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Risk assessment of phosphorus losses from utilized agricultural area in Poland

Phosphorus (P) is essential for proper plant growth and yield. Soil is a reservoir of phosphorus, which comes from both natural geological processes and human activity, such as the use of organic and mineral fertilizers. Most of the world's phosphate rock resources, the main raw material for the production of phosphate fertilizers, are concentrated in just a few countries, which raises concerns about global food security. However, excessive fertilization can lead to exceeding the sorption capacity of the soil, resulting in phosphorus losses. These losses are the result of both human activity and natural processes such as surface runoff, leaching or erosion. Effective phosphorus management in agriculture is therefore of key importance not only for the economy but also for environmental protection, especially in the context of pollution in the Baltic Sea basin.

The aim of the dissertation was to assess soil phosphorus saturation and to analyze the risk of erosive phosphorus losses from utilized agricultural area to waters. The relationship between the content of available phosphorus and the degree of soil phosphorus saturation determined by the Mehlich 3 and ammonium oxalate methods is presented. In addition, the relationships between phosphorus indices and phosphate content in shallow groundwater were analyzed, determining the safe levels (safety thresholds) of phosphorus in the soil for water. The average phosphorus content in the soil, determined by the Mehlich 3 method, was 121 mg/kg, and by the ammonium oxalate method – 393.9 mg/kg. Phosphorus saturation of soils, determined by the Mehlich 3 method, was on average 14.1%, while using the ammonium oxalate method it was 0,021. The safe threshold of soil phosphorus saturation and phosphorus in the soil for water determined by the Mehlich 3 method in Poland was 21.18% and 150.34 mg/kg. Low correlation coefficients between soil indicators and phosphorus content in waters suggests that soil phosphorus saturation is not a reliable indicator of the risk of phosphorus losses

from agricultural area in Poland. The results of the author's own research indicate that the amount of phosphorus emission from agricultural land to water is influenced not only by the phosphorus status of the soil. It should be assumed that the factors regulating the transport of phosphorus significantly affect the P content in water and should also be taken into account in the process of estimating the risk of losses, which was done. The paper presents the results of soil phosphorus content, water erosion assessment using the RUSLE equation, and erosive phosphorus losses assessment. Total phosphorus losses from agricultural land in Poland amounted to 3,418 t/year, which corresponds to 0.20 kg/ha/year. The highest losses were recorded in the Lublin (450 t/year) and Małopolska (430 t/year) voivodeships. The highest unit losses of phosphorus due to water erosion were observed in the Małopolskie (0.51 kg/ha/year), Świętokrzyskie (0.39 kg/ha/year) and Podkarpackie (0.37 kg/ha/year) voivodeships. Studies confirm that phosphorus losses are determined by surface water erosion. The presented model for assessing the risk of phosphorus losses can help identify areas particularly exposed to phosphorus losses. The research results confirmed that phosphorus losses in Poland are determined by water erosion. The presented model for assessing the risk of phosphorus losses can help identify phosphorus vulnerable zones in our country.

Keywords: phosphorus losses, degree of soil phosphorus saturation, water erosion, erosive losses of phosphorus, Mehlich 3

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