2: Influence of growth regulators on the area of the assimilation apparatus and the index of the leaf surface of sunflower crop (average for 2015-2017)

No.	Agents (Factor A)	Sunflower hybrids (factor B)							
		Forward				Zaklyk			
		Density of crops, thousand plants / ha	Leaf surface area of one plant, m^2	Leaf surface area per 1 ha, ths. m^2	Index of leaf surface	Density of crops, thousand plants / ha	Leaf surface area of one plant, m^2	Leaf surface area per 1 ha, this. m^2	Index of leaf surface
1	Reference (pure water treatment)	42	0.48	20.3	2.0	44	0.56	24.6	2.5
2	Helafit Combi ®	42	0.68	28.6	2.9	44	0.79	34.8	3.5
3	Myr®	42	0.60	25.4	2.5	44	0.69	30.4	3.0
4	Mifosat ®	42	0.63	26.6	2.7	44	0.72	31.7	3.2
least significant difference $_{05}$		-	0.08	1.74	-	-	0.09	1.79	-

According to the results of the research, certain regularities of changes in the leaf surface in the flowering phase were established. Thus, the area of the leaf surface of plants of Forward sunflower hybrid in the flowering phase ranged from 20.3 to 28.6 thousand m^2/ha, and of Zaklyk hybrid- from 24.6 to 34.8 thousand m ^{2}/ha. Carrying out foliar application of Helafit Combi®, Myr® and Mifosat® growth stimulating agents increased the area of the assimilation surface in comparison with the reference variant (treatment with pure water) by– 6.3, 5.1, and 6.1 thousand m^2/ha respectively.

Regarding the influence of plant growth regulators on the index of leaf surface, we also noted the positive trend to an increase in this indicator. The highest growth rates of the index of leaf surface were determined when applying Helafit Combi® to both sunflower hybrids (Table. 2). Then, the index of leaf surface in Forward hybrid was - 2.9, and Zaklyk hybrid - 3.5, which exceeded the reference variant by 0.9 and 1.0 respectively. Growth regulating agents Myr ® and Mifosat ® had a significant impact on the index of leaf surface, but slightly inferior to Helafit Combi ®.

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The size of the anthodium was determined by the phenotype characteristics of sunflower hybrids. However, the measurements of anthodium diameter of the studied hybrids carried out in a phase of physiological maturity showed that all the studied plant growth regulators affected its size (Table 3).

Table 3: Influence of growth regulators on the diameter of sunflower hybrids inflorescence in the ripening phase and mass of 1000 seeds (average for 2015-2017).

No.	Agents (Factor A)	Sunflower hybrids (factor B)					
		Forward			Zaklyk		
		Anthodium diameter, cm	Weight of 1000 seeds, g		Anthodium diameter, cm	Weight of 1000 seeds, g	
			weight of 1000 seeds	± to reference variant		weight of 1000 seeds	± to reference variant
1	Reference (pure water treatment	19.5	58	-	23.4	61	-
2	Helafit Combi ®	24.0	62	+4	29.0	67	+6
3	Myr®	26.0	60	+2	31.0	65	+4
4	Mifosat ®	23.0	64	+6	30.5	68	+7
least significant difference $_{05}$		2.15	-	-	2.21	-	-

As determined by the results of measurements, all growth regulating agents positively affected the increase in the diameter of the anthodium of sunflower plants, but Myr ® agent showed the most significant impact on this indicator compared to other agents. Thus, inflorescence diameter of Forward hybrid being treated with Myr ® agent exceeded the reference variant by 6.5 cm, or 33%; of Zaklyk hybrid - by 7.6 cm, or 24.0%, respectively. Level of influence of additional foliar fertilization with Helafit Combi ® and Mifosat ® was significant, but somewhat inferior to Myr®.

One of the important indicators of sunflower seeds quality, which affects the yield, is the size and fullness of the seeds. It is characterized by such an indicator as weight of 1000 seeds. The use of growth regulators has led to an improvement in the weight of 1000 seeds of sunflower hybrids. Mifosat ® growth regulator affected this indicator the most. Additional weight as compared to the reference variant in Forward hybrid was + 6 g, and in Zaklyk hybrid + 7 g, which makes 10.3% and 11.5% respectively.

Determination of individual biometric indices of plants confirmed that they tend to grow under the influence of the studied growth regulators.

Yield is the main indicator for evaluation of one or another agronomic measure. According to the field studies, growth stimulating agents affected acceleration of growth processes of sunflower agrocenosis and helped increase its productivity differently in different years depending on specific weather and climatic conditions (Table 4).

Table 4: Influence of growth regulators on the productivity of conditioned seeds of sunflower hybrids (average for 2015-2017)

No.	Agents (Factor A)	Sunflower hybrids (factor B)			
		Forward		Zaklyk	
		Yield, t/ha	± to reference variant, t/ha	Yield, t/ha	± to reference variant, t/ha
1	Reference (pure water treatment)	1.81	-	1.74	-
2	Helafit Combi ®	2.32	+0.51	2.21	+ 0.47
3	Myr®	2.05	+0.24	2.09	+ 0.35
4	Mifosat ®	2.19	+0.38	2.13	+ 0.39
least significant difference $_{05}$		0.15	-	0.16	-

Data analysis enables to conclude that the largest increase in the yield of seeds of sunflower hybrids occurred when plants were treated with Helafit Combi ® growth regulating agent. Such an increase compared to the reference variant was in the Forward hybrid +0.51 t/ha, and in Zaklyk hybrid + 0.47 t/ha. A slightly smaller increase in yield was observed during additional foliar fertilization with Myr ® and Mifosat ® agents.

CONCLUSION

The activation of growth processes of sunflower plants by the studied growth stimulating agents after their one-time foliar application during vegetation contributed to an increase in the formation of the assimilation surface, strengthening of the adaptive ability of sunflower agrocenosis to unfavourable climatic conditions, and to increase of the crop productivity.

The influence of these agents unleashed genetic potential of plants created by plant breeder. Determination of individual biometric indices of sunflower plants made it possible to verify that all of them tend to increase under the influence of the studied stimulants. According to the results of field studies, fulfilment of plants' potential through the use of growth stimulants can increase productivity of sunflower crops by 28%. Even in the conditions of absence of productive precipitation in the phase of the of early flower-bud formation to the full maturity of the sunflower, as well as in drought conditions, treatment of plants with growth regulating agents contributed to significant increase in the yield. The highest level of the yield was obtained after the treatment of sunflower hybrids with Helafit Combi ®, regulator: for Forward hybrid – 2.32 t/ha, for Zaklyk hybrid - 2.21 t/ha. Treatment with Mifosat ® and Myr ®, regulators also had a positive impact on plants, but the level of their influence on yield formation was slightly inferior to Helafit Combi ®, agent.

Further use of research results will provide the possibility of multidimensional study and determination of the degree of influence of new agents and plants growth stimulators on increase of the adaptive potential of sunflower agrocenosis and their subsequent use during cultivation of the crop in agro climatic conditions of the steppe zone of Ukraine.

REFERENCES

[1] Bikbulatova G.G. O vliyanii antropogennogo faktora na klimat [On the influence of anthropogenic factor on the climate] // G.G. Bikbulatova // Omsk Scientific Bulletin. - 2013. – No.1. - P. 249 - 252.

[2] Domaratskiy Ye. Hlobalne poteplinnia – palytsia z dvoma kintsiamy dlia ukrainskykh ahrariiv [Global warming - a double-edged sword for Ukrainian agrarians] / Ye. Domaratskiy // Materials of the international scientific and practical Internet conference "Condition and prospects of selection in conditions of climate change" February 23, 2018, abstracts. - Kherson: Institute of Irrigated Agriculture, National Academy of Sciences of Ukraine, 2018. - P. 44 - 47.

[3] Domaratskiy Ye.O. Podolannia vplyvu stresovykh yavyshch pid chas vyroshchuvannia pshenytsi ozymoi za umov hlobalnykh klimatychnykh zmin [Overcoming the effects of stress phenomena during winter wheat cultivation under global climate change] / Ye.O. Dmaratskyi // Materials of the International Scientific and Practical Conference with the participation of FAO "Climate Change and Agriculture. Challenges for Agrarian Science and Education" Kyiv, March 13-14, 2018, abstracts. - Kyiv, NMTs "Agroosvita", 2018. - P. 227-232.

[4] Bazalii V.V. Osoblyvosti produktsiinoho protsesu pshenytsi miakoi ozymoi za umov hlobalnoho poteplinnia (prohnoz vchenykh) [Features of soft winter wheat production in the conditions of global warming (prognosis of scientists)] / V.V. Bazalii, Ye.O. Domaratskiy, G.G. Basalii, O.O. Domaratskiy // 4th International Ecological Forum "Clean city. Clean river. Pure planet". - Kherson, 2012. - P. 544-547.

[5] Kondratiev K. Ya. Parnikovyiy effekt atmosferyi i klimat [Greenhouse effect of the atmosphere and climate] / K.Ya. Kondratiev, N.I. Moskalenko - Leningrad: Gidrometeoizdat, 1984. - 212 p.

[6] Sorokhtin O.G. Adiabaticheskaya teoriya parnikovogo effekta atmosfery [Adiabatic theory of the greenhouse effect of the atmosphere] / O.G. Sorokhin, S.A. Ushakov // Bulletin of Moscow State University. Series: Geography. - 1996 – No. 5 - P. 27 - 37.

[7] Karnaukhov A.V. Kuda tekli sibirskie reki vo vremya lednikovyih periodov? [Where did the Siberian rivers flow during the glacial periods?] / A.V. Karnaukhov, V.N. Karnaukhov // Nature. - 1997. – No. 1. - P. 46-55.
[8] Kreynin E.V. Globalnyiy klimat i parnikovyiy effekt: prichinno-sledstvennyie svyazi, Kiotskiy protokol i tehnicheskie resheniya [Global climate and greenhouse effect: cause-and-effect relationship, Kyoto protocol and technical solutions] / E.V. Kreynin, A.S. Evergetidova // Ecology and industry of Russia. - 2007. – P. 43 – 45
[9] Lisetskii F. Quantitative motivation of pedogenesis model key components / F. Lisetskii, O. Chepelev // Advances in Environmental Biology. - 2014 - No. 8 (4). - P. 996 - 1000.
[10] Russell Rubie. Global warming is already a fact, but not yet the end / R. Russell, M. M. // [Electronic resource] / Access mode: http://p.dw.com/p/2mtPl
[11] Becker Andreas. Global warming: what will climate change cost for humanity? / A. Becker, A. Magazova // [Electronic resource] / Access mode: http://p.dw.com/p2nKrZ
[12] Rudnyk-Ivashchenko O.I. Osoblyvosti vyroshchuvannia ozymykh kultur za umov zmin klimatu [Features of winter crops cultivation under climate change] / O.I. Rudnyk-Ivashchenko // Journal: "Sort Studies and Classification", 2012. – No. 2. - P. 8 - 10.
[13] Domaratskiy, Yevgenii, Yuri Yaremko, and Alexander Domaratskiy. "The Use of Growth-Regulating Substances in the Agrocenosis of Sunflower as a Factor of Ecologization in Plant Growing Technology." RESEARCH JOURNAL OF PHARMACEUTICAL BIOLOGICAL AND CHEMICAL SCIENCES 8.3 (2017): 1944-1949.
[14] Domaratskiy Ye. O. Vplyv ristrehuliuiuchykh preparativ ta mineralnykh dobryv na pozhyvnyi rezhym soniashnyka [The influence of growth regulating and mineral fertilizers on the nutrition of a sunflower] // Scientific Papers of the National University of Life and Environmental Sciences of Ukraine. - 2018. - No. 1 (71).
[15] Domaratskiy Ye.O., Dobrovolskyi A.V. Osoblyvosti vodospozhyvannia soniashnyka za riznykh umov mineralnoho zhyvlennia [Features of water consumption by sunflower under different conditions of mineral nutrition] // Scientific Papers of the National University of Life and Environmental Sciences of Ukraine. - 2017. - No. 1 (65).
[16] Ponomarenko S.P. Shliakhamy do ekolohichnoi syrovyny dlia vyroshchuvannia produktiv dytiachoho kharchuvannia [Ways to ecological raw materials for growing baby food products] // Plant protection. No. 4. - 2005. - P. 15-17.
[17] Dospekhov B.A. Metodika polevogo opyta [Methodology of field expertise] / B.A. Dospekhov - Moscow: Kolos, 1985. - 335 p.
[18] Riabchun N. Fotosyntez ta vrozhainist zernovykh kultur [Photosynthesis and yield of grain crops] / [Electronic resource] / N. Riabchun // Access mode: http://propozitsiya.com/ua/fotosintez-ta-vrozhaynist-zernovih-kultur
[19] Karpenko V.P. Intensyvnist protsesiv lipoperoksydatsii ta stan antyoksydantnykh system zakhystu yachmeniu yaroho za dii herbitsydu Hranstar 75 i rehuliatora rostu roslyn Emistym C [Intensity of lipoperoxidation processes and the state of spring barley antioxidant protection systems affected by Granstar 75 herbicide and the Emistim C plant growth regulator] / Karpenko V. P. // Collection of scientific works of Uman State Agrarian University. - 2009. - Vol. 72. - Part 1. - P. 30-39.