THE TROPHIC CONDITIONS FOR AGRICULTURAL CROPS, FROM THE BORȘULUI PLAIN

Octavian BERCHEZ, Cristian BUTCA, Maria BRONȚ, Ioana STANCIU, Raul Dacian VIDICAN

University of Oradea, Faculty of Environmental Protection, Gen.Magheru st., no.26, 410048, Oradea, Romania

Corresponding author email: berchez_octavian@yahoo.com

Abstract

Knowing and monitoring the vegetation conditions of agricultural crops in the Borșului Plain (climate regime, soil types, soil fertility potential) offers the possibility of specialist intervention in remedying or limiting the limiting or restrictive factor of agricultural production (low content in nutritional elements, acidity current soil condition, excess phreatic moisture, low and unevenly distributed precipitation during the vegetation period).

Key words: *trophic conditions, climatic regime, soil types, fertility, limiting factors*

INTRODUCTION

The Borșului Plain occupies a total area of 15,516 ha, it is a subdivision of the Crișurilor Plain, it stretches from the south of Crișul Mic to Crișul Repede and extends through the Crișului Repede meadow to Oradea (**Figure 1**). It presents as its western limit the western border of the country (the Romanian-Hungarian border), in the north it borders the Parhidei Plain, in the east the Bihariei Plain, the Bihariei Plain, the Oradiei Hills and the Oradea-Borod Corridor and in the south the Salontei Plain, the Veljurilor Plain and Miersig Plain. The Borșului Plain is located in the area of Borș (Santău Mare, Santău Mic, Sântion), Girișul de Criș (Tărian, Girișul de Criș), Săntandrei (Palota, Săntandrei), Toboliu (Cheresig, Toboliu) and the western part of the city of Oradia (**Figure 2**). The altitude is 98 - 110m on the line Crișul Mic - Crișul Repede and on the diagonal of Bihor Bishopric - Santăul Mic the altitude is 110m, having the character of an intermediate plain. In the valley of Crișului Mic, on the right of Crișului Repede and along the border, the plain has the character of a meadow.

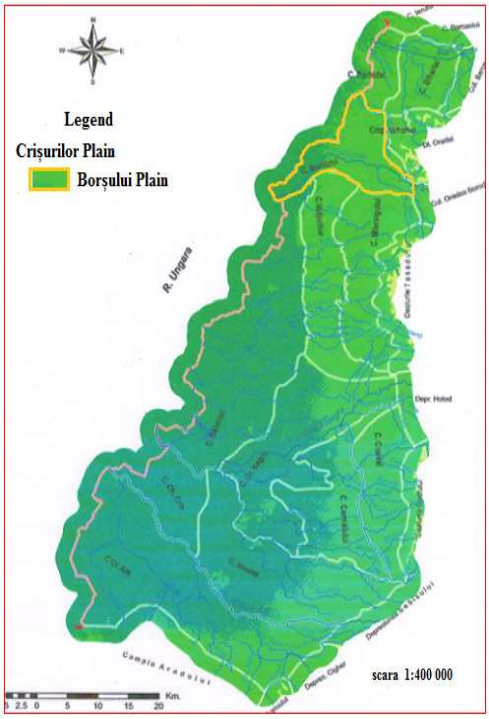

Figure 1. Borșului Plain, subunit of the Crișurilor Plain (Source: processing after G. Posea)

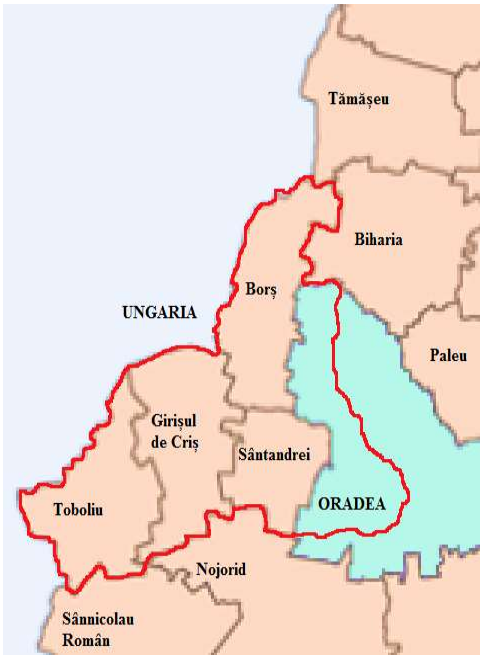

Figure 2. Borșului Plain. Administrative-territorial map

MATERIAL AND METHODS

Climatic parameters

The study of climatic parameters: air temperature, soil temperature, precipitation and air current movements was carried out over a period of 4 years - 2019, 2020, 2021, 2022, based on the data provided by ANM Bucharest, for the Oradea Meteorological Station.

1. Air temperature

Being the result of the interaction between solar radiation, atmospheric circulation and the earth's surface, air temperature shows variations depending on altitude, local and general circulation of the atmosphere, microrelief, vegetation, slope, exposure, hydrography. **Table 1** shows the average temperature for the period 01.01.2019 – 31.12.2022.

Table 1. Average temperature for the period 01.01.2019 – 31.12.2022.

Medium temperature 01.01.2019 – 31.12.2022	Minimum value	Maximum value
+12,2 °C	-13,9 °C , 12.01.2022	+38,7°C , 23.07.2022

Table 2 shows the average annual temperature values for the period 01.01.2019 – 31.12.2022.

Table 2. Average annual temperatures for the period 01.01.2019 – 31.12.2022.

Year	Medium temperature	Minimum value	Maximum value
	annually		
2019	+12,9	-12,1 – 08.01.2019	+36,1 – 12.08.2019
2020	+11,9	-8,8 08.01.2020	+34,9 – 30.08.2020
2021	+11,6	-13,3 – 16.01.2021	+37,1 – 16.08.2021
2022	+12,3	-13,9 – 12.01.2022	+38,7 – 23.07. 2022

Figure 3 shows the average annual temperatures for the period 01.01.2019 – 31.12.2022.

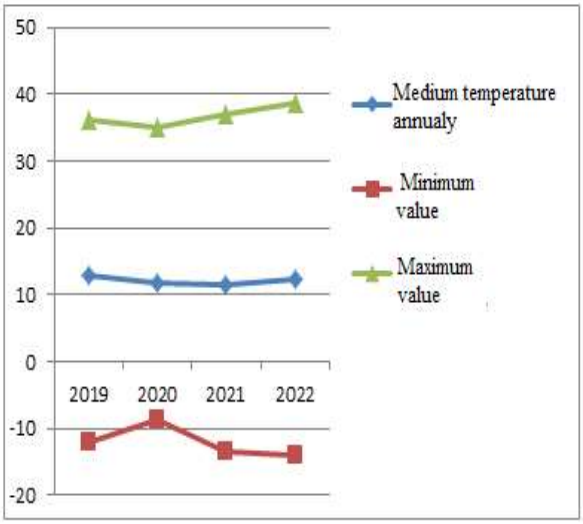

Figure 3. Graphic representation of average annual temperatures for the period 01.01.2019 – 31.12.2022

2. Soil temperature

The average annual temperature recorded at the ground surface has an average value of 11.64°C for the period 2019 - 2022

Average monthly temperatures recorded at the soil surface are presented in **Table 3**

Table 3. Average monthly temperatures recorded at the soil surface (°C) for the period 2019 - 2022 (data provided by ANM).

Month	Average monthly temperature - °C
I	-1,1
II	0,4
III	5,5
IV	11,9
V	19,2
VI	23,0
VII	24,6
VIII	23,5
IX	17,2

X	10,8
XI	4,4
XII	0,3

Figure 4 shows the average monthly temperature values recorded on the soil surface (°C), for the period 2019 - 2022.

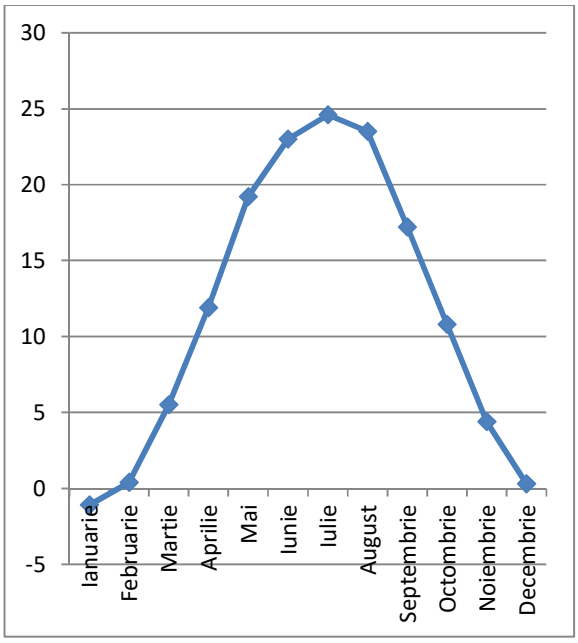

Figure 4. Graphic representation of the average monthly temperature values recorded at the soil surface (°C), for the period 2019 – 2022

3. Precipitation

The values of the rainfall regime for the 2019-2022 research period were provided by the Oradea Meteorological Station.

Table 4 shows the total amount of precipitation recorded in the period 01.01.2019 – 31.12.2022.

Table 4. The total amount of precipitation recorded in the period 01.01.2019 – 31.12.2022.

Period	Precipitation - mm	Share of days with precipitation
01.01.2019 – 31.12.2022	3198 mm	596

In Table 5, the rainfall recorded annually, for the period 01.01.2019 – 31.12.2022 is presented.

Table 5. Annual precipitation for the period 01.01.2019 – 31.12.2022.

Period	Precipitation - mm	Share of days with precipitation
01.01.2019-31.12.2019	835 mm	158
01.01.2020 – 31.12.2020	945 mm	138
01.01.2021 – 31.12.2021	667 mm	150
01.01.2022 – 31.12.2022	752 mm	150

Figure 5 shows the annual rainfall for the period 01.01.2019 – 31.12.2022.

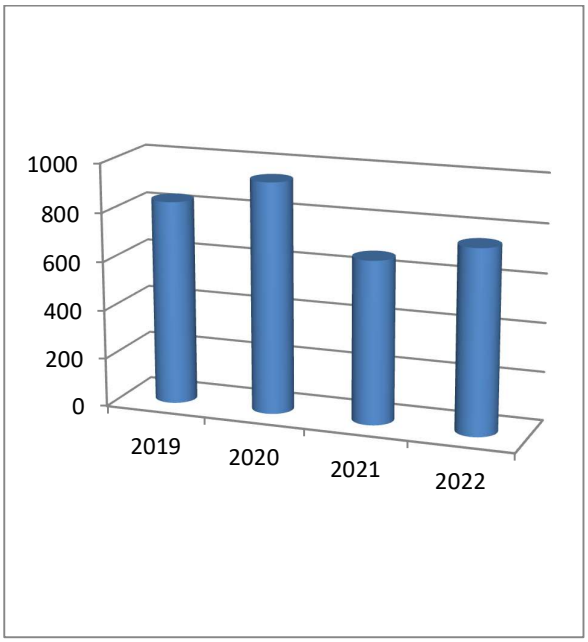

Figure 5. Graphic representation of annual precipitation for the period 01.01.2019 – 31.12.2022.

Table 6 shows the monthly rainfall recorded in the period 01.01.2019 – 31.12.2022.

Table 6. Monthly precipitation recorded in the period 01.01.2019 – 31.12.2022.

Month	Monthly precipitation	Share of days with precipitation
I	227 mm	68
II	200 mm	48
III	135 mm	33
IV	238 mm	49
V	446 mm	68
VI	410 mm	45
VII	361 mm	39
VIII	139 mm	40
IX	326 mm	44
X	131 mm	33
XI	281 mm	55
XII	305 mm	74

Figure 6 graphically represents the monthly rainfall recorded in the period 01.01.2019 – 31.12.2022.

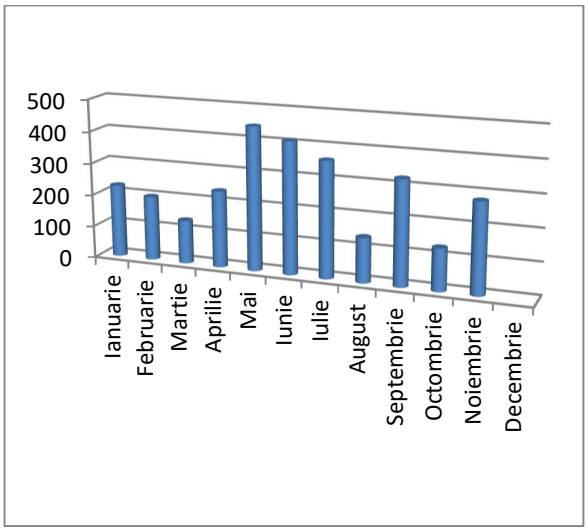

Figure 6. Graphical representation of the monthly rainfall recorded in the period 01.01.2019 – 31.12.2022

4. Relative air humidity

The values of the relative humidity of the air were processed based on the data provided by ANM - Oradea Meteorological Station.

Table 7 shows the relative air humidity expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

Table 7. Relative air humidity expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

Month	Medium value - %
I	86
II	87
III	75
IV	59
V	62
VI	70
VII	66
VIII	62
IX	61
X	67
XI	74
XII	86

Figure 7 shows the relative air humidity expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

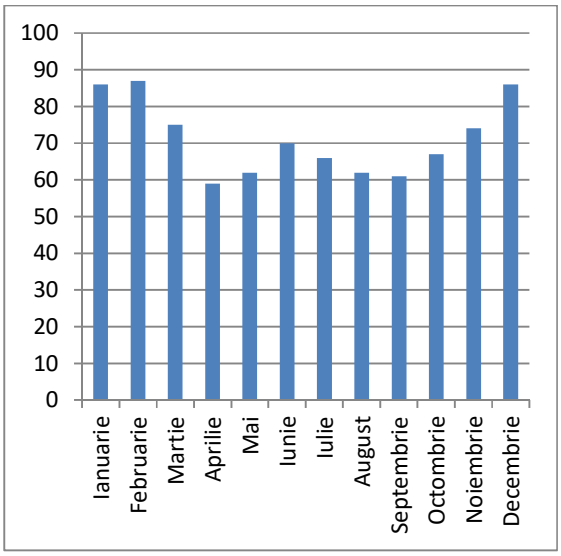

Figure 7. Graphic representation of the relative humidity of the air expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

Table 8 shows the monthly relative air humidity expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

Table 8. Monthly relative air humidity expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

Month	Medium value - %			
	2019	2020	2021	2022
I	87	90	85	83
II	76	74	81	74
III	60	65	64	51
IV	62	50	69	68
V	70	66	72	63
VI	66	77	60	55
VII	62	72	61	50
VIII	61	63	62	59
IX	62	64	64	78
X	74	82	66	80
XI	86	90	84	89
XII	86	85	88	87

Figure 8 shows the graph of the monthly relative air humidity expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

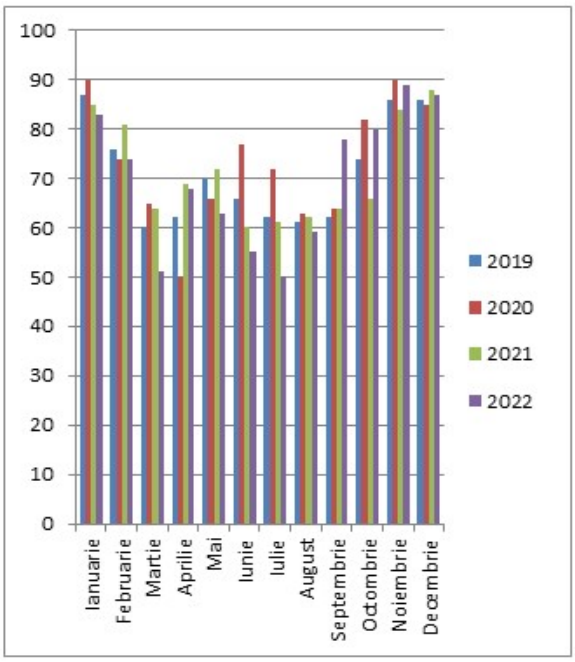

Figure 8. Graph of the monthly relative air humidity expressed in %, at 2 m above the ground, for the period 01.01.2019 – 31.12.2022.

5. Air currents

For the entire research period, the currents with the highest frequency were in the East and South direction, presenting values of 19.6% in the East direction, respectively 13.5% in the South direction.

Table 9 shows the cardinal direction of air currents and frequency, for the entire study period 01.01.2019 – 31.12.2022.

Table 9. Cardinal direction of air currents and frequency, for the entire study period 01.01.2019 – 31.12.2022.

Period	N	NNE	NE	ENE
01.01.2019 - 31.12.2022	9.5 %	6.8 %	3.3 %	3.3 %
	E	ESE	SE	SSE
	19.6 %	6.8 %	3.5 %	4.0 %
	S	SSV	SV	VSV
	13.5 %	6.6 %	4.4 %	3.2 %
	V	VNV	NV	NNV
	4.3 %	2.7 %	3.5 %	4.9 %

Figure 9 graphically shows the cardinal direction of air currents and frequency, during the period 01.01.2022 – 31.12.2022.

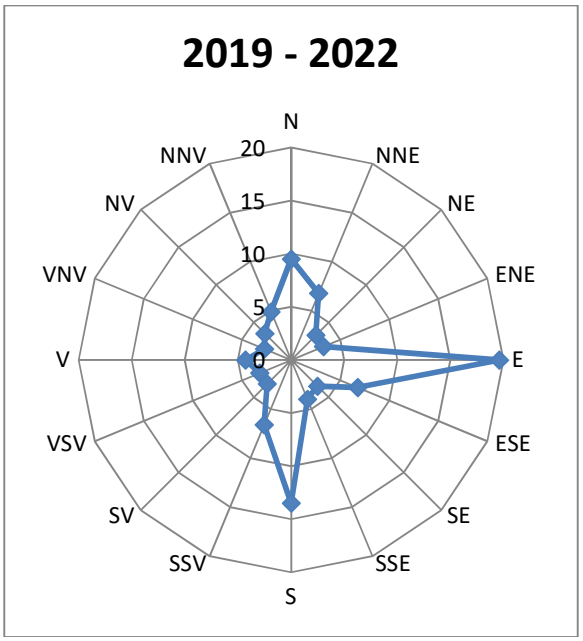

Figure 9. Cardinal direction of air currents and frequency, in the period 01.01.2022 – 31.12.2022.

Soils of the Borșului Plain

Following field research and subsequent correlation with laboratory results, 7 types of soil were identified, researched and mapped according to SRTS 2012+ and 6 types of soil according to WRB - SR-1998. The soils are presented in the taxonomic systems: WRB – SR-1998 and SRTS 2012+. Also, the Map of the soil units of the Borșului Plain was drawn up.

Table 10 shows the soil cover of the Borșului Plain (by territorial administrative units), classes, soil types and surfaces. (according to SRTS).

Table 10 The soil cover of the Borșului Plain (by territorial administrative units), by soil classes and types (according to SRTS 2012+).

Soil type	Area	Ha
Fluvisols (Aluviosol SRTS)	Santăul Mare, Sântion, Sântandrei, Oradea, Tărian, Girișul de Criș, Cheresig	7229
Phaeozems (Faeoziom SRTS)	Santăul Mic, Sântion, Girișul de Criș, Palota, Tărian, Sântadrei, Cheresig	4463,9
Eutric Cambisols (Eutricamboso l SRTS)	Sântandrei, Palota	605,2
Haplic Luvisols	Oradea, Sântandrei	216,3

(Preluvosol SRTS)		
Haplic Luvisols (Luvosol SRTS)	Oradea, Sântandrei	129,2
Gleysols (Gleiosol SRTS)	.Cheresig, Toboliu, Girișu de Criș, Tărian, Sântandrei, Santău Mare, Santău Mic	2776,6
Solonetz (Soloneț SRTS)	Palota	1,3

The Borşului Plain occupies a total area of 15516 ha, in the localities of Borș (Santău Mare, Santău Mic, Sântion), Sântandrei (Palota, Sântandrei), Girișu de Criș (Tărian, Girișul de Criș), Toboliu (Cheresig, Toboliu), and the part west of Oradea. Large areas are occupied by alluviosols: 7229 ha, phaeosols 4463.9 ha, gleiosols 2776.6 ha, eutricambosols 605.2 ha, preluvosols 216.3 ha, luvosols 129.2 ha, solonets 1.3 ha, About 223.3 ha are occupied by valleys, channels, waters.

Following the processing of the information obtained in the field by performing the main, secondary and control profiles and the correlation with the laboratory analyses, the Soil Map of the Borșului Plain was drawn up.

Figure 10 shows the soil map of Borșului Plain

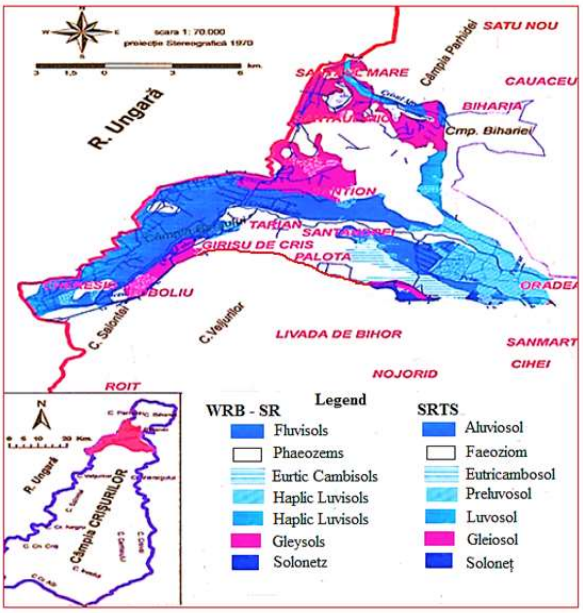

Figure 10. Soil map of Borșului Plain

RESULTS AND DISCUSSION

In the Borșului Plain, agricultural production is influenced annually by a series of restrictive or limiting factors. By knowing the limiting factors of agricultural production and monitoring them, the causes that generate them and that determine production decreases can be established, thus being able to intervene to remedy or remove the restrictive factor.

The main limiting factors of agricultural production are represented by: the low content in nutritional elements, the current acidity of the soils, the excess of phreatic moisture, the climatic regime.

Soils with a low content of nutrients

1. Soils with low and medium total N supply

The chemical analyzes carried out on the soils of the Borșului Plain highlighted values of the supply in total nitrogen, expressed in %, between 0.07% and 0.190%, values corresponding to a supply from low to medium supply. The average N supply shows the soil type Phaeozems (Faeoziom – SRTS) with values between 0.160% and 0.190% total N.

The low and middle values of total N supply (%) correspond to the soil types: Fluvisols (Aluviosol SRTS), Haplic Luvisols (Preluvosol, Luvosol – SRTS), Cambisols (Eutricambosol – SRTS), Gleysols (Gleiosol – SRTS), Solonetz (Soloneț -SRTS). These soils have values between 0.07% total N and 0.115%.

2. Poor and medium soils supplied in P

Following the analysis of the phosphorus content of the soils of Câmpia Borșului, values between 5 and 54 ppm phosphorus content were obtained, values that correspond to a state of supply from very poor to a good supply.

A good P supply (between 36.1 – 72.0 ppm) shows the type of soil: Phaeozems (Faeoziom – SRTS). Poor and very poor P supply is presented by the soil types: Fluvisols (Aluviosol SRTS), Haplic Luvisols (Preluvosol, Luvosol - SRTS), Cambisols (Eutricambosol - SRTS), Gleysols (Gleiosol - SRTS), Solonetz (Soloneț -SRTS), with values between 6 and 36 ppm.

3. Low and medium K-supplied soils.

In order to assess the state of potassium supply of the soils of the Plain, analyzes were carried out regarding the potassium content of the soils. Values ranging from 33 to 200 ppm were obtained. Good supply in K shows the type of soil: Phaeozems (Faeoziom - SRTS), presenting ae supply values between 132 and 200 ppm (138

– 200 ppm). The soil types have a weak and average K supply: Fluvisols (Aluviosol SRTS), Haplic Luvisols (Preluvosol, Luvosol - SRTS), Cambisols (Eutricambosol - SRTS), Gleysols (Gleiosol - SRTS), Solonetz (Soloneț -SRTS), with values between 33 – 120 ppm.

The **Table 11** shows the soils of the Borșului Plain that have a low and medium supply of nutrients (N, P, K). The total area occupied by soils poorly supplied with nutrients is 10,597.6 Ha, representing 70.62% of the total area (15,516 Ha).

Table 11 Soils from the Borșului Plain showing a low and medium supply of nutrients (N, P, K)

Soil type	Area	Ha
Fluvisols (Aluviosol SRTS)	Santăul Mare, Sântion, Sântandrei, Oradea, Tărian, Girișul de Criș, Cheresig	7229
Eutric Cambisols (Eutricambosol SRTS)	Sântandrei, Palota	605,2
Haplic Luvisols (Preluvosol SRTS)	Oradea, Sântandrei	216,3
Haplic Luvisols (Luvosol SRTS)	Oradea, Sântandrei	129,2
Gleysols (Gleiosol SRTS)	Cheresig, Toboliu, Girișu de Criș, Tărian, Sântandrei, Santău Mare, Santău Mic	2776,6
Solonetz (Soloneț SRTS)	Palota	1,3

2. Current acidity (pH value)

Current acidity or pH is another limiting factor of agricultural production in the Borșului Plain. Out of the total of 15516 ha, about 3727.6 Ha has moderate and strong acidity (values lower than 6.2 pH units), representing 24% of the total area of the plain.

Strong and moderate acidity presents the surfaces occupied by the soil types: Haplic Luvisols (Preluvosol, Luvosol – SRTS), Cambisols (Eutricambosol – SRTS), Gleysols (Gleiosol – SRTS).

These soils occupy large areas in the localities: Sântandrei, Palota, Oradea, Toboliu, Girisu de Criș, Tărian, Santău Mare, Santău Mic. About 1.3 Ha are occupied by the Solonetz soil type (Soloneț - SRTS), the pH value being 7.9 at the level of the plowed horizon (0 - 30 cm depth).

The **Table 12** shows the types of soils that have moderate and strong acidity.

Table 12. Types and surfaces of soils with moderate and strong acidity.

Soil type	Area	Ha
Eutric Cambisols (Eutricambosol SRTS)	Sântandrei, Palota	605,2
Haplic Luvisols (Preluvosol SRTS)	Oradea, Sântandrei	216,3
Haplic Luvisols (Luvosol SRTS)	Oradea, Sântandrei	129,2
Gleysols (Gleiosol SRTS)	Cheresig, Toboliu, Girișu de Criș, Tărian, Sântandrei, Santău Mare, Santău Mic	2776,6

The Map of soils with ph < 6.2 is presented in the **Figure 11**

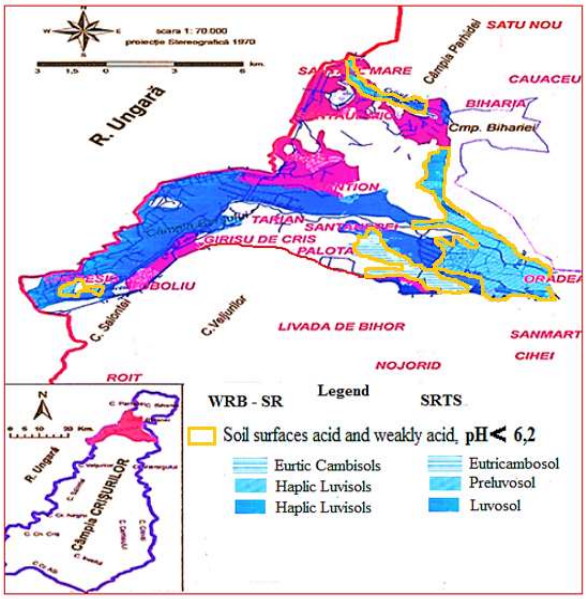

Figure 11. Map of soils with ph < 6.2

3. Excess phreatic moisture

It constitutes a limiting factor for agricultural production, on the low relief units of the Low Meadow of Crișului, where the groundwater is found at depths of 1-2 m. In the Borsului Plain, an area of 2776.6 Ha is affected by the fluctuations of the groundwater level, being represented by the soil type Gleysols (Gleiosol – SRTS). The surface of soils affected by excess

phreatic moisture represents 17.9% of the surface of the Borșului Plain. The **Table 13** shows the area and the surface occupied by the soil type Gleysols (Gleiosol – SRTS).

Table 13. Area and surface area occupied by the soil type Gleysols (Gleiosol – SRTS).

Soil type	Area	Ha
Gleysols (Gleiosol SRTS)	Cheresig, Toboliu, Girișu de Criș, Tărian, Sântandrei, Santău Mare, Santău Mic	2776,6

Based on the observations and the mapping work carried out in the field, the Map of soils with excess phreatic moisture was drawn up.

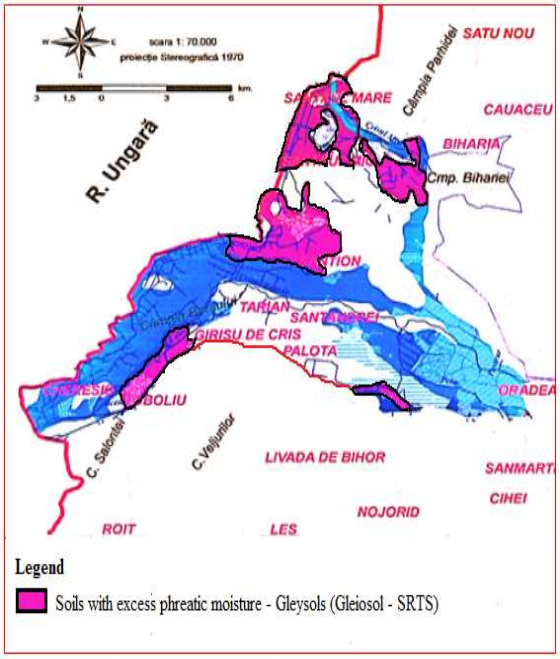

Figure 12. Map of soils with excess water table moisture.

4. Climatic regime

The climate regime influences the processes of growth, development and fruiting of plants through the main climatic indicators: temperature, precipitation, cardinal direction of air currents and frequency.

Temperature

Temperature is one of the limiting factors of agricultural production in Borșului Plain. The analysis of the temperature regime was carried out based on the data provided by ANM - Oradea Meteorological Station.

For the research period 2019 – 2022, the average annual temperature had values between 11.6°C and 13°C. The maximum values (13°C) were recorded in 2019 and the minimum values in 2021 (13°C).

Table 14 shows the average annual temperatures recorded during the research period, 2019 – 2022.

Table 14. Average annual temperatures recorded during the research period, 2019 – 2022.

Period	Average value °C
01.01.2019 - 31.12.2019,	+13.0
01.01.2020 - 31.12.2020,	+11.9
01.01.2021 - 31.12.2021,	+11.6
01.01.2022 - 31.12.2022,	+12.4

Figure 13 shows the graph of average annual temperatures recorded during the research period, 2019 – 2022.

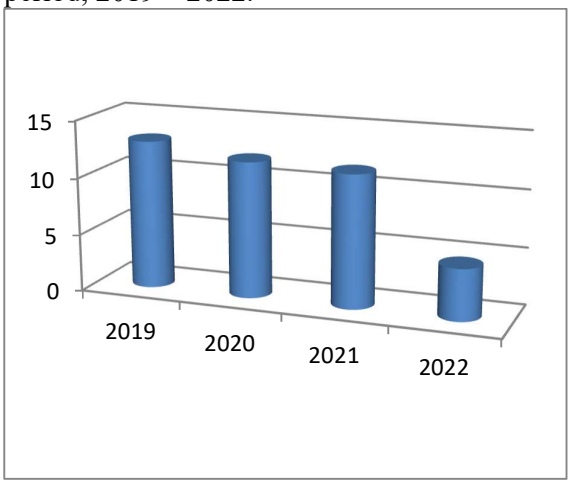

Figure 13. Graph of average annual temperatures recorded during the research period, 2019 – 2022

Average temperatures during the bioactive period April-September (04.01 – 09.30)

for the entire research period they had values between 18.2°C in the year 2020 and 19.1°C in the years 2019 and 2022.

The average temperatures recorded during the bioactive period April-September (01.04. – 30.09), for the study years 2019, 2020, 2021, 2022 are presented in **Table 15.**

Table 15. Average temperatures recorded during the bioactive period April-September (01.04. – 30.09), for the study years 2019, 2020, 2021, 2022.

Perioadă	Average value °C
01.04.2019 - 30.09.2019,	+19.1
01.04.2020 - 30.09.2020,	+18.2
01.04.2021 - 30.09.2021,	+18.3
01.04.2022 - 30.09.2022,	+19.1

Figure 14 shows the graph with the average temperatures recorded during the bioactive

period April-September (01.04. – 30.09), for the study years 2019, 2020, 2021, 2022.

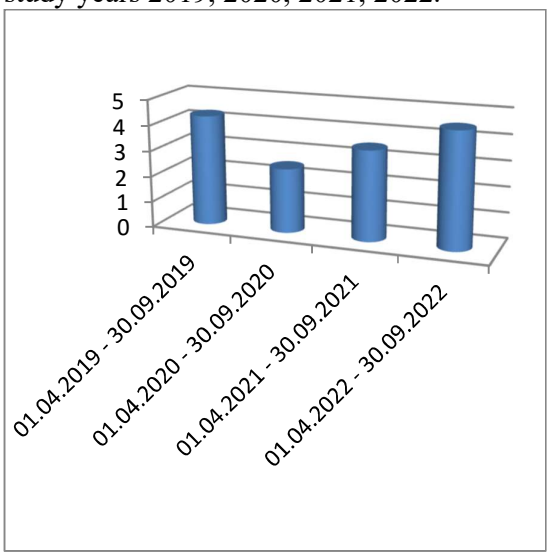

Figure 14. Graph of average temperatures recorded during the bioactive period April-September (01.04. – 30.09), for the study years 2019, 2020, 2021, 2022

For the period of maximum drought, June – August, the highest average was recorded in 2021 – 22.9℃ and the lowest in 2020 – 21.5℃.

The average temperatures recorded in the summer period June – August (01.06.2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022 are presented in **Table 16**.

Table 16. Average temperatures recorded in the summer period June – August (01.06.2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022.

Period	Average value ℃
01.06.2019 - 31.08.2019,	+22.7
01.06.2020 - 31.08.2020,	+21.5
01.06.2021 - 31.08.2021,	+22.9
01.06.2022 - 31.08.2022,	+23.7

Figure 15 shows the graph of average temperatures recorded in the summer period June – August (01.06.2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022.

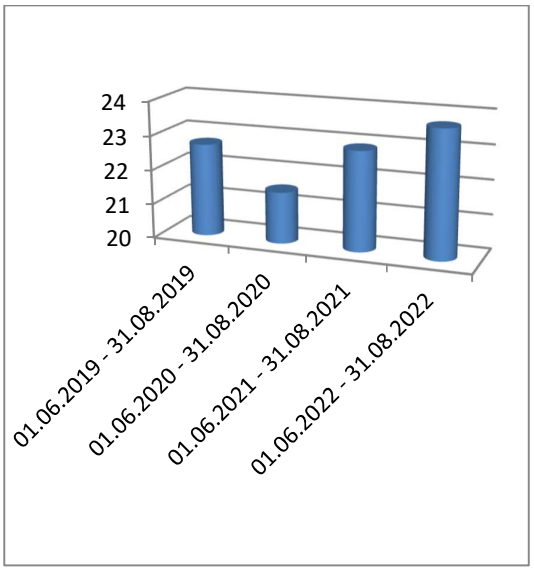

Figure 15. Graph of average temperatures recorded in the summer period June – August (01.06.2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022

For the entire bioactive period March – October, 2019 – 2022, the average values of monthly temperatures were between 5.0℃ and 24.2℃. The minimum values of the monthly average were recorded in March 2021 and the maximum values in August 2022.

Average monthly temperatures from the bioactive period March - October, by research years, are presented in **Table 17**.

Table 17. Average monthly temperatures from the bioactive period March – October, 2019, 2020, 2021, 2022.

Month	Average monthly temperature - ℃			
	2019	2020	2021	2022
III	+8,7	+7,2	+5,0	+5,3
IV	+13,4	+11,2	+8,8	+9,7
V	+14,8	+14,4	+14,6	+17,2
VI	+22,7	+20,0	+22,0	+22,9
VII	+21,5	+21,3	+24,9	+24,0
VIII	+24,0	+23,3	+21,8	+24,2
IX	+18,1	+19,1	+17,3	+16,1
X	+13,7	+12,9	+11,0	+12,9

Figure 16 shows the graph with the average monthly temperatures from the bioactive period March - October, 2019, 2020, 2021, 2022.

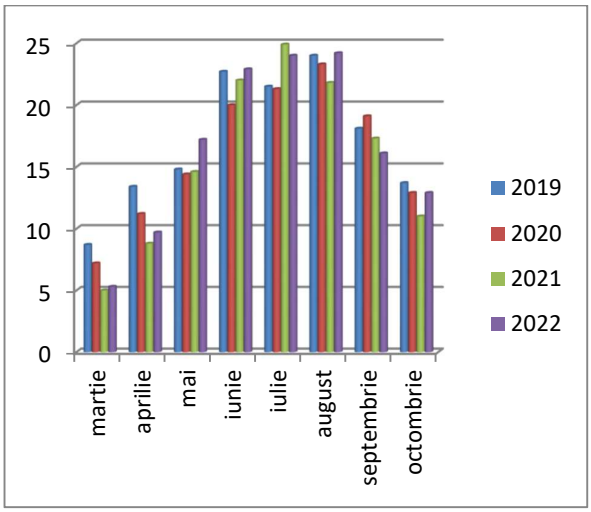

Figure 16. Graph of average monthly temperatures from the bioactive period March – October, 2019, 2020, 2021, 2022.

For the period of maximum drought, June – August, the monthly temperature averages showed minimum values of 20°C in June – 2020 and maximum values in August – 2022.

Table 18 shows the average monthly temperatures recorded during the maximum drought period, by years: 2019, 2020, 2021, 2022.

Table 18. Average monthly temperatures recorded during the maximum drought period, by years: 2019, 2020, 2021, 2022.

Month	Average monthly temperature - °C			
	2019	2020	2021	2022
VI	+22,7	+20,0	+22,0	+22,9
VII	+21,5	+21,3	+24,9	+24,0
VIII	+24,0	+23,3	+21,8	+24,2

The graph of average monthly temperatures recorded during the maximum drought period, by years: 2019, 2020, 2021, 2022 is presented in **Figure 17**.

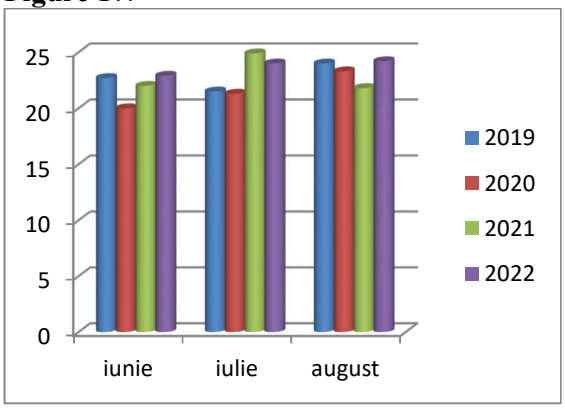

Figure 17. Graph of average monthly temperatures recorded during the maximum drought period, by years: 2019, 2020, 2021, 2022.

Precipitation regime

Precipitation directly influences the development and production of agricultural crops, through the annual amount of precipitation, the amount of precipitation during the bioactive period April - October, the amount of precipitation during the summer (maximum drought period) June - August and the distribution over time.

Precipitation values were processed based on data taken from ANM - Oradea Meteorological Station.

For the research period 2019 – 2022, the highest amount of recorded precipitation was 945 mm in 2020 and the lowest was 667 in 2021.

The annual precipitation recorded in the period 2019 – 2022 is presented in **Table 19**.

Table 19. Annual precipitation recorded in the period 2019 – 2022.

Period	Precipitation mm	The proportion of days with precipitation
01.01.2019 - 31.12.2019	835	158
01.01.2020 - 31.12.2020	945	138
01.01.2021 - 31.12.2021	667	150
01.01.2022 - 31.12.2022	752	150

The annual precipitation recorded in the period 2019 – 2022 is presented graphically in **Figure 18**.

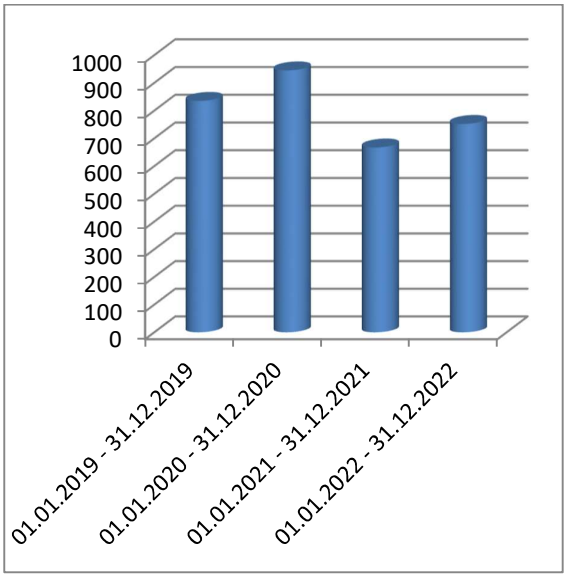

Figure 18. Graph of annual precipitation recorded in the period 2019 – 2022

For the bioactive period March - September ((01.04. - 30.09), for the study years 2019, 2020, 2021, 2022, the amount of recorded precipitation showed minimum values in the year 2921 and maximum values in the year 2020.

Table 20 shows the amount of precipitation from the bioactive period March - September ((01.04. - 30.09), for the study years 2019, 2020, 2021, 2022

Table 20. The amount of precipitation from the bioactive period March – September ((01.04. – 30.09), for the study years 2019, 2020, 2021, 2022.

Period	Precipitation mm	The proportion of days with precipitation
01.04.2019 - 30.09.2019	567	77
1.04.2020 - 30.09.2020	583	63
01.04.2021 - 30.09.2021	270	64
01.04.2022 - 30.09.2022	499	81

The amount of precipitation from the bioactive period March – September ((01.04. – 30.09), for the study years 2019, 2020, 2021, 2022 are shown graphically in **Figure 19**.

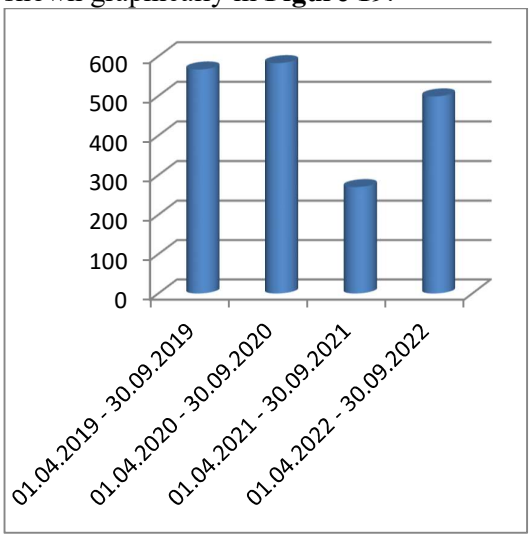

Figure 19. The amount of precipitation from the bioactive period March – September ((01.04. – 30.09), for the study years 2019, 2020, 2021, 2022

The amount of precipitation recorded during the period of maximum drought, June – August (01. 06. 2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022, showed minimum values in 2021 and maximum values in 2020.

Table 21 shows the amount of precipitation from the summer period, June – August (01.06.2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022

Table 21. Sum of precipitation in the summer period, June – August (01.06.2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022.

Period	Precipitation mm	The proportion of days with precipitation
01.06.2019 - 31.08.2019	247	32
01.06.2020 - 31.08.2020	401	38
1.06.2021 - 31.08.2021	90	24
01.06.2022 - 31.08.2022	172	30

In Figure 20, the amount of precipitation from the summer period, June – August (01. 06. 2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022 is graphically represented.

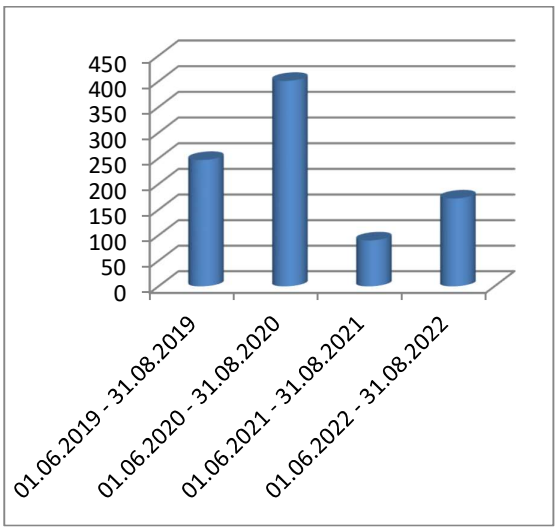

Figure 20. Sum of precipitation in the summer period, June – August (01.06.2019 – 31.08.2022) for the study years 2019, 2020, 2021, 2022

For the period March – October, the average monthly rainfall recorded showed the lowest values in October 2021 – 5.6 mm and October 2022 – 6 mm.

The highest values were recorded in May 2019 – 183 mm, June 2019 – 182 mm and June 2020 – 182 mm.

Table 22 shows the average monthly rainfall recorded by study years, 2019 – 2022.

Table 22. Average monthly rainfall recorded by study years, 2019 – 2022.

Month	Precipitation - mm			
	2019	2020	2021	2022
III	23	65	28	19
IV	81	26	51	79
V	183	110	117	36
VI	182	182	6,2	40
VII	38	172	47	104
VIII	25	47	37	29
IX	55	46	12	213
X	17	102	5,6	6

In **Figure 21**, the average monthly rainfall recorded by study years, 2019 - 2022 is graphically represented.

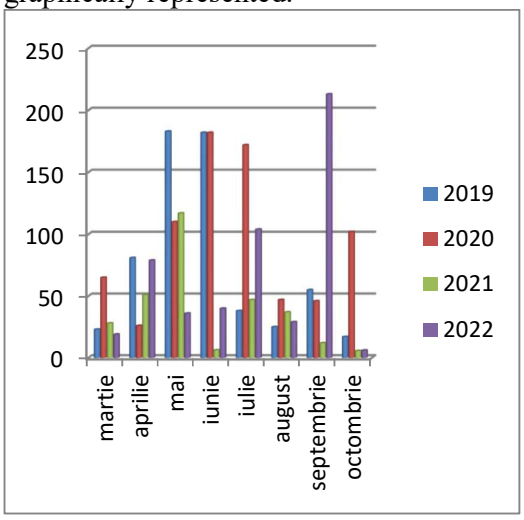

Figure 21 Graphic representation of the average monthly rainfall recorded by study years, 2019 – 2022.

CONCLUSIONS

he identification of soil taxonomic units was carried out at the level of class, type and subtype of soil. The current soil classification, known as the Romanian Soil Taxonomy System 2012+ (SRTS – 2012+), was used. At the same time, the soils were transposed into the international scientific systems, the World Reference Base for Soil Resources - World Reference Base for Soil Resource (WBR-SR-1998) and the current American soil classification system - USDA - Soil Taxonomy (USDA-ST -1999).

The Borşului Plain occupies a total area of 15516 ha, in the localities of Borş (Santău Mare, Santău Mic, Sântion), Sântandrei (Palota, Sântandrei), Girişu de Criș (Tărian, Girișul de Criș), Toboliu (Cheresig, Toboliu), and the part west of Oradea. Large areas are occupied by alluviosols: 7229 ha, phaeosols 4463.9 ha, gleiosols 2776.6 ha, eutricambosols 605.2 ha, preluvosols 216.3 ha, luvosols 129.2 ha, solonets 1.3 ha, About 223.3 ha are occupied by valleys, channels, waters.

In a systematic presentation, the pedogeographical studies and research carried out in the Borșului Plain constitute a real basis for solving some aspects that have been little studied or neglected until now, regarding:

- drawing up studies on the rationing of agricultural crops in the context of current climate changes.
- making maps and sketches regarding the main pedogenetic factors: climate, relief, rock, groundwater.
- making soil maps, in a unitary concept
- obtaining and making maps regarding: soil properties, technological indicators of the soil and maps regarding production capacity
- conservation and rational use of the entire land fund
- knowledge of soil surfaces affected by erosion and the establishment of anti-erosion measures in order to capitalize on these lands
- knowledge of the surfaces affected by pollution, application of depollution measures and restoration of the economic circuit of these soils
- improvement of soils affected by salinity; depending on the degree of alkalization or salinization
- the improvement of acidic soils follows the knowledge of the physico-chemical properties, the water regime, the nutritional regime and the surfaces occupied by these soils
- land leveling, by knowing the thickness of the humiferous horizon and the degree of development of the profile
- the organization of the territory
- the design of land improvement works
- the correct application of a differentiated agricultural technique in units with an agricultural profile
- credit rating and technological characterization of land surfaces.

REFERENCES

1. Berchez, O. (2015). Cheie pentru determinarea unităţilor taxonomice de sol la nivel superior: Sistemul Român de Taxonomie a Solurilor, corelarea cu Baza de Referinţă Mondială pentru Resursele de Sol (World

Reference Base for Soil Resource) şi Sistemul American (USDA – Soil Taxonomy). Oradea: Editura Universităţii din Oradea.
2. Berchez, O. (2019). Solurile României. Cambisolurile şi spodisolurile. Oradea: Editura Universităţii din Oradea.
3. Berchez, O. (2017). Solurile României. Cernisolurile. Oradea: Editura Universităţii din Oradea.
4. Berchez, O. (2017). Clasa Cernisoluri. Determinator de soluri. Oradea: Editura Universităţii din Oradea.
5. Berchez, O. (2018). ClasaLuvisoluri. Determinator de soluri. Oradea: Editura Universităţii din Oradea.
6. Berchez, O. (2018). Solurile României. Luvisolurile. Oradea: Editura Universităţii din Oradea.
7. Berchez, O. (2005). Pedologie ameliorativă. Ameliorarea solurilor prin utilizarea îngrăşămintelor chimice şi organice. Oradea: Universităţii din Oradea.
8. Blaga, Gh. (2004). Pedologie. Alcătuire, geneză şi proprietăţile solurilor. Cluj-Napoca: Editura Academic Press.
9. Borza I., (1997), Ameliorarea şi protecţia solurilor, Timişoara, Editura Mirton,
10. Editura Academiei Române, Chiriţă C. D., (1995), Pedologie generală, Bucureşti.Editura Agro. Silvică de Stat
11. Ciobanu Cornelia, (2007), Agricultură generală, Oradea. Editura Universităţii din Oradea,
12. Ciobanu Gh., (2003), Agrochimie, Oradea, Editura Universităţii din Oradea, Oradea.
13. Ciobanu Gh., (2007), Agrochimia îngrăşămintelor, Oradea, Editura Universităţii din Oradea, Oradea.
14. Ciobanu Gh., Domuţa C., (2003), Eroziunea solurilor din Bihor în contextul sistemului de agricultură durabilă, Editura universităţii din Oradea, Oradea.
15. Filipov F., (2005) , Pedologie,Iaşi, Editura Ioan Ionescu de la brad.
16. Florea N., (1964), Cercetarea solului pe teren, Bucureşti, Editura Ştiinţifică
17. Florea, N., Munteanu I., (2003), Sistemul Român de Taxonomie a Solurilor, Bucureşti. Editura Estfalia
18. Florea N., Munteanu, I. (2012). Sistemul Român de Taxonomie a Solurilor. Craiova: Editura Sitech.
19. Florea, N., Buza, M. (2003). Pedogeografie cu noţiuni de pedologie. Sibiu: Editura Lucian Blaga.
20. Guş P., Rusu T., Bogdan Ileana, (2004), Agrotehnica, Cluj Napoca. Editura Risoprint
21. Groza N., Petrescu E., Vatamanu V., (2006), Irigarea culturilor, Craiova.Editura Sitech,.
22. Ispas St., Murătoreanu G., Leotescu R., Ciulei S., (2006), Pedologie, cercetarea solului pe teren, Târgovişte, Editura Valahia University Press
23. Jelev I., (2000), Managementul mediului înconjurător, Oradea, Editura Universităţii din Oradea.
24. Josan N., Petrea Rodica, Petrea D., (1996), Geomorfologie generală, Oradea, Editura Universităţii din Oradea.
25. Josan N., (2002), Sisteme globale de mediu, Oradea, Editura Universităţii din Oradea
26. Josan N, Sabău N. C., Romocea T., Costea M., Cristea M., Borota D., Berchez O., Nistor S., Vlaicu M., Hazarde şi riscuri naturale şi antropice în bazinul Barcăului, (2004), Oradea, Editura Universităţii din Oradea
27. Arhiva Oficiului de Studii Pedologice și Agrochimice – Bihor.
28. Arhiva – ANM – Stația Meteorologică Oradea.