Abstrakt

Meat and bone Meal (MBM) can be a viable alternative to natural, organic and mineral fertilizers because it is rich in nitrogen, phosphorus, calcium, micronutrients and organic matter. It is a solution with many benefits, including: waste management and recyclement of nutrients important for plant growth and development, especially nitrogen and phosphorus, and reducing or replacing the use of expensive mineral nitrogen and phosphorus fertilizers.

The aim of this study was to evaluate the effect of MBM on the yield and quality of crops and on selected chemical properties of soil. A six-year rigorous field study was carried out in 2014-2019 at the Agricultural Experiment Station in Tomaszkowo owned by the University of Warmia and Mazury in Olsztyn. The experiment was conducted on brown soil developed from loamy sand, in a randomized block design, in four replications. Five fertilization objects were established: 1) no fertilization; 2) mineral NPK fertilization; 3) 1.0 Mg ha^{-1} MBM + N_{79}; 4) 1.5 Mg ha^{-1} MBM + N_{40}; 5) 2.0 Mg ha^{-1} MBM. Three crop species were grown twice on fixed 20 plots: maize, winter wheat and winter oilseed rape.

The yields of the tested plants depended on fertilization and weather conditions. Maize, winter wheat and winter rape fertilized with mineral (NPK) and meat and bone meal produced higher yields than non-fertilized plants. The highest yields of wheat grain and oilseed rape seeds were collected from plants fertilized with NPK. Fertilization with NPK or 2.0 Mg ha^{-1} MBM had a similar effect on N content in seed and straw of oilseed rape (2016) and maize (2019). Plants fertilized with NPK and MBM were more abundant in N and had a higher uptake of this nutrient than unfertilized plants. The uptake of N by winter oilseed rape was higher from mineral-fertilized soil than from fertilized with MBM, no such response was observed in other plants. Meat and bone meal had a more favorable effect on P content in oilseed rape (2016) and wheat grain (2018) than NPK fertilization. Plants grown on soil with MBM had similar P uptake to NPK fertilized plants.

Changes in soil mineral nitrogen content depended more on N uptake by plants than on the applied fertilization. The highest content of mineral nitrogen was found in soil fertilized with NPK. An annual, uniform dose of N (158 kg ha^{-1}) did not fully cover plant nitrogen fertilization needs in two treatments: NPK and 1.0 Mg ha^{-1} MBM. The MBM applied at the lowest dose, with which 45 kg P ha^{-1} was introduced, satisfied the nutritional requirements of the tested plants in relation to P to the same extent as its equivalent dose in the form of granular triple superphosphate. However, MBM applied in two higher doses (68 and 90 kg P ha^{-1}) for 6 years, led to a significant accumulation of available P in soil. Six years of cultivation, irrespective of

whether NPK or MBM was applied, led to a reduction in pH and a change in soil classification from slightly acidic to acidic.

The study shows that MBM can replace mineral phosphorus fertilizers and partly replace nitrogen fertilizers. Its dose should be adjusted to the nutritional requirements of the crop. The MBM did not prevent soil acidification, although its Ca content was quite high.

Key words: meat and bone meal (MBM), maize, winter wheat, oilseed rape, nitrogen, phosphorus, soil