

LONG-TERM RESEARCH ON THE STUDY OF WHEAT AND CORN FERTILIZATION ON SLOPE LANDS IN BARLAD PLATEAU, ROMANIA

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Abstract

In this scientific work, we present results obtained in wheat and corn culture, during the period 2013-2022, at the "Mircea Motoc" Perieni Soil Erosion Research and Development Station, through fertilization with several types of organo-mineral fertilizers.

The effect of long term (10 years) nitrogen and phosphorus fertilization upon soil fertility and yield, was followed with doses 0, 40, 80, 120, and 160 kg N/ha and 0, 40, 80, 120, 160 kg P/ha doses. Long term fertilization led to a statistically significant increase of grain yield.

The research carried out highlighted the fact that the rational use of chemical and organic fertilizers, offers the possibility of restoring the fertility of eroded soils in a short period of time, simultaneously with the important increase in production, depending on the type of soil, the degree of erosion and the doses of fertilizers applied.

Organic and organo-mineral fertilizers, are intended especially for ameliorative and soil protection treatments against water and wind erosion. By using organo-mineral fertilizers, erosion is reduced by 30%. By fertilizing with one ton of organo-mineral fertilizers, between three and eight tons of natural fertilizers are substituted and more than five hundred kilograms per hectares of humic acids and synthetic polymers are incorporated into the soil.

Keywords: long term fertilization, production, organic and chemical fertilizers, wheat and corn culture, soil fertility

1. INTRODUCTION

The rational fertilization of soils and crops is a permanent desire of agricultural technologies with technical, economic, environmental and consumer protection efficiency. It can be concluded that this field has progressed a lot due mainly to the quantitative and qualitative requirements of agricultural vegetable products effectively supported by the improvements in the agronomic optimization of the soil-plant system, by diversifying the factors involved and perfecting the methods and their increased efficiency. The basis of these advances are, in addition to the investments made in the technique and the multiplication of the assortments of fertilizers and research in the field of the rational use of fertilizers and the formulation with applicability of scientifically based technical measures, through experiments and research, especially stationary ones that included the effect of fertilizing resources in the soil-plant system (quantity and quality produced, productive fertility), maintaining food security and a balance of environmental resources.

"Long-term experiments with fertilizers" took off in 1966-1967 at the initiative of Cristian Hera (academic, then researcher at ICCPT Fundulea) who, in collaboration with Z. Borlan and a group of researchers from the network of this institute, designed and located a unique set of long-term experiences with fertilizers.

The long-term experiences with fertilizers, at SCDCES MM Perieni, are structured and have the same objectives as the other long-term experiences in the country, their specificity being determined by the conditions of sloping lands subject to erosion degradation.

In our country, sloping lands represent approximately 43.6% of the agricultural area, and on these lands the state of fertility has degraded and continues to degrade, the productions obtained qualitatively and quantitatively are inferior due to the washing of nutrients.

On these lands, in addition to obtaining competitive productions, it is necessary to preserve the soil, that is why all ways must be found and used in the complex that lead to the reduction of the phenomenon of erosion within the admissible limits and the improvement of their fertility.

The research in this direction on the sloped lands within the Perieni resort was carried out by M. Moțoc (1969, 1976), A. Popa (1974, 1986), N. Dumitrescu (1960, 1989), T. Neamțu (1977, 1996), D. Nistor (1979, 1988) and others, highlighted the fact that on these lands the change in soil fertility is much more pronounced and largely depends on pedoclimatic conditions, the way of use and human activity.

2. MATERIAL AND METHOD

2.1. Location of the research area

The long-term experiences with fertilizers and those regarding the rotation of crops and fertilizers on the production and fertility of the soil, are carried out in the perimeter of the Research and Development Station for Combating Soil Erosion "Mircea Moțoc" Perieni, Romania. Perieni commune is located in the Tutovei Hills within the Bârlad Plateau.

The experiments were located on the left and right slopes of Văia Țârnea (latitude – 46°18' and longitude – 27°37') at the altitude of 223 m, on a typical cambic chernozem, with a loamy-clay texture, with a slope of 12-13%, the exposure of the eastern slope, affected by moderate erosion.

2.2. Climatic aspects

The values of the meteorological elements (temperatures, precipitation) indicate the presence of a temperate-continental climate of excessive nuance, with hot, dry summers and cold winters. The data used were recorded both at the weather station Bârlad and at the one at the Perieni Resort.

Rainfall

The rainfall regime is of particular importance because the production is directly dependent on the amount of precipitation and its distribution over time, and on sloping lands the volume of liquid runoff and erosion largely depends on the torrential nature of the rain.

More than 47% of the annual volume of precipitation falls in the critical season of erosion, which explains the high values that erosion registers in the Bârlad Plateau. Also, about 18% of the annual volume of precipitation occurs when the soil is bare, freshly tilled and easily erodible.

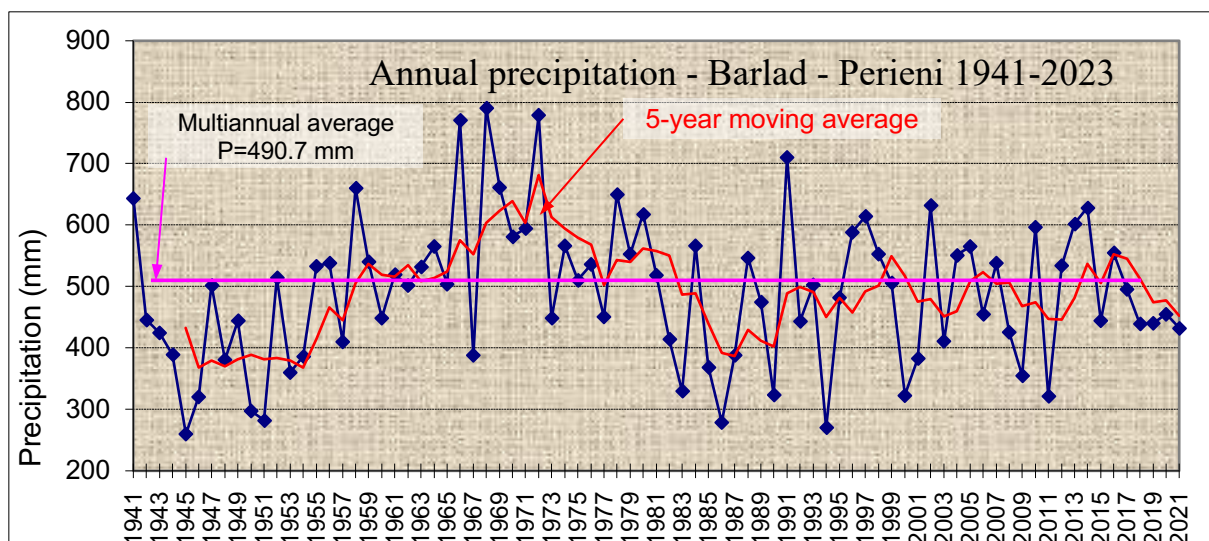


Fig. 1. Distribution of multiannual average precipitation in the period 1941-2023

The analysis of the annual amounts of rainfall recorded between 1941-2023 reveals a cyclical tendency of about 40 years, in which the rainy interval alternates with the dry one. The 5-year moving average, which conclusively expresses the climate evolution trend, suggests that in the period 1942-1957 there was a specific drought phenomenon and in the interval 1958-1984 the precipitation exceeded the multiannual average of 493.1 mm. Since 1985, the drought phenomenon has re-established itself, tending to continue even today.

Temperature

The average annual temperature varies between 8.0 °C and 13.0 °C, the coldest month being January (-2.7 °C) and the warmest July (21.8 °C). The transition between these limits is done gradually.

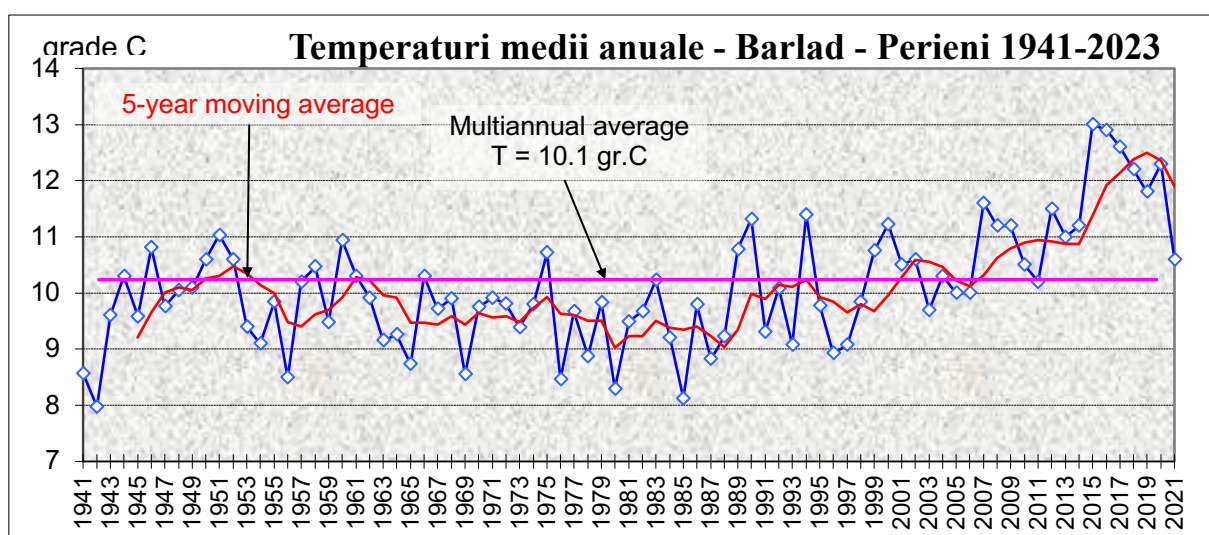


Fig. 2. Distribution of multiannual average temperatures in the period 1941-2023

Analysis of monthly values from 1941-2023 reveals a multi-year average of 10.1 °C, a minimum of -11.5 °C in January 1942 and a maximum of 26.2 °C in July 2012. The absolute maximum temperature record was of 39.7 °C and was recorded on July 25, 1942.

2.3. Research method

The experiences have a stationary character and were executed in the rotation: wheat - corn. The polyfactorial experiment placed in the field was carried out according to the method of two-factor storied blocks, of the type 6x5 in the experience with NP, respectively 6x4 in the experience NPK and in the experience NPG, in six repetitions.

The experience with nitrogen and phosphorus doses (NP) has the following fertilization options:

Factor A with five graduations:

A1 – P0;
A2 – P40;
A3 – P80;
A4 – P120;
A5 – P160;

Factor B with five graduations:

B1 – N0;
B2 – N40;
B3 – N80;
B4 – N120;
B5 – N160.

The experiment with doses of nitrogen, phosphorus and potassium (NPK) has the following variants:

Factor A with four graduations:

A1 – N0P0;
A2 – N100P0;
A3 – N0P100;
A4 – N100P100;

Factor B with four graduations:

B1 – K0;
B2 – K50;
B3 – K100;
B4 – K150.

The experience is 4x4.

The experiment with doses of nitrogen, phosphorus and manure (NPG) has the following variants:

Factor A with four graduations:

A1 – N0P0;
A2 – N0P50;
A3 – N50N50;
A4 – N100P100;

Factor B with four graduations:

B1 – G0;
B2 – G20;
B3 – G40;
B4 – G60.

3. RESULTS

3.1. Production dynamics of differential fertilization in wheat and corn crops in the long-term experience with fertilizer rates 2013-2022

The present study follows the evolution over time of wheat and corn production in the period 2013 – 2022 at SCDCES "MM" Perieni in the long-term experiments with fertilizers.

3.1.1. Long-term effect of NP fertilization on wheat crop

The superiority of wheat production achieved by using nitrogen is natural, considering that nitrogen is the "pivot of fertilization", the decisive factor in increasing wheat yields, and phosphorus has a smaller effect.

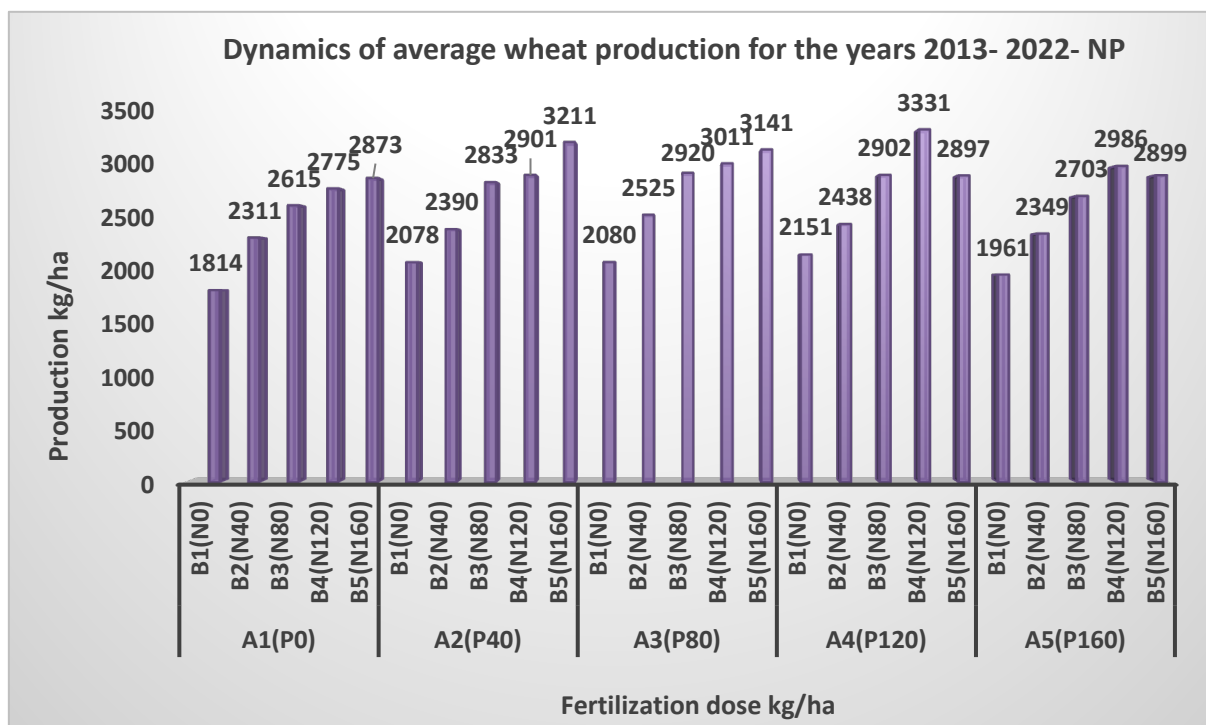


Fig. 3. Dynamics of wheat production for the years 2013-2022 fertilized with NP

On average, the wheat production obtained without fertilizers was 1814 kg/ha, and the maximum production was 3331 kg/ha. The increase in production obtained compared to the unfertilized control, 1517 kg/ha (184%), demonstrates the significant effect of nitrogen and phosphorus fertilization on wheat production (2013-2022).

3.1.2. Long-term effect of NPK fertilization on wheat crop

Grass cereals respond to the basic application (NPK) of the presence and potassium, with balanced crops and growth, healthy plants, resistant to breakage and good quality (including baking). They have consumption equal to that of N and higher than P.

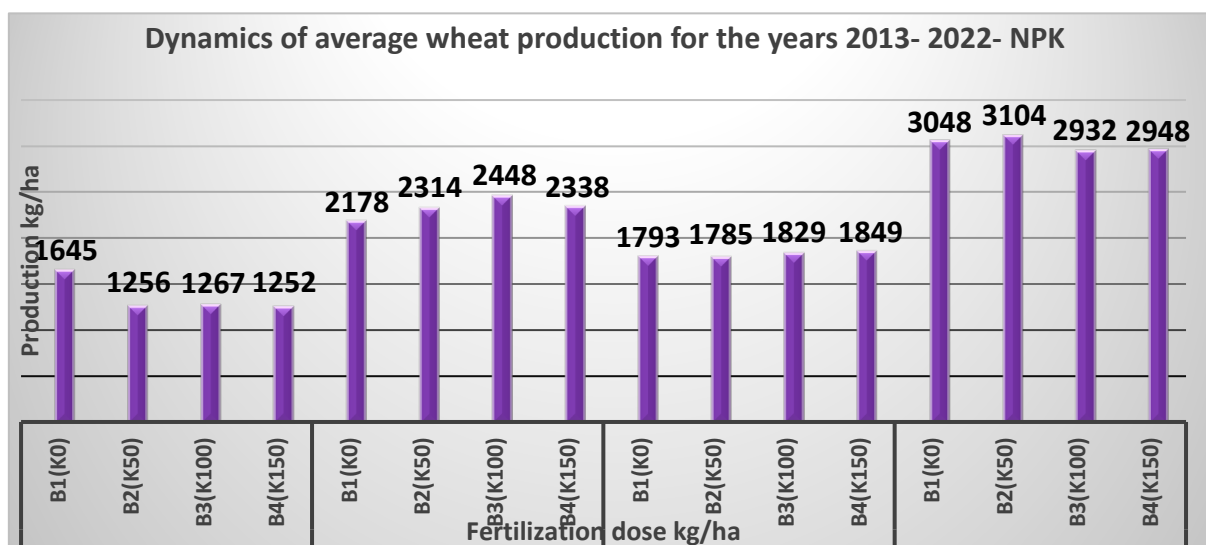


Fig. 4. Dynamics of wheat production for the years 2013-2022 fertilized with NPK

The influence of the doses of potassium on the effects of those of nitrogen and phosphorus was less, statistically ensured production differences being recorded when applying the doses of $N_{100}P_0K_{100}$ of 803 kg/ha significantly higher and $N_{100}P_{100}K_{50}$ of 1459 kg/ha distinctly significantly higher than the control.

3.1.3. Long-term effect of NPG fertilization on wheat crop

The effect of fertilizing with garbage is maintained for up to 3-5 years and through its slow action, a significant amount of nutrients needed during the entire vegetation period is ensured. The application of manure simultaneously with mineral fertilizers ensures both the immediate needs of nutrients in the soil and the needs in the longer term.

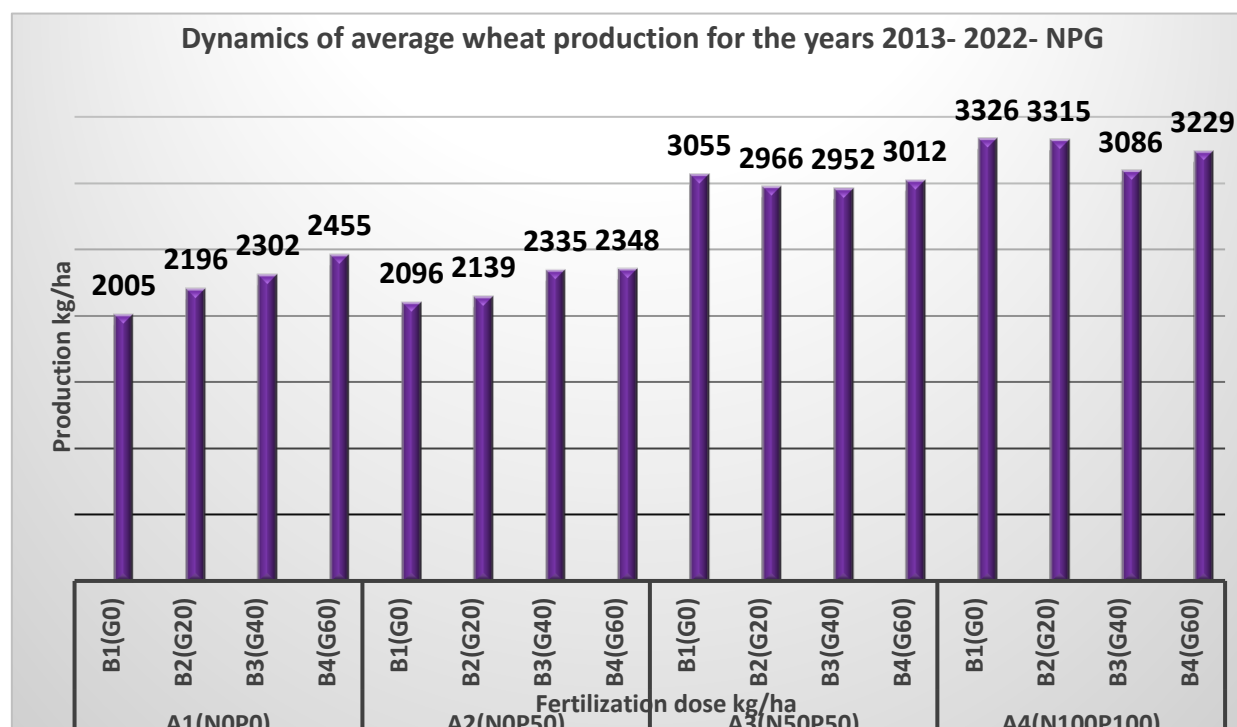


Fig 5. Dynamics of wheat production for the years 2013-2022 fertilized with NPG

The highest increase in production was obtained in the fertilization variant in which the dose of manure was 20 tons/ha, which was significantly higher by 1321 kg/ha compared to the control variant.

3.2. Production dynamics of differential fertilization in the maize crop in the long-term experience with fertilizer rates 2014-2021

The present study analyzes the reaction to long-term NP fertilization, in the period 2014 - 2021, with the general but particular appreciation of the determined factors, that nitrogen and phosphorus are basic components of some fertilization systems for this crop.

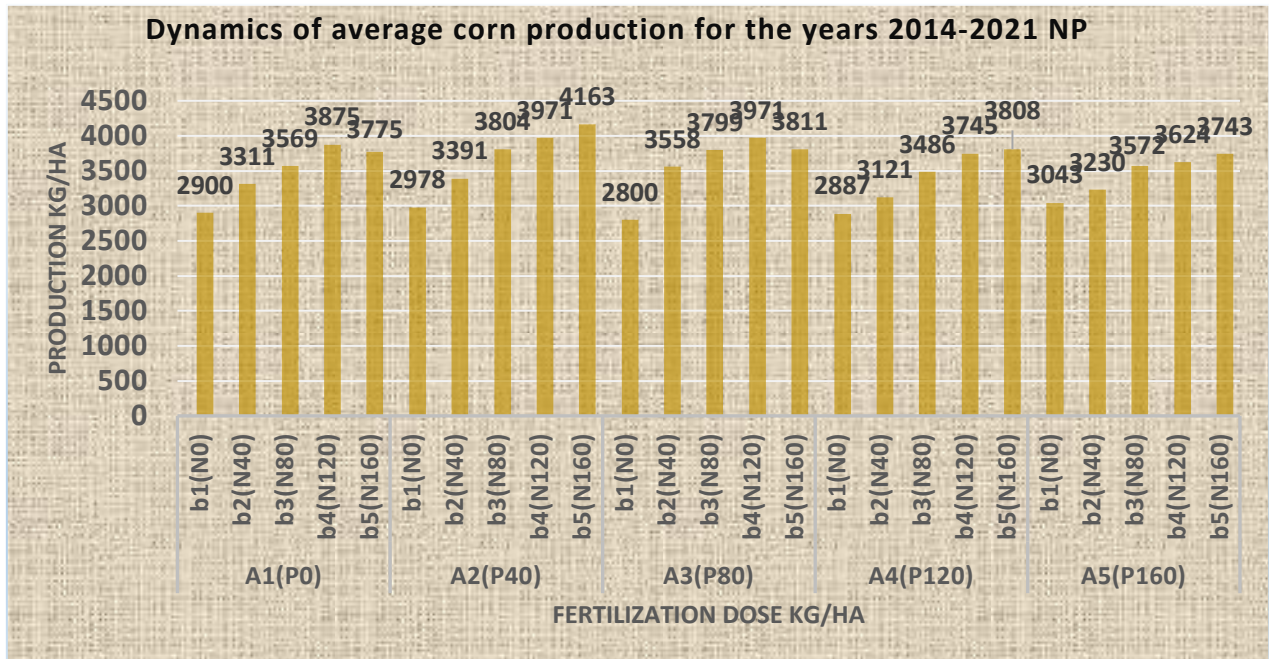


Fig. 6. Dynamics of average corn production for the years 2014-2021 fertilized with NP

The graphic expression of the dynamics of corn production, in the chosen intervals, generally shows the superiority of the fertilized variants compared to the dynamics of the control (N0P0).

3.2.2. Long-term effect of NPK fertilization on maize crop

Maize is a crop with efficiency in the application of NPK (basic) and with support for the facial application (including localized) of some varieties with N and complexes in whose efficiency the presence of potassium is essential (Rusu, 2021).

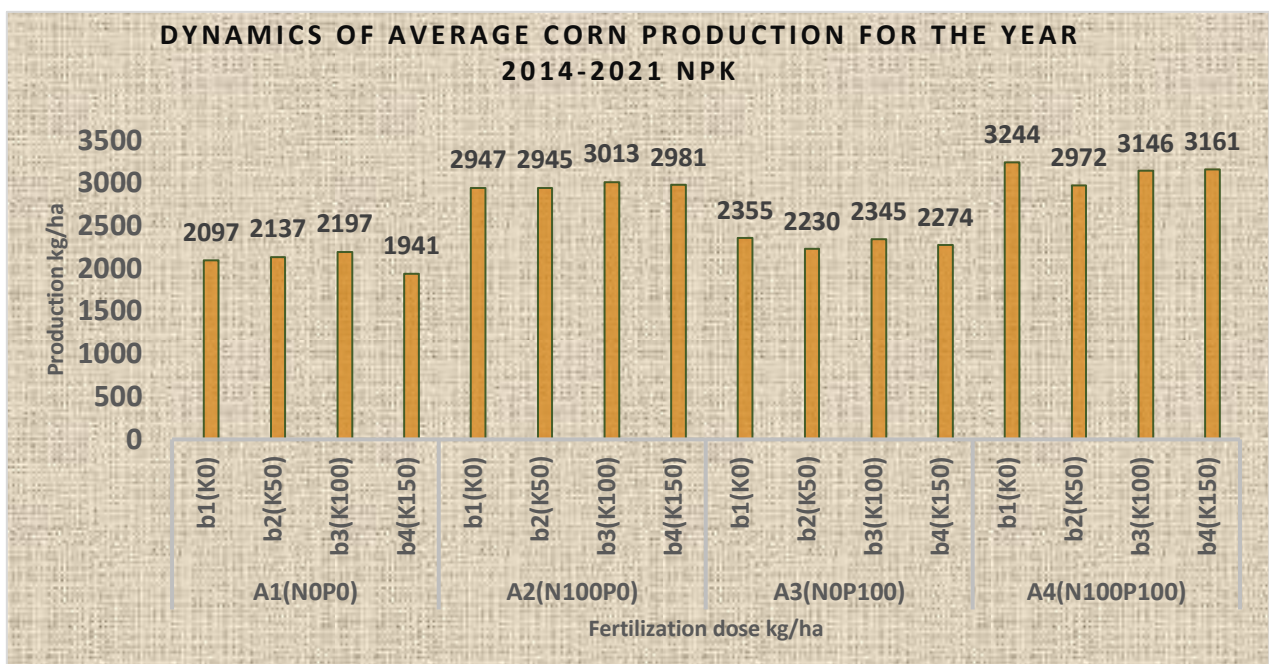


Fig. 7. Dynamics of average corn production for the years 2014-2021 fertilized with NPK

The influence of potassium determined the achievement of very significantly higher production differences than the control by applying $N_{100}P_{100}K_{150}$.

3.2.3. The long-term effect of fertilization with organo-mineral fertilizers on maize crop

For the corn crop, the fermented manure was administered in the fall before plowing, alone or combined with mineral fertilizers.

Due to the supply of nutrients and the improvement of organic matter in the soil, following the application of manure, a decrease in the need for nitrogen fertilizers is obtained.

Analyzing the results on the production of the two crops, from the last 8 years, it can be stated that the best productions are obtained with the $N_{100}P_{100}G_{60}$ variants, but even so, most of the productions have been in a continuous decrease due to climate changes, the lack of precipitation from the vegetation period, as well as other factors.

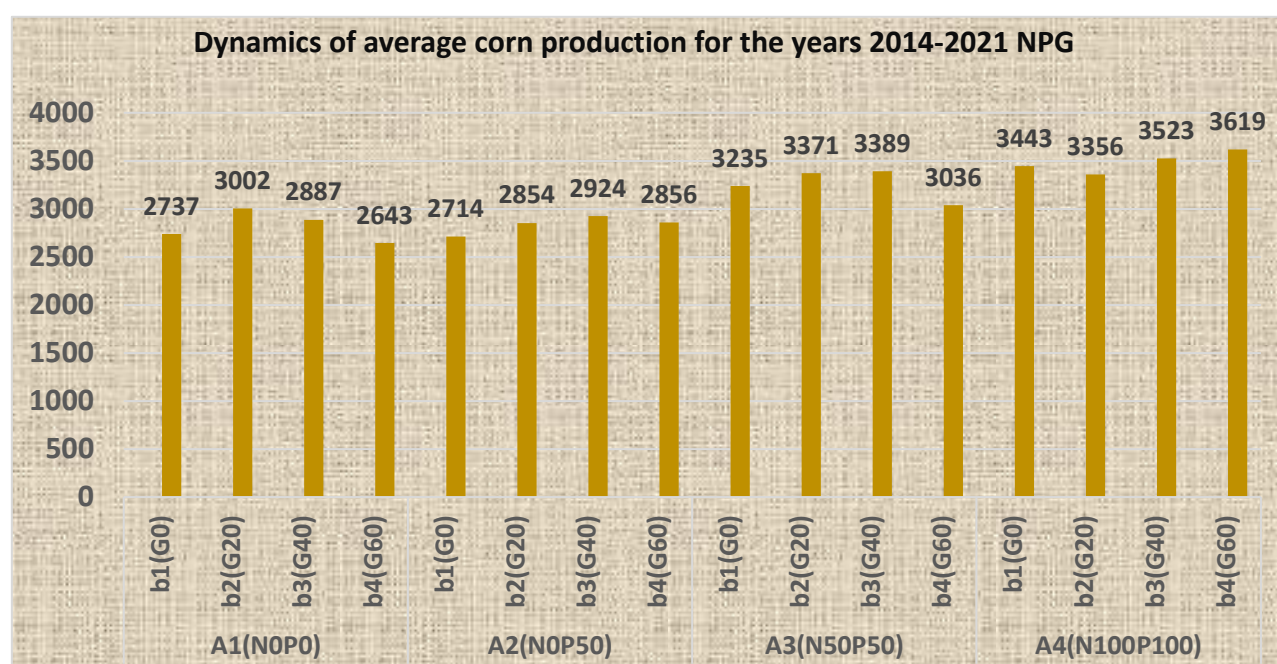


Fig. 8. Dynamics of average corn production for the years 2014-2021 fertilized with NPG

In corn, higher yields were obtained when a dose of 40 t/ha of fermented manure was applied, and in the variants where the manure was applied in combination with mineral fertilizers, significantly higher yields were obtained with 900-1200 kg/ha to the witness.

4. DISCUSSIONS

The simultaneous application, in time and space, of nitrogen and phosphorus (NP), in different doses and ratios, constitute productive alternatives for the winter wheat crop and applied in this way can constitute fertilization systems. The data of the wheat variance analysis show that grain production is primarily and decisively influenced by the doses of N applied, then by those of P, and lastly, the interaction of the doses of N with the climatic conditions is recorded. These influences can be seen during the experimental years.

Applied together, nitrogen and phosphorus through the effect of complementarity and mutual support, phosphorus potentiating the action of nitrogen, increases in the productions obtained are noted, but at increased doses, a slight reduction is noted.

The conservation and maintenance of the natural fertility of soils was and is supported and promoted by researchers and specialists from all over the world (Şimon Alina, 2013), and by fertilizing with fermented manure, a stimulation of microbiological activity in the soil and a reduction of the amount of chemical fertilizers required.

T. Neamţu (1982) in a long-term experience with rotations and fertilizers, in Perieni, after 11 years of experimentation, found that in non-fertilization conditions, rotation for 5 years ensures production of more than 3000 kg/ha of grain corn. The same author states that, on sloping land, plants suffer from a lack of fertilizing elements and therefore, in order to achieve high and constant wheat production, fertilization of this crop is absolutely necessary. The production increments that can be obtained vary depending on the preceding plant and the doses of fertilizers and are between 600 kg/ha and 1400 kg/ha.

After 22 years of experimentation, T. Neamţu (1992) returns with data regarding the influence of rotations on production and finds that the contribution of rotations to achieving wheat production on unfertilized sloping land is between 8.3% in the simple rotation wheat - corn and 73% in the 5-year rotation, compared to monoculture. Increasing the fertilization dose, although it increases production, reduces the effect of crop rotation with relative values from 63.8% (in the $N_{32}P_{32}$ variant) to 34.8% ($N_{128}P_{128}$), then increasing to 61.5% in the case of administering 50 t / ha of manure.

5. CONCLUSIONS

1. The influence of climatic conditions (temperature and precipitation) on the production of wheat and corn in years with drought in autumn or excessive amounts of precipitation in spring-summer, is manifested by large variations and limitations in the level of wheat and corn harvests.
2. Analyzing the results on the production of the two crops, from the last 8-10 years, it can be stated that the best productions are obtained with the $N_{100}P_{100}K_{40}$ variants, but even so, most productions have been in a continuous decrease due to climate changes, lack of rainfall during the vegetation period, as well as other factors.
3. The application of nitrogen, phosphorus and manure in the cultivation of wheat after maize (2-year rotation) bring yield increases of 1000-1200 kg/ha.
4. NP fertilization is the alternative that can ensure, over time, an efficient (technical and economic) management of wheat and corn crops.
5. Regarding the evolution of soil fertility under the impact of fertilization, it is useful to focus on the "sustainability" of the conditions - that is, high productions with the mention of the balance of the soil-plant system and the favorable evolution of the productive fertility of soils.

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