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FORMATION OF THE WATER REGIME OF THE SOIL ON DRAINED LANDS IN MODERN CLIMATE CONDITIONS

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Abstract. *The results of analytical and field studies of the influence of modern climatic conditions on the formation of the soil water regime on drained lands are presented. It has been determined that an increase in air temperature and uneven distribution, changes in the nature, intensity, and structure of precipitation, and an increase in the number of cases of heavy rainfall, which are local during the warm period of the year, do not allow for the effective accumulation of moisture in the soil. The formation of new conditions for the cultivation of crops and changes in the directions of the use of drained lands requires expanding the functional tasks of drainage systems and improving the efficiency of water regulation on drained lands. Due to the discrepancy between the technological integrity embedded in the existing drainage systems at the stage of their design, the technical and technological capabilities of the systems, and the modern infrastructure of the users of drained lands, operational management of the technological processes of water regulation and maintenance of the optimal water regime of the soil is not ensured today.*

Studies at production sites on drainage systems typical for the drainage reclamation zone have established that carrying out a set of works to restore the channels of the open and collector-drainage network to design indicators, repairing and equipping hydraulic structures, the presence on the drainage systems of the possibility of water accumulation and the use of irrigation systems (drum-type sprinkler), made it possible to regulate the water regime of the soil and maintain humidity in the active soil layer within the limits close to optimal during the growing season. By regulating the groundwater level, the increase in the yield of crops was: spring wheat – by 19.8 %, oats – by 26.5 %, corn for grain – by 24.6 %, and soybeans – by 48.0 %. The cost of the increase in yield obtained by the water regime regulation during the study period averaged: spring wheat – 5.1 thousand UAH, oats – 4.8 thousand UAH, corn for grain – 12.9 thousand UAH, soybeans – 16.0 thousand UAH for 1 hectare. Information materials on the influence of modern climatic conditions on the formation of the soil water regime on reclaimed lands were obtained, which serve as the basis for the development of a methodology for substantiating the parameters for managing the soil water regime on reclaimed lands, taking into account the peculiarities of its formation under modern economic conditions and climate change.

Key words: *drainage system, drained lands, climate changes, soil water regime, water regulation*

Relevance of research. Globally, climate changes are manifested in different ways in the regions of the globe, and their impact on the state of the environment and socio-economic development of the regions is becoming more and more noticeable and is turning into one of the key problems. Climate change already today poses a potentially serious threat to the global economy and international security due to the increase in risks of various levels, which are associated with providing the population with food, drinking water and the stable existence of ecosystems [1–3].

First of all, climate change has a significant impact on agricultural production, one of the most climate-sensitive sectors of the economy. They lead to a lack of moisture supply, which is the main limiting factor in the sustainable functioning of agriculture [4–8]. The impact of weather conditions on yield is on average 52 % [9]. Therefore, in the context of climate change, modern agriculture needs to develop and implement measures to adapt to it [10].

Modern climate changes make adjustments to technological maps and the structure of crop rotations of agricultural enterprises in the drainage reclamation zone. At the same time, a number of economically attractive crops (corn, sunflower, soybeans, rapeseed, etc.) have taken leading positions in agricultural production, the cultivation of which is subject to the conditions of the agricultural market [11].

Considering that climate change impedes sustainable agricultural production, there is a need to use the potential of drainage systems, which is an untapped resource for increasing the efficiency of agricultural production through the introduction of modern technologies for growing economically attractive crops and obtaining stable yields [12]. At the same time, the formation of new conditions for growing crops and changing the directions of use of drained lands determines the need to expand the functional tasks of drainage systems and restore water regulation on drained lands.

Taking into account changes in natural moisture supply, an important limiting factor for the effective management of modern agricultural production is the reserves of moisture in the active layer of soil, the required amount of which is not provided during the growing season also on drained areas.

Analysis of the latest research and publications shows that climatic changes are manifested in an increase in air temperature, the average annual indicator of which in the period 1991–2020 compared to the period 1961–1990, in general, in Ukraine, increased by 1.2 °C. At the same time, in the zone of drainage reclamation, its increase is more significant: in the western regions – by 1.2–1.3 °C, in the northern and central regions – by 1.4–1.5 °C [3, 5, 13, 14].

In general, there is an increase in the duration of the warm period in Ukraine, which begins 15–20 days earlier in the spring and ends 1–6 days later in the autumn, while in Polissia and Forest Steppe zones, the duration of the warm period increased by an average of 4–10 days.

According to the estimates of world and domestic climatologists, there is a high probability of a further increase in air temperature in the future both on a global scale and in various natural and climatic regions of Ukraine [9, 10, 14–17].

Atmospheric precipitation is one of the main factors that determine the features of the regional climate. Their quantity and seasonal distribution are determining indicators of the formation of the territory's wetting regime, which determine the hydrological regime, the nature of soil wetting and other characteristics of the ecological state and climatic resources. In contrast to the air temperature, the annual amount of atmospheric precipitation compared for the periods 1991–2020 and 1961–1990, both in Ukraine in general and in the drainage reclamation area, changed insignificantly (within 5–10 %). The general trend is the redistribution of their seasonal and monthly amount, which is manifested in a decrease in the amount of precipitation in winter and summer and an increase in spring and autumn. The decrease in the amount of precipitation during the growing season is most noticeable for the drainage reclamation zone in the Kyiv, Vinnytsia, Zhytomyr, and Chernihiv regions, whose territories already today correspond to the zone of insufficient hydration in terms of water availability. In the autumn period, especially in October, a significant (up to 20 %) increase in precipitation is noted [18, 19].

With an insignificant change in the amount of atmospheric precipitation in general for the territory of Ukraine, the nature and intensity of their precipitation has changed noticeably [20, 21]. Their structure has also changed, which with a significant increase in air temperature in the cold period is manifested in an increase in the frequency of rains and a decrease in snowfall and an increase in the number of cases of wet and sleet snow; in the warm period – in a decrease in the number of days with rains, an increase in the number of days with showers, and an increase in the duration of the rainless period [18].

The increase in the probability of excessive precipitation is noted in the reports of the

Intergovernmental Panel on Climate Change (IPCC). It is noted that against the background of moderate changes in the total amount of precipitation, their daily amount in many regions of the planet has significant positive trends [22].

In Ukraine, excessive precipitation in summer can have particularly dangerous consequences, including the formation of floods in any region of the country, especially in the west [23]. Therefore, their consideration is particularly relevant for the adaptation of the economy, especially the agricultural sector [24].

Literary sources indicate that at the beginning of the 21st century, both in Ukraine in general and in the area of drainage reclamations, there is a tendency to increase the number of heavy downpours (the amount of precipitation is 30 mm or more, falling in 1 hour or less). The largest number of heavy downpours in the period 1986–2015 occurred in the Ivano-Frankivsk and Transcarpathian regions, slightly less in the Kyiv, Cherkasy, Chernivtsi, and Lviv regions. In the period 2001–2010, the number of heavy downpours more than doubled from 1991–2000. In 2011–2015, the number of heavy downpour attacks in Kyiv and Chernihiv regions increased significantly [22, 25–27].

In the period 1991–2015, the largest number of rains in the area of drainage reclamations was observed in June and July. Heavy downpours with 30–40 mm of precipitation are frequent. It was established that there is a close relationship between the duration of rains and their average intensity. The highest average intensity values are observed during short-term rains. The longer the downpour, the lower its average intensity [28, 34].

Despite the wide range of possible future changes in the average amount of atmospheric precipitation, it is predicted that extreme precipitation in all seasons may become more intense, which will cause an increase in the number of high water days per year by 10–25 % and surface runoff and rain floods by the end of the century [29, 30].

An increase in air temperature and uneven distribution, change in the nature, intensity, structure of precipitation and an increase in the number of cases of heavy downpours, which are local in the warm period of the year, do not allow for effective accumulation of moisture in the soil. In general, the frequency of droughts in different soil-climatic zones of Ukraine has increased by 20–40 %, which prevents sustainable agricultural production also in the zone of sufficient atmospheric moisture, which covers Polissia and the northern territories of the Forest-Steppe.

Deterioration of the conditions of natural moisture supply in an increasingly large part of the territory of the zone of drainage reclamation, as well as the formation of conditions not only of overwetting of soils, but also of moisture deficit in them, especially in the second half of the growing season, increases the role of drainage systems in the sustainable management of agriculture on drained lands [31, 32].

As a result of climatic conditions, there was a change in the specialization of agricultural production, which changed the structure of cultivated areas. Traditional crops (rye, oats, corn for silage, flax, sugar beets, etc.) were replaced by economically attractive ones (corn, sunflower, soybeans, etc.), the cultivation of which is subject to the market conditions of agricultural goods. Since modern agricultural production is accompanied by non-observance of crop rotations and inadequate scientific justification of agrotechnical and hydromelioration measures, for the effective use of drained lands it is necessary not only to develop the structure of cultivated areas, but also water regulation technologies that take into account the specialization and needs of modern agricultural production [11, 31].

The latest studies and publications show that modern climate changes are one of the main factors that determine the conditions for the formation of the water regime of the soil on drained land, affect the water supply of reclaimed territories and the technical and technological features of the functioning of drainage systems, the water regulation capacity of which depends on the effectiveness of water regulation technologies soil regime [33–35].

The impact of climatic changes on the natural moisture supply of drained territories and the requirements of modern agricultural production to ensure water regulation on reclaimed land during the cultivation of economically attractive crops make it necessary to conduct research into the processes of forming the water regime of the soil under the conditions of the functioning of drainage systems, taking into account various regime-forming factors.

The aim of the research is to study the influence of modern climatic conditions on the formation of the soil water regime on drained areas.

Materials and methods of research. The basis of methodological approaches to conducting field research is the use of generally accepted methods for conducting meteorological observations (air temperature and precipitation), determining the groundwater level (GWL), soil moisture, biometric characteristics (the onset of

the main phenological phases, yield) of crops during the growing season.

Measurements of groundwater levels in the field experiment were carried out using pentads. To determine soil moisture using the thermostat-weight method, ten-day sampling was carried out in the experimental plots along the depth of the root layer of the soil.

Sowing and caring for the studied crops were carried out following generally accepted technologies for their cultivation using mechanisms and tools directly in production conditions. Crop harvest recording was carried out using a continuous method throughout the entire recording area.

Research results and discussion. To study the processes of formation of the water regime of soils on reclaimed lands, experimental production sites were selected on drainage systems typical for the drainage reclamation zone (taking into account natural and climatic conditions and design and technological features) in the Rivne, Volyn and Sumy regions: reclamation systems of the Sarnenska Research Station (SRS) IWPaLR of NAAN and Agrarian Polygon LLC "ZAHIDAGROPROM" (Rivne region), drainage-irrigation system (DIS) "Romen" (SE DG "Nadyua" NAAN, Sumskyi region), drainage systems (DS) "Melnytska" and "Bobrovka" (Volyn region).

According to the research methodology, meteorological parameters were determined on the reclamation system of the SRS at the meteorological post of the station. It was established that in the growing season of 2022, 244.3 mm of precipitation fell, which is 155.7 mm less than the average long-term norm. Precipitations fell extremely unevenly, and more than 80 % of total amount were torrential rains (Fig. 1).

May was especially cold, with the average monthly temperature 1.4 °C lower than normal; during June, July and August – higher by 3.2, respectively; 1.2 and 2.6 °C, and in September – 2.8 °C lower than the long-term norm (Fig. 2).

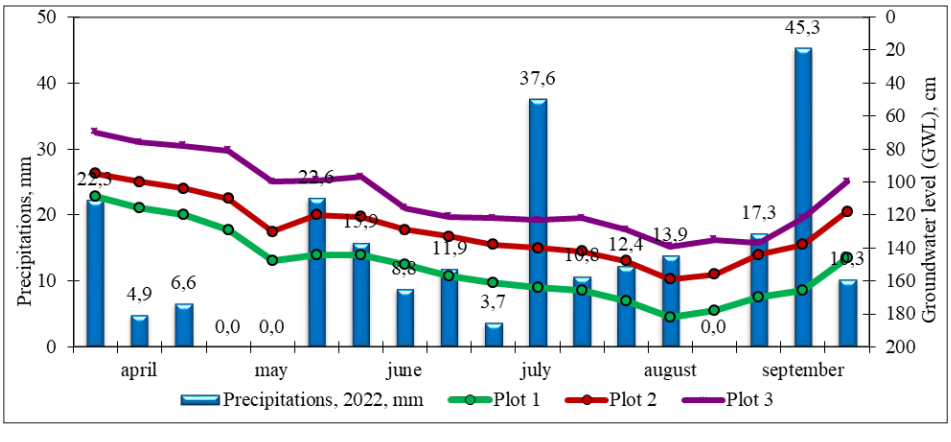

Fig. 1. Precipitation and dynamics of the groundwater level (GWL) in the 2022 growing season, reclamation system of the Sarnenska Research Station (SRS)

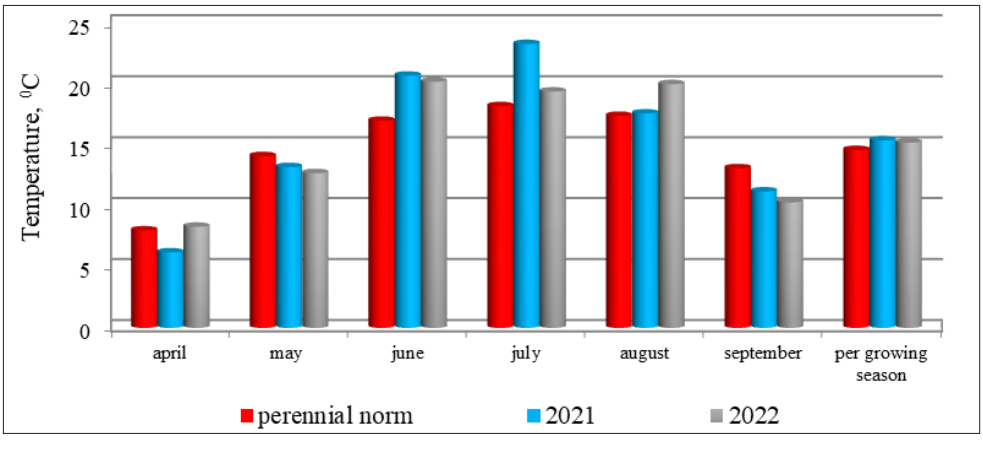

Fig. 2. Average monthly air temperature in the growing season of 2022, SRS reclamation system

The following promising crops were studied in the field experiment based on the basic cultivation technology on the background of 3 variants of GWL maintenance: spring wheat – Kitri variety, oats – Zubr variety, winter rape – Atlant variety, corn for grain – DK 315 hybrid, soybean – Astor. Regulation of the water regime of the soil in the experimental areas was carried out with the help of sluicing. During the growing season of 2022, observations of GLW were carried out at the experimental sites, the results of which are shown in Fig. 1.

It was established that in the conditions of 2022, high productivity indicators were obtained for all studied crops, and the potential of corn grain of the DK 315 hybrid of the Dekalb (USA) selection was 100 % realized. Depending on the GWL, the yield of spring wheat was 53.5–64.1; oats – 43.4–54.9; corn per grain – 147.1–183.3 and soybean – 28.1–41.1 t/ha (Table 1).

1. Crop productivity on the background of 3 options of GWL's maintaining on sod-podzolic light loamy soils

Crop	Variety/ hybrid	Yielb by the GWL options, c/ha		
		100–140	85–100	75–85
spring wheat	Kitri	53.5	58.9	64.1
oat	Zubr	43.4	49.1	54.9
corn	DK 315	147.1	173.9	183.3
soybean	Astor	28.1	36.3	41.1

Due to the regulation of GWL, the increase in yield for spring wheat was 19.8 %, oats – 26.5 %, corn for grain – 24.6 % and soybean – 48.0 %. Among the studied crops, soybean is the most sensitive to moisture supply.

The average cost of the increase in yield obtained by regulating the water regime was: spring wheat – 5.1 thousand UAH, oats – 4.8 thousand UAH, corn for grain – 12.9 thousand UAH, soybeans – 16.0 thousand UAH for 1 hectare.

Determination of meteorological parameters on the drainage systems "Maryanivka" and "Olshanka" was carried out at the meteorological station of the Agrarian Polygon of "ZAKHIDAGROPROM" LLC (Figs. 3, 4).

It was established that 445.3 mm of atmospheric precipitation fell in the 2022 growing season, which is close to the average long-term norm. June (90.4 mm), July (112.6 mm) and September (87.3 mm) were the wettest months. The warmest months were June and August – average monthly temperatures were 20.2 and 20.0 °C, respectively.

In production conditions, according to the basic technology of agricultural production, the research was carried out during the cultivation of the following crops: winter rye – KVS Eterno, winter rapeseed – KVS Alvaro, winter wheat – KVS Ronin, sunflower – Sumiko, corn for grain – LN30273.

In 2021, at the "Maryanivka" DS, a complex of works was carried out on the restoration of open channels and the collector and drainage network to the design parameters and the completion of hydrotechnical structures and restoration of their stability. At the same time, within the boundaries of the "Vilshanka" DS, irrigation was implemented on an area of 80 hectares. The system was used to accumulate additional volumes of water in the MK-1 channel (length 1000 m), which made it possible to provide irrigation during dry periods of growing crops using a drum-type sprinkler.

Therefore, the renewal of both systems made it possible to ensure the regulation of the water regime of the soil and maintain the moisture of the active layer of the soil during the cultivation of the studied crops within optimal

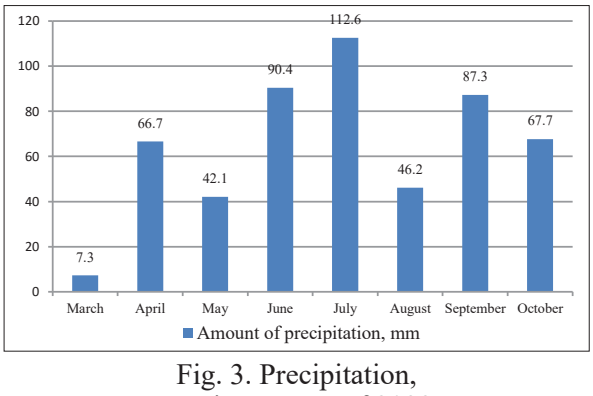

Fig. 3. Precipitation, growing season of 2022, DS "Maryanivka" and "Olshanka"

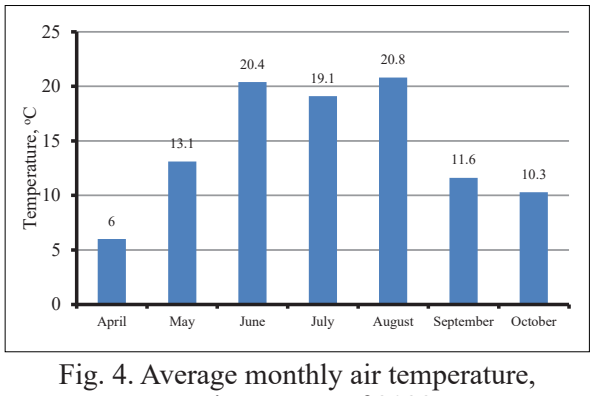

Fig. 4. Average monthly air temperature, growing season of 2022, DS "Maryanivka" and "Olshanka"

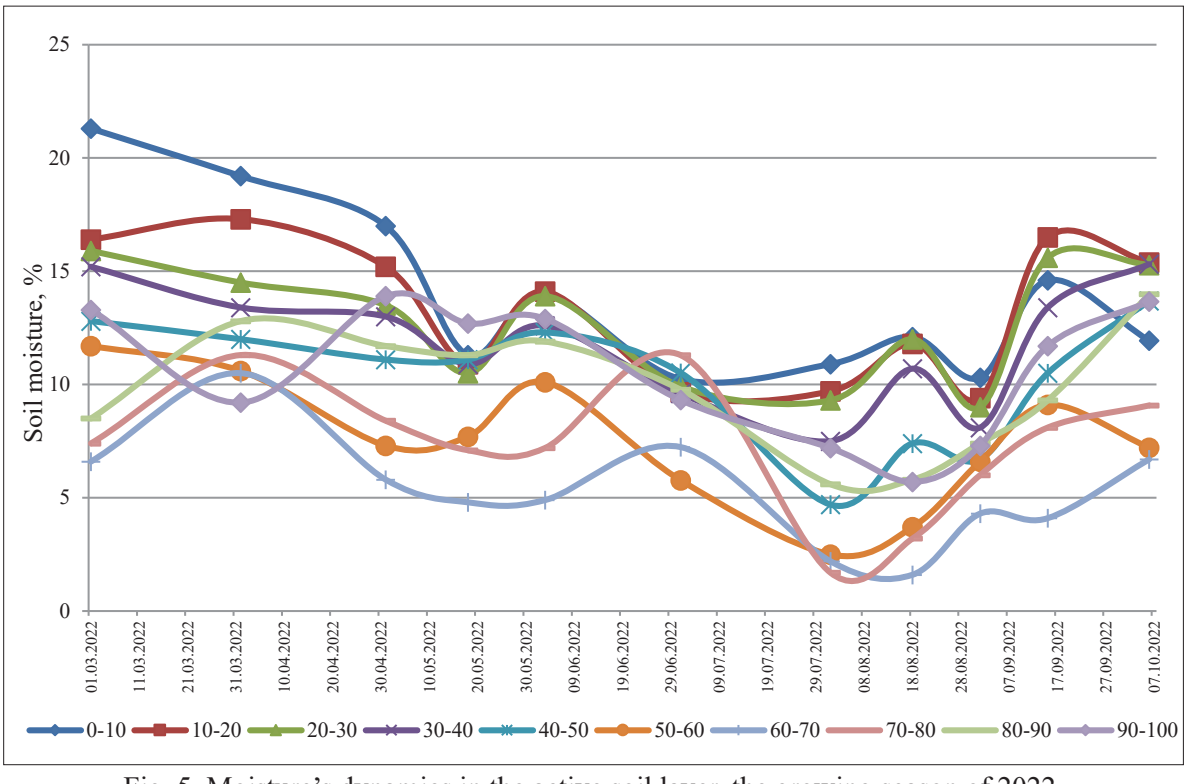

Fig. 5. Moisture's dynamics in the active soil layer, the growing season of 2022, DS "Maryanivka" and "Olshanka"

limits throughout the entire growing season. The dynamics of soil moisture in the aeration zone is presented in Fig. 5.

The yield characteristics of the studied crops were established (Table 2).

2. Yield of crops on the drained lands of the agrarian landfill of "ZAHID AGROPROM" LLC, Rivne region.

№	Crop	Area, ha	Yield, t/ha
1	winter rye	220.0	5.4
2	winter rape	210.0	2.8
3	winter wheat	154.0	6.2
4	sunflower	139.4	3.4
5	Corn for grain	420.0	9.2
Total		1143.4	

Indicators of meteorological factors (precipitation, air temperature) were determined on reclaimed lands of the "Romen" drainage and irrigation system (DIS) (Figs. 6, 7). It was established that in the growing season of 2022, the amount of precipitation was 493.6 mm, which is 171.6 mm more than the average long-term value. The average daily air temperature during the growing season was 1.7 °C less than the long-term value (14.5 °C) and only the average temperature for June was 0.8 °C higher.

Cultivated crops – plot No. 1: corn for grain mid-season hybrid DK315, FAO 310 (on an area of 1.5 hectares) and buckwheat of the Slobozhanka variety (on an area of 28 hectares); plot No. 2 – perennial grasses (on an area of 12 hectares); plot No. 3 – perennial grasses (on an area of 5.3 hectares).

Regulation of the soil water regime in the experimental plots was carried out using sluicing. If necessary, it is possible to supply water for humidification from existing water sources (storage tank, Karabutiv reservoir).

A study of the dynamics of GLW and moisture of the active soil layer during the growing season was conducted (Fig. 8, 9).

Under the conditions of the growing season of 2022 at experimental plot 1 (mineral soils), the actual GWL was on average within the following range: in May – 75–95 cm; June – 100–145 cm; July – 150–170 cm; August – 170–200 cm; September – 190–200 cm from the soil surface. Taking into account the fact that the GWL of the experimental plots at the end of the growing season were quite low from the surface, namely: in the spring period 0.6–1.2 m, during the summer 1.2–1.8 with a decrease until autumn within 2.0 m, the formation of soil moisture took place due to atmospheric precipitation.The GWL of plots 2 and 3 (peat soils) during the growi ng season

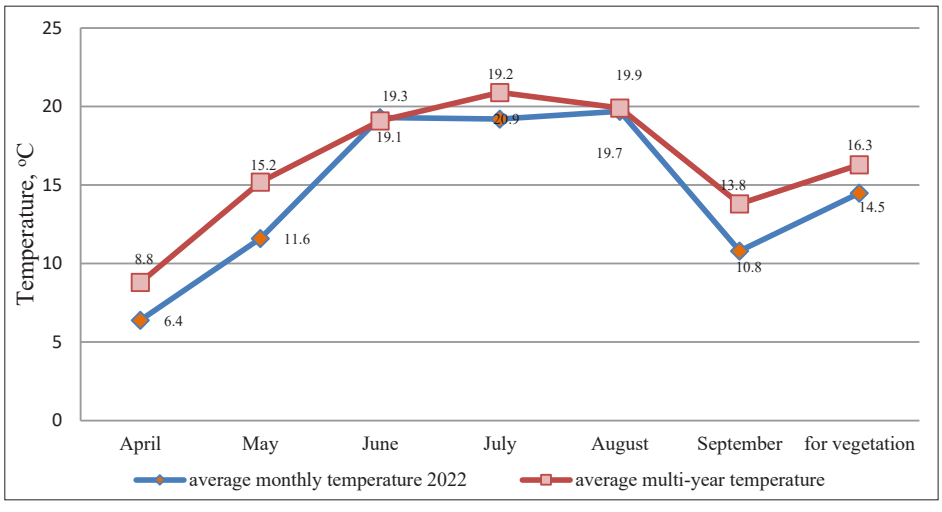

Fig. 6. Dynamics of average monthly air temperature during the growing season of 2022, DIS “Romen”

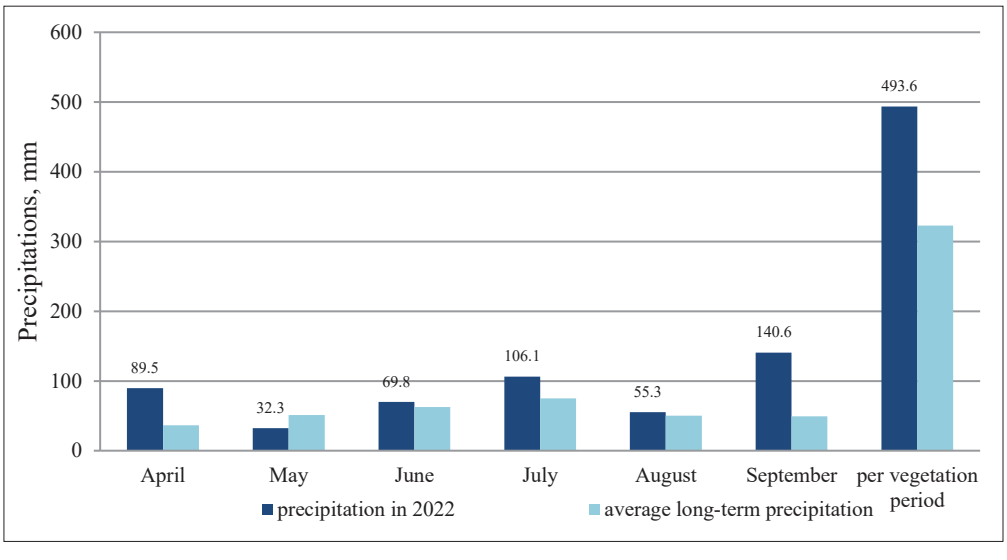

Fig. 7. Precipitations during the growing season of 2022, DIS “Romen”

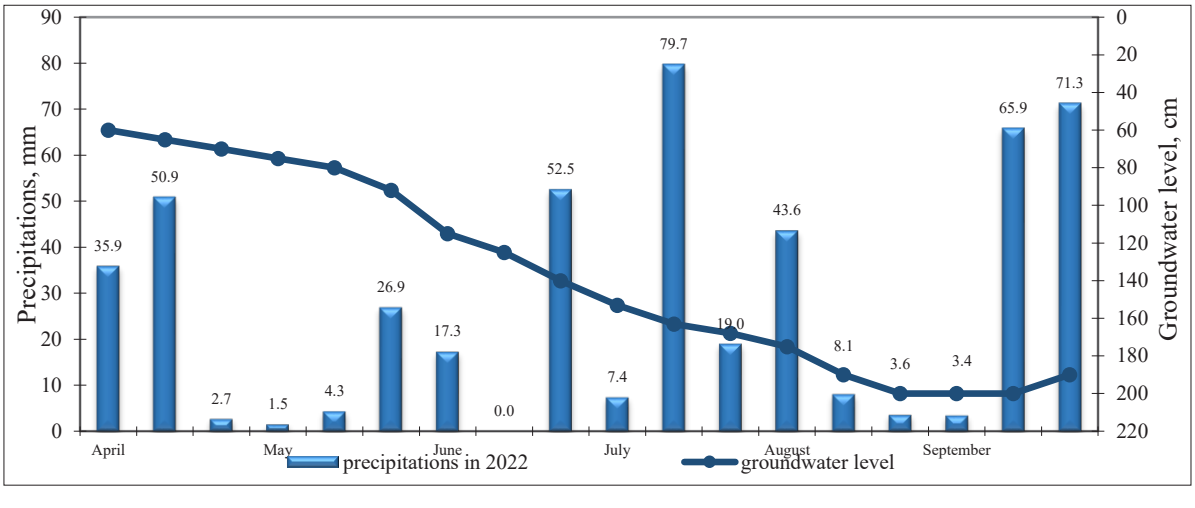

Fig. 8. Dynamics of GWL in the growing season of 2022, DIS “Romen”

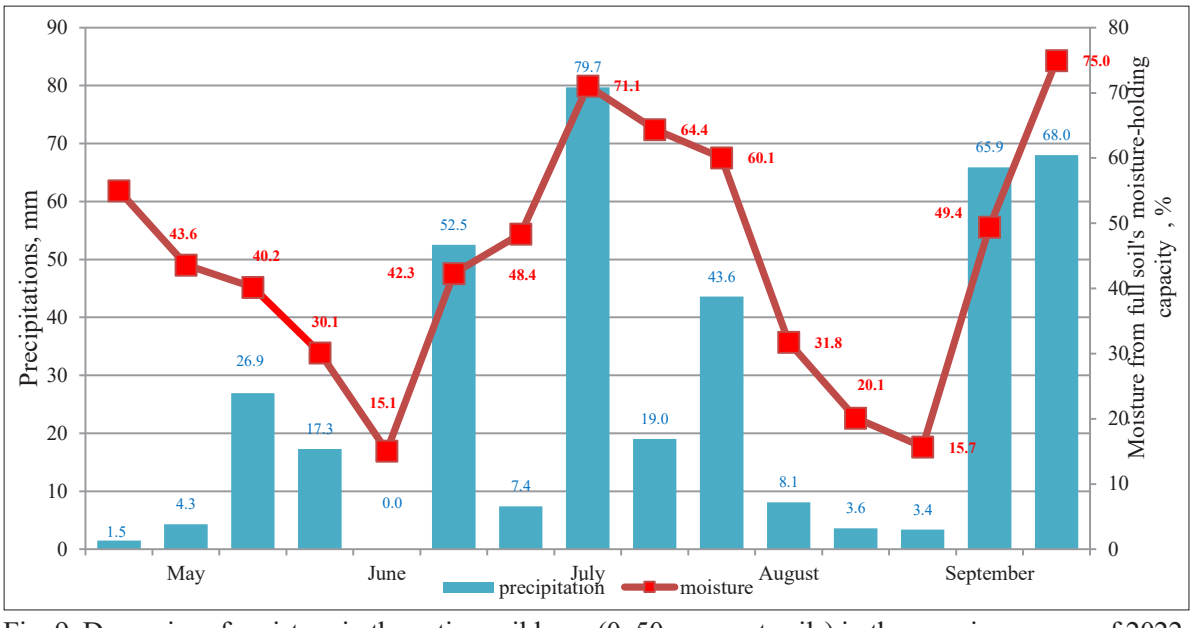

Fig. 9. Dynamics of moisture in the active soil layer (0–50 cm, peat soils) in the growing season of 2022, DIS "Romen"

was within the limits: in spring – 0–65 cm, in summer – 45–110 cm, in autumn – 50–115 cm from the soil surface.

The productivity of buckwheat and corn per grain was determined depending on the application of mineral fertilizers, respectively, at the rate of $N_{30}P_{30}K_{30}$ (for buckwheat) and $N_{60}P_{60}K_{60}$ (for corn per grain), which contributed to an increase in productivity by 26 and 38 %, respectively.

It was established that the yield of perennial grasses of 1 and 2 mowings, with different options for water regulation on peat soils, averaged 260 and 170 c/ha of green mass, respectively. High yields of perennial grasses of 1st and 2nd mowings were achieved in the area where water regulation is carried out through the use of steady drainage and moistening. The introduction of mineral fertilizers in all variants of the experiment helped to increase the yield of perennial grasses by 23 and 48 %, respectively.

Based on the results of research into the structural and technological parameters of the drainage systems (DS) "Melnytska" and "Bobrovka" (Kovelsky district, Volyn region), the need to restore the engineering infrastructure within the agricultural lands of the "Vasyuty" and "Bilynske" water treatment plant farms was established, and it was carried out clearing of drainage channels (up to design marks) and the mouths of drains and collectors from siltation, the operation of hydrotechnical structures has been restored (Fig. 10).

The dynamics of weather factors (Fig. 11), growth and biometric indicators of cultivated crops were observed at the experimental sites (Agricultural Limited Liability Company (ALLC) "Vasyuty" – sunflower and corn for grain; ALLC "Bilynske" – corn for grain and winter wheat),

Fig. 10. Technical condition of the MK-28 open channel and restoration of the mouth of the closed collector at DK-1 on the Melnytska DS

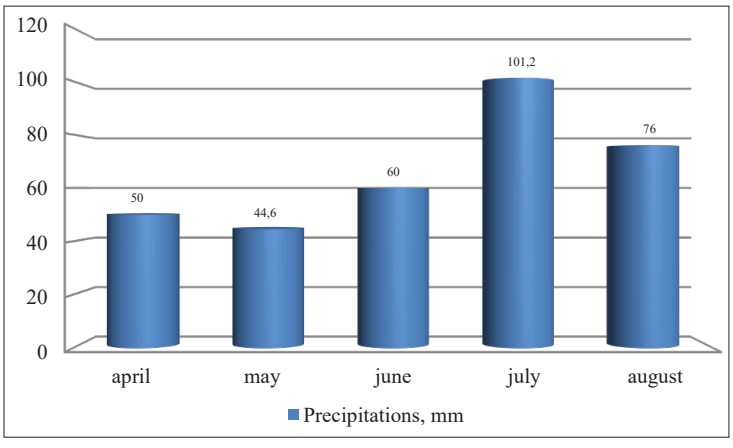

Fig. 11. Precipitations during the growing season of 2022, ALLC "Vasyuty"

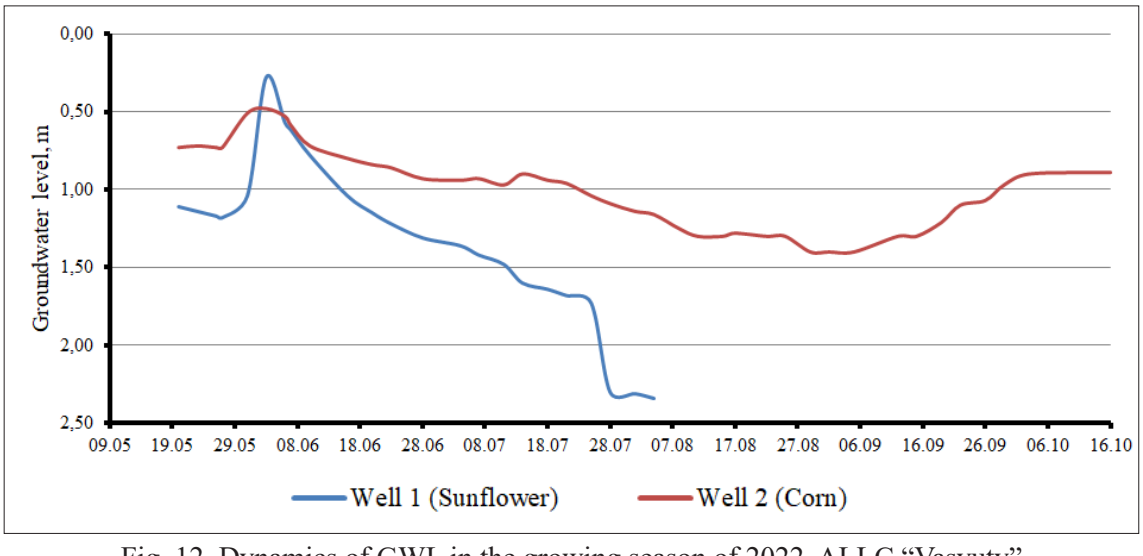

Fig. 12. Dynamics of GWL in the growing season of 2022, ALLC "Vasyuty"

the water-physical properties of soils were determined, five observation wells were equipped to measure groundwater levels, and a study of the dynamics of RHV was conducted (Fig. 12).

On the reclaimed lands of ALLC "Vasyuty", according to the results of research (well No. 1, the cultivated crop is sunflower), the GWL in the period from the end of May to the middle of June was in the range of 0.28–1.1 m. Starting from the middle of June and until the beginning of August, the GWL gradually dropped to a mark of 2.3 m. Regulation of the water regime of the soil was not carried out. There was no water in the well since the beginning of August.

According to the results of research on the reclaimed lands of the ALLC "Vasyuty" (well 2, the cultivated crop is corn for grain), the GLW during the growing season was in the range of 0.5–1.4 m. From the end of July until the end of the growing season, growing corn for grain The GWL was at the marks 1.0 m lower than the soil surface.

On the reclaimed lands of the ALLC "Bilynske" (well 3, the cultivated crop is corn for grain), the GWL at the beginning of June was at the mark of 0.78 m. Subsequently, there was a gradual decrease in the GWL to 1.38 m (08/04/2022).

In the area where winter wheat was grown (well 4), by the beginning of June the GWL was at the level of 1.38 m, by the end of June (06/23/2022) the GWL reached the level of 1.77 m and subsequently there was no water in the well. Consequently, regulation of the soil water regime at the site was not carried out.

Conclusions. It has been determined that due to an increase in air temperature and uneven distribution, changes in the nature, intensity and structure of precipitation and an increase in the number of cases of heavy rainfall, which are local in the warm season, it is impossible to ensure effective accumulation of moisture in the soil. Due to the discrepancy between

the technological integrity inherent in existing drainage systems at the stage of their design, the technical and technological capabilities of the systems and the modern infrastructure of users of drained land, today the operational management of technological processes of water regulation and maintaining the optimal water regime of the soil is not ensured.

Research at production sites of drainage systems typical for the drainage reclamation zone has established that carrying out a set of works to restore the channels of the open and collector-drainage network to design indicators, repairing and equipping hydraulic structures, the availability of drainage systems for accumulating additional water reserves for irrigation and the use of irrigation systems (drum-type sprinkler) made it possible to regulate the soil water regime and maintain humidity in the active soil layer within limits close to optimal during the growing season. It was determined that by regulating the groundwater level (GWL), the increase in crop yield was in the range of 20–48 %, and the cost of the increase in yield was 4.8–16.0 thousand UAH per 1 hectare.

Information materials were obtained on the influence of modern climatic conditions on the formation of the soil water regime on reclaimed lands, which will be the basis for the development of a methodology for substantiation of the parameters for managing the soil water regime on reclaimed lands, taking into account the peculiarities of its formation in modern economic conditions and climate change.

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ФОРМУВАННЯ ВОДНОГО РЕЖИМУ ҐРУНТУ НА ОСУШУВАНИХ ЗЕМЛЯХ У СУЧАСНИХ КЛІМАТИЧНИХ УМОВАХ

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Анотація. *Наведено результати аналітичних і натурних досліджень щодо впливу сучасних кліматичних умов на формування водного режиму ґрунту на осушуваних землях. Визначено, що підвищення температури повітря та нерівномірний розподіл, зміна характеру, інтенсивності, структури опадів і збільшення кількості випадків сильних злив, які мають локальний характер у теплий період року, не дозволяють забезпечити ефективне накопичення вологи в ґрунті. Формування нових умов вирощування сільськогосподарських культур і зміни напрямів використання осушуваних угідь вимагає розширення функціональних задач дренажних систем та підвищення ефективності водорегулювання на осушуваних землях. Через невідповідність між технологічною цілісністю, закладеною в існуючі дренажні системи на стадії їх проєктування, техніко-технологічними можливостями систем та сучасною інфраструктурою користувачів осушуваних земель, на сьогодні не забезпечується оперативне управління технологічними процесами водорегулювання та підтримання оптимального водного режиму ґрунту. Дослідженнями на виробничих ділянках на типових для зони осушувальних меліорацій дренажних системах встановлено, що проведення комплексу робіт із відновлення каналів відкритої та колекторно-дренажної мережі до проєктних показників, ремонт та укомплектування гідротехнічних споруд, наявність на дренажних системах можливостей акумулювання додаткових запасів води для проведення зволоження та застосування систем зрошення (дощувальної машини барабанного типу), дозволили забезпечити регулювання водного режиму ґрунту та підтримувати вологість в активному шарі ґрунту в межах, близьких до оптимальних, впродовж періоду вегетації. За рахунок регулювання рівня ґрунтових вод приріст урожайності вирощуваних культур становив: яра пшениця – на 19,8 %, овес – 26,5 %, кукурудза на зерно – 24,6 % та соя – 48,0 %. Вартість приросту урожаю, одержаного за рахунок регулювання водного режиму у досліджуваний період в середньому становила: яра пшениця – 5,1 тис. грн, овес – 4,8 тис. грн, кукурудза на зерно – 12,9 тис. грн, соя – 16,0 тис. грн на 1 га. Отримано інформаційні матеріали щодо впливу сучасних кліматичних умов на формування водного режиму ґрунту на меліорованих землях, які є основою для розроблення методології обґрунтування параметрів управління водним режимом ґрунту на меліорованих землях з урахуванням особливостей його формування в сучасних умовах господарювання та змін клімату.*

Ключові слова: *дренажна система, осушувані землі, зміни клімату, водний режим ґрунту, водорегулювання*