THE IMPACT OF NITROGEN AND PHOSPHORUS FERTILIZATION ON SOIL PHYSICO-CHEMICAL INDICATORS ON SLOPED PLOTS OF WINTER WHEAT CROPS IN EASTERN ROMANIA

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Abstract

Winter wheat is one of the most important crops in Romania, ranking second in terms of cultivated area. This research investigates the influence of nitrogen and phosphorus fertilization on key soil physico-chemical indicators in a moderately eroded cambic chernozem soil in Eastern Romania. The study was conducted on sloped land at the "Mircea Moțoc" Soil Erosion Research and Development Station in Perieni, Vaslui County, located in the middle basin of the Țărnii Valley, in the Tutova Hills. Fertilization was applied in a differentiated manner, tailored to the specific growth stages of the wheat, taking into account factors such as species, variety, soil conditions, and other agronomic variables. Soil samples were collected from fertilized and unfertilized plots across three sections (upstream, middle, and downstream) at a depth of 0-10 cm to assess nutrient levels and other relevant soil characteristics. The results showed that soil pH ranged from 4.78 to 5.98, nitrogen content varied between 0.103% and 0.181%, and humus levels fluctuated between 1.97% and 3.5%. These findings highlight the direct impact of fertilization on soil quality and the importance of precise agrochemical treatments to optimize agricultural production while preserving soil resources.

Key words: slope, fertilization, soil

Matache *et al*, (2021) published data on soil degradation caused by surface and deep erosion, highlighting its impact in Romanian watersheds, such as the Alb River. This research highlights the negative effects of erosion on soil quality and agriculture, providing relevant data for areas exposed to accelerated erosion. Fertilization represents an indirect means of reducing soil erosion as plants develop a richer leaf apparatus that ensures a higher degree of coverage.

In modern agriculture, the importance of using chemical fertilizers is undeniable. In the structure of chemical fertilizers, those with nitrogen occupy the main place by their contribution in determining the yield increase, as well as by the weight with which they participate in the applied fertilization formulas (Dumitrașcu et al., 2003; Mihăilă et al., 1996; Petcu et al.., 2003).

Administering the optimal amount of nutrients contributes to maintaining or increasing soil fertility capacity, to increasing the productive potential of plants, avoiding the phenomena of plant nutritional imbalances (Axinte et al., 2008).

Dai Z. et al. (2020) investigated the impact of long-term fertilization on phosphorus cycling and microbial functionality in diverse agroecosystems. The study shows that continuous nutrient input can change microbial profiles and the carbon mineralization process, thereby influencing soil fertility and plant nutrient use.

Zhao J. et al. (2022) studied the effects of nitrogen and phosphorus combined fertilization on alfalfa, showing that a balance between these two elements significantly improves both photosynthetic characteristics and crop yield.

Zhang L. et al. (2023) performed a meta-analysis of the stability of soil aggregates following the application of nitrogen, phosphorus and organic fertilizers. It has been shown that the long-term use of organic fertilizers, in combination with chemical ones, can improve soil resistance to erosion, thus contributing to sustainable agriculture.

The role of experiments with long-term fertilizers is to provide information on the need for mineral fertilizers to obtain high yields and to establish, for the main field crops, the doses of fertilizers to maintain soil fertility at an optimal level. As is known, when harvesting any crop, large amounts of nutrients are exported from the soil; only in the case of wheat, at a production of 5000-6000 kg/ha, 100-140 kg of nitrogen, 50-60 kg of phosphorus and other nutrients, which must be returned to the soil. That is why it is important to know the need for fertilizers, which differ a lot depending on the state of soil fertility, the climate and the needs of each species of cultivated plants.

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The research carried out by Popa A. and the collaborators at Perieni, established that the losses of fertilizing elements caused by erosion, in some crops, differ according to the size of the slope, being double on lands with a slope of 24% compared to the losses on lands with a slope of 12%.

MATERIAL AND METHOD

The study was carried out at the Research and Development Station for Combating Soil Erosion "Mircea Moțoc" Perieni, Romania. The study was carried out on a cambic chernozem type soil with moderate erosion, 12% slope. This type of soil is characterized by loamy texture with loessose deposits.

This study consists of two successive stages. In the first stage, soil samples were taken from the two plots with unfertilized wheat and with wheat fertilized with nitrogen and phosphorus. The soil samples (photo 1) were taken with the help of Eijkelkamp probes (photo 2) from upstream, middle, downstream at a depth of 0-10 cm. These samples were taken to the Laboratory for various analyzes within the Soil Physics Department of the Iași Agriculture and Environment Research Institute (ICAM).

Figure 1 **Soil samples taken from the wheat plot**

Figure 2 **Eijkelkamp type soil sampling probe**

In the period preceding the sowing, manual digging with a harrow was carried out on the unfertilized wheat plot and the fertilized wheat plot. When sowing, the seedbed was prepared with a Bertolini-type motor cultivator with milling unit. Sowing of the wheat crop was done manually both in the unfertilized plot and in the fertilized plot, with the row spacing of 12.5 cm and the sowing depth of 4-7 cm.

RESULTS AND DISCUSSIONS

On sloping land, the change in physical-chemical indicators is much more pronounced and depends to a large extent on the relief, pedoclimatic conditions, the way of use and human activity. Research in this direction was done by Filiche E. (1995-2000).

The physico-chemical indicators studied were: pH, humus, nitrogen. The determinations were made in the year 2024. Therefore, as I said previously, the changes in the physico-chemical indicators of the soil can be noticed after a long period, comparisons were made between the values obtained in this period (2024) with the values obtained from the research carried out by Filiche E. (2000).

Table 1

Losses of fertilizing elements through the soil in the plots for the control of runoff in the year 2000 (Filiche E.)

Culture	Humus (%)	Azote (%)
Wheat	2.26	82.96
Unfertilized wheat	4.98	94.95

Research on the influence of the fertilization system on the physico-chemical indicators was carried out on the cambic chernozem, moderately eroded with a slope of 12-13% at the Research-Development Station for Combating Soil Erosion "Mircea Moțoc", in an experience with character stationary established in 1970. In this study, the following fertilization system was applied: unfertilized (N_0P_0); fertilized with nitrogen and phosphorus in a dose of 150 N kg/ha + 150 kg P_2O_5/ha ($N_{150}P_{150}$).

On the plot with unfertilized wheat in the 3 sectors, the pH of the soil recorded values from the upstream of the plot of 5.97 to the downstream of the plot where it recorded the value of 5.98. In the case of the plot fertilized with nitrogen and phosphorus in the 3 sectors (upstream, middle,

downstream), the pH of the soil shows decreasing values from the upstream of the plot with the value of 5.07 to the downstream of the plot where the pH is 4.78 (figure 1).

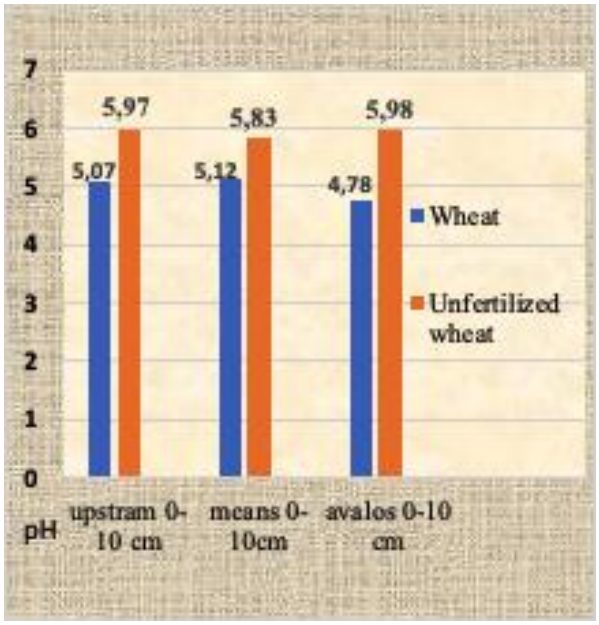

Figure 1 **Dynamics of soil pH in three sectors at a depth of 0-10 cm in the fertilized and unfertilized wheat crop**

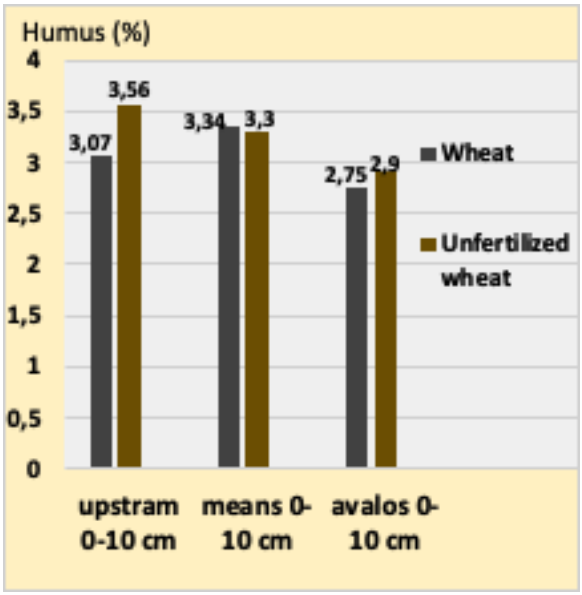

Figure 2 **Dynamics of soil humus content in three sectors at a depth of 0-10 cm in the fertilized and unfertilized wheat crop**

Humus represents the most important element of soil fertility, preservation and above all the increase of its content, which is highly dependent on agricultural production.

The humus content of the soil, on the plot with fertilized wheat, varied with values from the upstream of the plot where it indicated the value of 3.07% to the downstream of the plot where it had the value of 2.75%. In the case of the unfertilized wheat plot, the humus showed values between 3.56 % (upstream) and 2.9 % (downstream).

Comparing the humus values recorded (table 1) in the year 2000 (Filiche E.) with the current humus values (figure 2), we can see an evolution of the humus content from 2.61% to 3.34% on the plot with fertilized wheat, and in the case of the plot with unfertilized wheat, the amount of humus in the soil decreased from 4.98% in 2000 (Filiche E.) to 3.56% in 2024.

Nitrogen, being an easily soluble element, is quickly leached into the deep layers of the soil, having no possibility to quantify except the state at a given moment.

From the data represented in figure 3, significant differences can be distinguished between the fertilized and the unfertilized wheat plot in the three sectors (upstream, middle, downstream). Thus, in the fertilized plot, the amount of nitrogen varied from 0.148 % (downstream plot) to 0.181 % (upstream plot). In the case of the unfertilized plot, the nitrogen content of the soil varied from 0.139 % (downstream plot) to 0.165 % (middle plot).

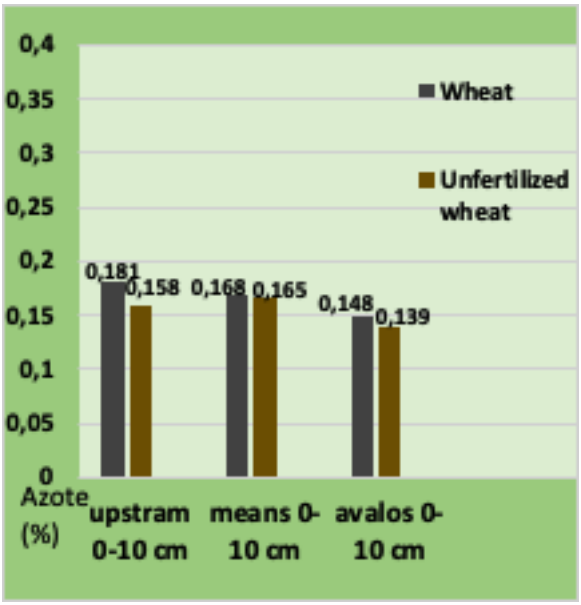

Figure 3 **Dynamics of soil nitrogen content in three sectors at the depth of 0-10 cm in the culture of fertilized and unfertilized wheat**

The nitrogen content data have the following meaning (according to I.C.P.A. Bucharest):

- at concentrations of nitrogen in the arable layer below 0.14%, it is considered that the soils are poorly supplied with nitrogen, for the cultivation of wheat and corn;
- at nitrogen concentrations in the arable layer between 0.14% and 0.27%, it is considered that the soils are moderately supplied with nitrogen;

- if the concentration of 0.27% nitrogen in the arable layer is exceeded, it is considered that the soils are well and very well supplied with this element.

If in 2000 (Filiche E.) the nitrogen content of the fertilized plot was 82.96%, the long application of chemical fertilizers led to a state of medium supply with a content of 0.148%. In the unfertilized wheat plot, the amount of nitrogen decreased in 24 years, so that in the year 2000 it was 94.95% reaching in the year 2024 a content of 0.139%, which constitutes a state of medium nitrogen supply.

CONCLUSIONS

The pH of the soil at the plot fertilized with nitrogen and phosphorus in the 3 sectors (upstream, middle, downstream) shows values from 4.78 (downstream plot) to 5.07 (upstream plot). In the case of the unfertilized wheat plot, the soil pH indicated values between 5.97 (upstream plot) and 5.98 (downstream plot).

The humus content in the soil of the fertilized plot, recorded in 2000, is 2.61% evolving after 24 years to 3.34%. In the unfertilized wheat plot, the amount of humus in the soil decreased from 4.98% in 2000 to 3.56% in 2024, constituting an average state of soil supply.

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