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OPTIMIZATION OF THE WATER REGIME OF TYPICAL CHERNOZEM IN SHORT-ROTATION CROP ROTATIONS IN THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

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Relevance. The rational use of soil moisture is critically important for stabilizing and increasing crop productivity in the Forest-Steppe zone of Ukraine, which is characterized by uneven moisture availability. Investigating the dynamics of plant-available soil moisture under different crop rotations and fertilization systems makes it possible to develop effective climate-change adaptation strategies and enhance the ecological resilience of agrocenoses.

Objective. To assess the effects of different types of short-rotation crop rotations—cereal–forage–row crop, row crop, and cereal–row crop rotations—and fertilization systems on the dynamics of plant-available soil moisture reserves in the 0–150 cm soil layer and on total water consumption over a five-year rotation period from 2021 to 2025 under the conditions of the Right-Bank Forest-Steppe of Ukraine.

Materials and Methods. The study was conducted from 2021 to 2025 within a long-term stationary field experiment in fields No. 3, 4, and 5 of the Bila Tserkva Experimental Breeding Station, located in the Right-Bank Forest-Steppe of Ukraine. The soil of the experimental site was a typical Chernozem. Plant-available soil moisture reserves in the 0–150 cm layer were determined at crop sowing and harvesting. Precipitation during the occupied fallow period and crop-growing seasons, as well as total water consumption over the five-year rotation, were also analysed.

Three crop rotation types and several fertilization systems were investigated.

The cereal–forage–row crop rotation included a vetch–oat mixture, winter wheat, sugar beet, spring barley undersown with clover, and clover. The treatments were as follows: treatment 11, unfertilized control maintained since 1976; treatment 13, organo-mineral fertilization consisting of mineral fertilizers combined with 40 t

ha^{-1} of manure applied to sugar beet; treatment 14, organic fertilization consisting of 40 t ha^{-1} of manure applied to sugar beet once per rotation; and treatment 2, mineral fertilization consisting of $N_{90}P_{60}K_{60}$ for winter wheat, $N_{100}P_{90}K_{90}$ for sugar beet, and $N_{40}P_{40}K_{40}$ for clover.

The row crop rotation included treatment 31, unfertilized control; treatment 33, organo-mineral fertilization in which organic nutrition was supplemented with $N_{90}P_{60}K_{60}$ for winter wheat and $N_{40}P_{40}K_{40}$ for soybean; and treatment 29, organic fertilization.

The cereal–row crop rotation included a vetch–oat mixture, winter wheat, sugar beet, spring barley, spring vetch, and repeated winter wheat. The treatments were as follows: treatment 51, unfertilized control; treatment 53, organo-mineral fertilization consisting of 40 t ha^{-1} of manure applied to sugar beet in combination with mineral fertilizers; and treatment 55, mineral fertilization.

Results. The results obtained during 2021–2025 demonstrated that the combined application of organic and mineral fertilizers was the most effective approach for establishing a favourable soil water balance and improving the ecological resilience of crop rotations.

In the cereal–forage–row crop rotation, the unfertilized treatment 11 had the largest residual soil moisture reserve, reaching 861 mm in field No. 5. However, this treatment was associated with lower crop productivity and lower water use, with total water consumption amounting to 1,710 mm. The organo-mineral treatment 13 and organic treatment 14 promoted more intensive water consumption, reaching 1,925 mm, and reduced residual soil moisture to 646 mm, indicating more efficient water uptake and use by crops. The mineral treatment 2 provided an optimal balance between water consumption, which amounted to 1,890 mm, and residual soil moisture, which reached 681 mm.

In the row crop rotation, the unfertilized treatment 31 was characterized by the highest residual soil moisture reserve, reaching 527 mm in field No. 4, primarily because of lower crop stand density and weaker plant growth. The organo-mineral treatment 33 and organic treatment 29 improved water-use efficiency. At similar total water consumption levels of 1,692–1,702 mm, residual soil moisture reserves ranged from 394 to 404 mm, indicating a relatively stable soil water regime under conditions of vigorous crop growth.

In the cereal–row crop rotation, the unfertilized treatment 51 had the highest residual soil moisture reserve of 662 mm; however, this was associated with lower biomass production and crop yields. The organo-mineral treatment 53 ensured the most efficient use of soil moisture, with total water consumption reaching 1,776 mm, and demonstrated the highest crop water-use capacity, thereby confirming the stabilizing effect of organic amendments on the soil water balance. The mineral treat-

ment 55 maintained a more balanced water regime and left 686 mm of residual soil moisture.

Overall, the organo-mineral fertilization systems represented by treatments 13, 33, and 53 resulted in the highest total water consumption, ranging from 1,925 to 1,976 mm, which reflected the intensive use of available moisture by high-yielding crops. In contrast, the unfertilized treatments 11, 31, and 51 were associated with deterioration of soil structure and lower total water consumption, ranging from 1,710 to 1,840 mm.

Conclusions. The results of the 2021–2025 study conducted at the Bila Tserkva Experimental Breeding Station confirmed the key role of crop rotation type and fertilization system in regulating the water regime of typical Chernozem. The organo-mineral fertilization system was the most effective in maintaining a favourable soil water regime, increasing the water productivity of agrophytocenoses, and ensuring stable crop yields under the conditions of the Right-Bank Forest-Steppe of Ukraine. The findings provide a scientific basis for developing adaptive soil moisture management strategies under increasingly variable climatic conditions.

Keywords: crop rotation, water regime, plant-available soil moisture, fertilization, typical Chernozem, Right-Bank Forest-Steppe.

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