

# IDENTIFICATION OF SOIL ACIDIFICATION AND FERTILITY STATUS IN SELECTED FARM FROM TWO DIFFERENT POLISH REGIONS IN THE ASPECT OF SHAPING SUSTAINABLE CROP PRODUCTION

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**Abstract:** A study was conducted to evaluate the acidification of soils and abundance of phosphorus, potassium and magnesium in 50 selected farms located in two different regions in Poland. It has been found that in many cases, soils were characterized by improper - in the aspect of formation of a sustainable crop production- reaction and the content of P, K and Mg. Based on the results, recommendations were formulated to improve the current situation.

**Keywords:** SUSTAINABLE CROP PRODUCTION, REACTION AND ABUNDANCE OF SOIL, FARMS IN POLAND

## 1. Introduction

The soil reaction and its abundance of macroelements as phosphorus, potassium and magnesium are the primary determinants of the sustainable crop production. The soil reaction affects on the content and assimilation of nutrients in plants, both macro- and microelements. Phosphorus, potassium and magnesium are essential plant nutrients, which are necessary for its proper growth and development. In crop production it is very important that the soil is rich in all these components at the appropriate level. However excessive and insufficient levels of soil fertility are both unfavorable. If in soil is a deficiency of some components, and others are sufficient or even excess, their effect is limited by those which are not enough (according to the Liebig's law of the minimum states that the yield of a crop depend on the nutrient occurring in the soil in the smallest amount). In turn, if in the soil is too much of the component, it increases risk of its losses, which has negative economic consequences and may pose a risk to the environment. Thus, for economic and environmental reasons, especially related with water protection, it is important that soil reaction and its fertility were maintained at an optimum level. For this purpose, it is necessary to determinate soil acidity and content of the phosphorus, potassium and magnesium in soil.

## 2. Problem discussion

Baltic Sea waters, due to delivering excessive amounts of nutrients has become a basin strongly eutrophicated. Eutrophication causes many adverse changes in marine flora and fauna (it is considered the most important environmental problem of the Baltic Sea) and generates a large social and economic losses. The largest anthropogenic source of nutrients delivered to the Baltic Sea are compounds of nitrogen and phosphorus from agricultural sources. Therefore, in the Baltic Sea region, also in Poland, it is necessary to undertake various activities aimed at reducing discharges of these components to the waters. In Poland, where 99,7 % of territory is in the area of the watershed Baltic Sea, to the activities that would contribute to reducing agricultural pressure on water, may include regulation of soil reaction and rationalization of fertilization on the basis of determination soil acidity and its richness in phosphorus, potassium and magnesium.

This issue have been analyzed - as a case study, based on the results of research conducted in farms situated in two Polish regions, with regard to pH and the content of P, K, Mg in the soils of agricultural land belonging to these farms. In this study was considered the following research problem: What are the real needs to improve soil reaction and fertility in farms covered by the studies in terms of shaping their sustainable crop production?

## 3. Objective and research methodologies

The aim of the study was to assess the state of acidity and soil fertility in the example of selected farms situated in two Polish regions and on the basis of results, elaborate the recommendations to optimize fertilizer management in these farms, and indirectly, represented by these farms area.

Soil samples was collected in 2013 in 50 farms. These farms after half (i.e. 25) were located in the Pomorskie Voivodeship (in 16 counties) and Mazowieckie voivodship (in 4 counties - typically agricultural). Average area of farms in Pomorskie was 26.9 ha (from 7.3 to 52.8 ha) and Mazowieckie 38.6 ha (12.0 to 100.0 ha). 858 soil samples from the farm fields from both of these voivodships (429 of each) was analyzed. Soil samples for laboratory tests were taken by sampling stick from the top layer 0-20 cm.

Determination of soil samples:

- granulometric composition using laser diffraction method (in mineral soils);
- pH - potentiometrically in 1 mol KCl;
- content of available phosphorus, potassium and magnesium, methods: P and K in mineral soils the Egner-Riehm method, Mg - the Schachtschabel method; P, K and Mg in organic soil in extract 0,5 mol HCl·dm<sup>-3</sup>.

Based on the results of determinations granulometric composition, analyzed mineral soils are classified by agronomic category on: very light (to 10% of floatable particles with a diameter <0.02 mm), light (11-20% of floatable particles), medium (21-35% of floatable particles) and severe (> 35% of floatable particles).

Assessment of soil reaction was performed according to classification used for this purpose in Poland - Table 1. For the assessment soil abundance in digestible macronutrients: P, K and Mg used criteria specified in the standards: PN-R-04023, PN-R-04022, PN-R-04020, PN-R-04024

**Table 1.** Assessment of soil reaction

The pH range in KCl	Reaction
≤4,5	very acid
(4,5-5,5>	acid
(5,5-6,5>	light acid
(6,5-7,2>	neutral
> 7,2	alkaline

### 4. Results

Executed research showed that soil of agricultural land in farms from Pomorskie and Mazowieckie voivodeships were significantly different in terms of agronomic categories, reaction (and needs for liming) and abundance of P, K and Mg – Figure 1-6.

Soils from the farms in Pomorskie voivodeship characterized :

- highly unfavorable pH (about 65% of tested soil samples has very acidic or acid reaction);
- large deficiency of available phosphorus (more than 53% of tested samples graded into classes with very low and low abundance);
- very large deficiency available forms of potassium, especially in peat soils) (about 71% of the samples were classified as "low" or "very low" rich in K);
- considerable deficit of magnesium (magnesium content in more than 42% of the analyzed soil samples was very low, or low).

Soils from the farms in Mazowieckie voivodeship stand out:

- unsatisfactory, but in a large part correct pH (around 29% of samples tested soils had neutral reaction) or tolerable (ie. slightly acidic - approx. 35% of the samples);
- fairly good abundant in phosphorus (soil with a more than 60% of the samples were classified into classes of high and very high abundance of phosphorus, and only less than 19% for classes with very low and low abundance);
- average abundance of potassium (more than 68% of the samples soils was characterized by at least an average level abundance potassium);
- good state accumulation of magnesium (only in soil with 3.3% of the sample population found to "low" or "very low" state of the accumulation of magnesium).

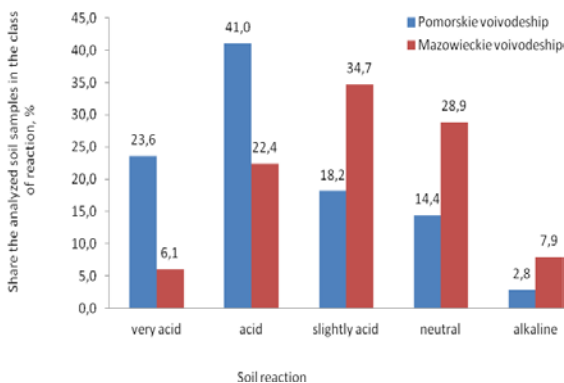


Fig. 1 Distribution of of soil reaction in the farms from Pomorskie and Mazowieckie

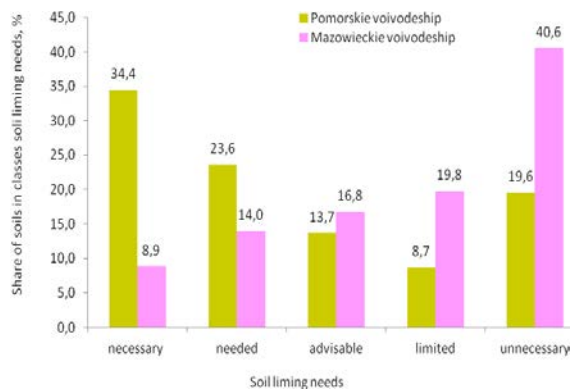


Fig. 2 Distribution of soil liming needs in the farms from Pomorskie and Mazowieckie

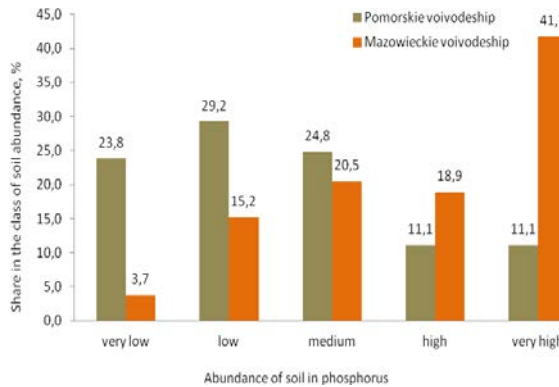


Fig. 3 Distribution of soil abundance in phosphorus in farms from Pomorskie and Mazowieckie

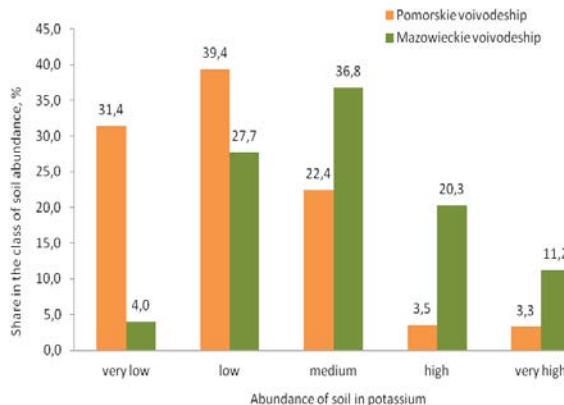


Fig. 4 Distribution of soil abundance in potassium in the farms from Pomorskie and Mazowieckie

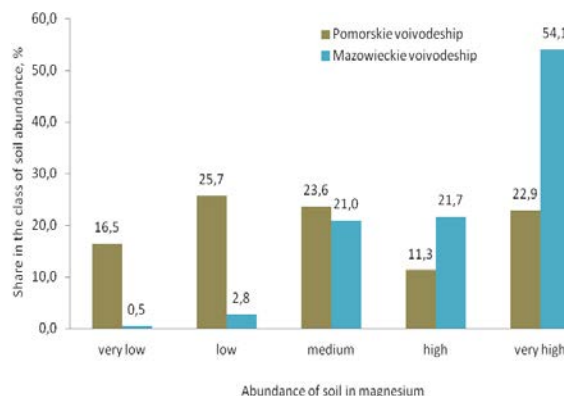


Fig. 5 Distribution of soil abundance in magnesium in the farms from Pomorskie and Mazowieckie

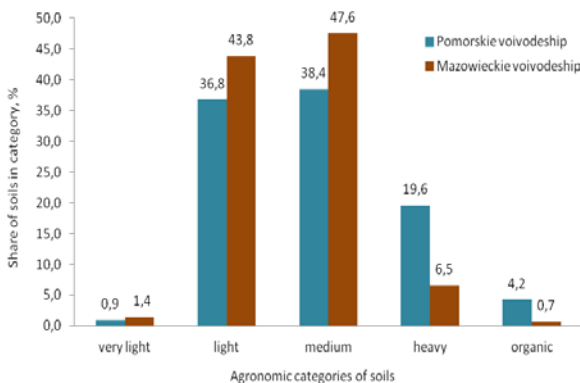


Fig. 6 Share of soils in farms from Pomorskie and Mazowieckie in various categories agronomic

## 5. Conclusion

Obtained results showed that on a very large area of agricultural land in evaluated farms from the province Pomeranian, exist a needs to regulate soil pH (by conducting liming) and rationalize fertilization, in adjusting to the needs of cultivated plants.

In the farms of the Mazowieckie voivodeship (and it can be assumed that also in all 4 counties where farms are located) soils have a much more favourable reaction and are much more abundant in P, K and Mg in soils than evaluated farms from the Pomorskie voivodeship. It seems that in these farms management practices for maintaining proper soil reaction and the abundance of major nutrients do not require radical remedial action, but rather nature perfecting (i.e. correction). These should to improve soil reaction on the plots with defective pH and to increase content of P, K and Mg in soils which are poor in mineral compounds. At the same time, they should eliminate unjustifiable using of excessively high doses of fertilizers, especially in situations where soils are very rich in nutrients. This applies especially to supply soil with phosphorus. In both groups of farms in each of the voivodeships occur the farms,

where reaction and abundance of soil are on an appropriate level. It would be helpful to use experience of the owners of these farms, associated with conducting sustainable crop production in the agricultural advisors work.

## 6. Literature

PN-R-04020:1994 Agrochemical soil analyse. Determination of assimilated magnesium content.

PN-R-04022:1996 Agrochemical soil analyse. Determination of assimilated potassium content.

PN-R-04023:1996 Agrochemical soil analyse. Determination of assimilated phosphorus contents.

PN-R-04024:1997. Agrochemical soil analyse. Determination of available phosphorus, potassium, magnesium and manganese contents in organic soils.

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