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MODERN FEATURES OF CHANGES IN THE WATER REGIME OF CHERNOZEMS UNDER THE INFLUENCE OF FOREST BELTS

Research article

Abstract

The research was conducted in the conditions of the South-East of the of the Central-Chernozem zone (Kamennaya Steppe) in 2018-2020 biennium. Features of formation of reserves of productive moisture in agroforestry complex are shown. Data for studying changes in soil moisture profile are presented. The first decade of the current century was characterized by a widespread rise in the ground water level (GWL) to 1.2-2 m and the formation of seasonally waterlogged soils. In the dry conditions of 2010, the most critical conditions developed. The entire 200-cm layer of soil in the summer was characterized by a complete lack of available moisture. In the following years, up to 2020, at all research sites, the GWL fluctuates in the range of 3-4 m.

Keywords: forest strip, fallow land, arable land, productive moisture.

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СОВРЕМЕННЫЕ ОСОБЕННОСТИ ИЗМЕНЕНИЯ ВОДНОГО РЕЖИМА ЧЕРНОЗЕМОВ ПОД ВЛИЯНИЕМ ЛЕСНЫХ ПОЛОС

Научная статья

Аннотация

Исследования проведены в условиях юго-востока Центрально-Черноземной зоны (Каменная Степь) в 2006-2020 гг. Показаны особенности формирования запасов продуктивной влаги в агролесомелиоративном комплексе. Приведены данные изучения изменения увлажненности почвенного профиля. Первое десятилетие текущего столетия характеризовалось повсеместным подъемом уровня грунтовых вод (УГВ) до 1,2-2 м и формированием сезонно-переувлажненных почв. В засушливых условиях 2010 г. сложились наиболее критические условия. Весь 200-сантиметровый слой почвы в летний период характеризовался полным отсутствием доступной влаги. В последующие годы вплоть до 2020 г. на всех объектах исследований УГВ колеблется в интервале 3-4 м.

Ключевые слова: лесная полоса, залежь, пашня, продуктивная влага.

1. Introduction

The main task of the forest belts near the beam, as well as the entire erosion control system, is to transfer surface runoff to ground. Forest belts prevent erosion of the banks of beams, prevent the development of weeds [1, P. 121-137]. Specialists in agroforestry identified a significant increase in moisture reserves in the fields adjacent to forest strips [2, P. 1179-1187]. An important activity is also the study of the ground water level (GWL). Studies have shown that under the influence of the forest strip, the rise of the GWL occurs [3, P. 171]. The transfer of runoff to the in-ground can raise the GWL to a significant height. For example, in the agricultural landscapes of the Volga agglomeration AREA and the Timashevsky stronghold, the GWL has increased by 3 m over 25 years and ground water has become root-accessible [4, P. 546]. According to A. I. Mikhovich [5, P. 82], it was noted that the amount of precipitation in the forest belt system also increases. In General, forest strips increase the snow-holding capacity of the stubble background by 65-75% [6, P. 41-44]. Forest strips also contribute not only to the retention and accumulation of snow, but also to the retention of meltwater and storm water flowing from neighboring fields [7, P. 258-259]. Thus, the study of the water regime of the forest belts near the beam is relevant, especially in the Kamennaya Steppe, where the forest-reclamation influence of the bands has been occurring for more than a hundred years.

2. Research methods

The objects of research were the soils of the Kamennaya Steppe of various degrees of hydromorphism, including a complex of waterlogged soils. The ground water level was determined by drilling wells to the depth of the ground aquifer. Soil moisture was determined by the thermostatic-weight method. The reserve of productive moisture in the soil was defined as the difference between the total reserves of moisture and the reserves of hard-to-reach moisture.

3. Results and discussion

Our research on the humidity regime of various lands of the Stone Steppe during 2006-2020 shows significant changes in its annual and vegetation cycle. The first decade of this century was characterized by a widespread rise in the ground water level (GWL) and the formation of seasonally waterlogged soils. The maximum groundwater table was recorded in 2006. In the first half of 2007 the GWL under forest lane 40 fluctuated in the range of 1.4-2.1 m. In the area adjacent to the forest strip of the fallow land, the GWL was at a lower level – 0.8-1.5 m. On arable land, the water table rose to 1.2 m at the end of March 2007, but remained at this level for a short time and by may had fallen below 2 m. While on the fallow and in the forest zone, the period with the marked water table lasted until June - early July. In the following years, up to 2020, at all research sites, the GWL fluctuates in the range of 3-4 m.

In terms of reserves of productive moisture in the soil layers of 0-200 cm during the years of research, a significant contrast was noted due to the developing hydrothermic conditions. Under the forest belt, the best moisture conditions were observed in 2007. In the soil layer of 0-20 cm in early spring, the amount of available moisture is marked at the level of 55 mm, in the layer of 0-100 cm – 220 mm and in the layer of 0-200 cm – 400 mm. For the soil of the fallow, these indicators were 50, 210 and 356 mm, respectively. Arable land was characterized by the lowest amount of productive moisture content. In the arable horizon (0-20 cm), the reserve of available moisture is marked at the level of 37 mm, the meter layer – 200 mm and the two-meter layer of soil – 350 mm. During the growing season, due to the desiccation of the soil column, moisture content decreases. In the soils of the forest zone, by the beginning of August, the amount of available moisture in the 0-20 cm soil layer decreased to 10 mm, in the 0-100 cm layer to 63 mm, and in the 0-200 cm – layer to 118 mm. Under natural vegetation, the distribution of moisture along the soil horizons was somewhat different and amounted to 9.0; 38 and 134 mm, respectively. In the arable analog, the conditions of humidification were quite critical. The upper half-meter layer (0-50 cm) was characterized by a practical lack of available moisture. Only, starting from the underlying soil horizons, there is some presence of available moisture. In total, the 0-100 cm layer contained 16 mm of productive moisture, and the 0-200 cm layer contained 109 mm.

In the dry conditions of 2010 (table), the most critical conditions developed. The soil profile, starting from the autumn of the previous year, experienced a lack of moisture. Replenishment of productive moisture reserves is noted at the end of March. Under the forest strip, its value was 67.0, 288.1 and 426 mm for the analyzed layers. Similar indicators were observed on the fallow (57.0, 237.0 and 427 mm). The largest amount of available moisture is typical for arable land – 87.0; 300.0 and 556.0 mm (horizons 0-20, 0-100 and 0-200cm).

Table 1 – Reserve of productive moisture (mm) under various lands, 2010

Soil layer, cm	Forest strip		Fallow land		Arable land	
	March	July	March	July	March	July
0-20	67	0	57	0	87	0
0-100	288	26	237	17	300	0
0-200	426	67	427	105	556	42

The lack of precipitation during the summer period with an elevated temperature background led to drying and moisture deficit. In the soil of the forest strip by the beginning of August, it decreased to the indicators of a dead moisture reserve. The entire 200-cm layer of soil was characterized by a complete lack of available moisture. The picture was similar for the fallow and arable land. Replenishment of soil moisture reserves began to be noted only from the beginning of September. Moreover, the nature of moisture significantly differed. On arable land, the presence of soil moisture is noted only in the layer below 100 cm – up to 200 cm) – 42 mm. In the upper 0-100 cm, the presence of productive moisture was not observed. The highest amount of available moisture in the upper meter layer was characteristic of the soils of the forest strip (26 mm), its amount was significantly lower for fallow land – 17 mm. But in the underlying soil horizon, the nature of moisture changes and the advantage of fallow areas is noted. The reserve of productive moisture was 105 mm against 67 mm under the forest strip.

Of considerable interest is the analysis of changes in the nature of soil moisture profile in the conditions of autumn 2019 and the first half of the current 2020 with an extremely soft and snowless winter. The second half of 2019 was characterized by a low degree of moisture. Especially acute moisture deficit is noted in the arable analogue and under the forest strip. In December, the available moisture reserves in the first case were 31; 91 and 155 mm (for horizons 0-20, 0-100 and 0-200 cm, respectively), in the second – 29, 74 and 107 mm. Thus, we can note a significant lack of moisture in the layer of 100-200 cm, caused by the influence of an old-age forest strip with a powerful root system. The highest indicators were observed in the soil of the fallow – 44; 131 and 214 mm.

During the winter period of 2020, in the absence of soil freezing and plus temperatures, there was a gradual replenishment of moisture to a greater extent in the upper horizons. By the beginning of February, the productive moisture content under the forest strip was 50 mm in the 0-20 cm layer, 128 mm in the 0-100 cm layer, and 188 mm in the 0-200 cm layer. The largest amount of available moisture in this period of determination was characterized by the fallow – 44, 131 and 214 mm, respectively. The arable land occupied an intermediate position – 36.0, 133.0 and 220.0 mm.

By the beginning of spring field work, the nature of moisture has changed. The leading position in terms of reserves of productive moisture was occupied by the fallow – 43 mm (0-20 cm); 213 mm (0-100 cm) and 396 mm (0-200 cm). Under the forest belt, these values were 51.0 mm (close to February indicators), 187.0 mm and 275 mm, respectively. We can state a gradual more significant increase in the moisture content of the first meter layer. The arable area on the reserves of the upper arable layer at the beginning of the field season (0-20 cm) was inferior to the soils of the fallow and forest strip – only 27 mm. Similarly, smaller reserves are characteristic of the meter-long soil layer (154 mm) and the entire 0-200 cm horizon (292 mm).

By the middle of the growing season (June) 2020, soil moisture availability was quite high. Precipitation at a low temperature background contributed to the conservation and rational use of soil moisture. The highest amount of productive moisture in the upper horizon of the soil (0-20 cm) is noted under the forest strip – 39 mm, the minimum in the soil of arable land – only 18 mm, for fallow, the intermediate value is 23 mm. At the same time, very close values are typical for the meter thickness – 127, 123 and 109 mm, respectively.

4. Conclusion

The conducted studies of the humidity regime of various lands of the Stone Steppe during 2006-2020 show significant changes in its annual and vegetation cycle. The first decade of the current century was characterized by a widespread rise in the ground water level (GWL) to 1.2-2 m and the formation of seasonally waterlogged soils. In the dry conditions of 2010, the most critical conditions developed. The lack of precipitation during the summer period with an elevated temperature background led to drying and moisture deficit. The entire 200-cm layer of soil was characterized by a complete lack of available moisture. In the following years, up to 2020, at all research sites, the GWL fluctuates in the range of 3-4 m.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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