VEGETATION CONDITIONS OF AGRICULTURAL CROPS IN THE CRIŞULUI NEGRU PLAIN AND LIMITING FACTORS OF AGRICULTURAL PRODUCTION

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RESEARCH ARTICLE

Abstract

The main aim and objective of the research is the approach in a detailed interdisciplinary analysis of all the aspects related to the natural environment of the Câmpia Crişului Negru, the characterization in a unitary conception of the soil taxonomic units, the quantification of the existing trophic conditions, the identification and quantification and cataloging of the factors limiting and restrictive of agricultural production. The research was carried out over a period of 5 years (2019 – 2023). The following were studied and quantified: the time variation of climatic parameters (air temperature, precipitation, relative air humidity, air current movements) and soil trophic conditions (nutrient content, current acidity – pH value, excess moisture from precipitation, excess groundwater). Based on the research results, the limiting and restrictive production factors of agricultural production were established. In the preparation of the work, it was considered to synthesize the results of the research carried out in recent years, to collect in the field the elements related to the soil and natural conditions, so that the data obtained for the soil and the environment can allow the solution of practical problems related to the use and valorization of resources of soil and the most accurate choice of the assortment of crop plants, considering the impact of the climate changes recorded in recent years. The most precise definition of the soil and environmental elements allow the processing and further use of the data for economic-applicative purposes. The results of current research can be stored in data banks and integrated into the National Soil Quality Monitoring System, within the International Monitoring System of Environmental Quality.

Keywords: trophic conditions; climatic regime; soil types; fertility; limiting factors..
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INTRODUCTION

The research was carried out with the aim of establishing the soil units of the Crişului Negru Plain, knowing in detail the trophic conditions for agricultural crops in the Veljurilor Plain and quantifying the limiting and restrictive factors of agricultural production. The permanent changes in the elements of the climatic regime that have occurred in the recent period have significantly modified the trophic conditions, materialized by considerable decreases in agricultural production (National Meteorological Administration, 2023; Berchez et al. 2021). Quantifying the climatic parameters will allow for a better zoning and rotation of agricultural crops, as well as the choice of the assortment of agricultural crops with a high degree of adaptability (Combating Desertification in the EU,33/2018; Rusu Teodor et al, 2014). The Crişului Negru Plain is located in the NW part of Romania (Figure 1), being geographically a subdivision of the Crişurilor Plain. It occupies an area located in the central-southern part (**Figure 2**), having as its northern limit the Veljurilor Plain, to the west the Salontei Plain, to the southwest and south the Ineului Plain and to the east the Cermeiului Plain . The total area of the Crişului Negru Plain is 34823.3 ha, the area of the plain being located in the localities: Tulca, Tinca, Batăr, Ciumeghiu, Avram Iancu, Mişca, Apateu, Sintea Mare, Sepreuş.

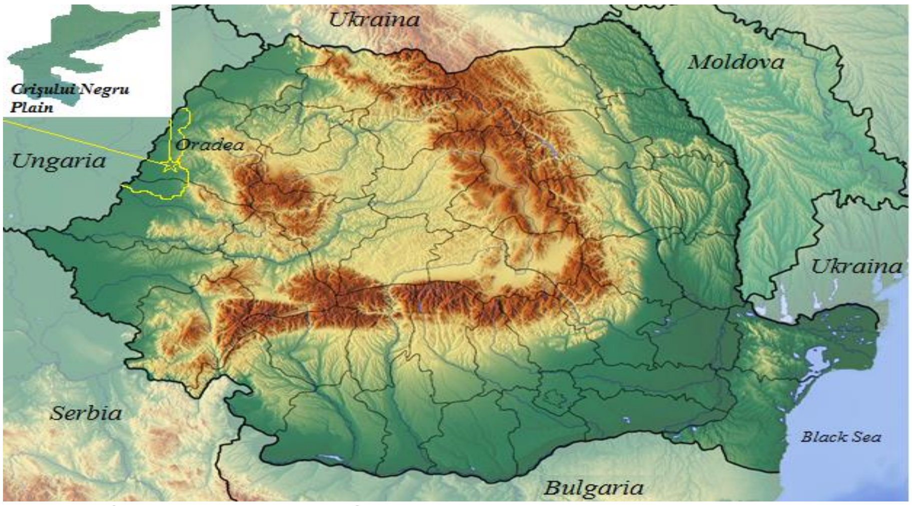

Figure 1**. Crişului Negru Plain. Geographical location**

The altitude of the plain is between 60 and 100m in the western part and between 100 – 150 m in the north-western part (**Figure 2**). The surface deposits are represented by deluvial deposits, deluvial-proluvial deposits and alluvial deposits (**Figure 3**). The parental materials on which the soil units were formed and evolved are represented by: loess, loessoid deposits, clays, clays, marls, alluvial deposits (Map of relief units in Romania, 1980; Posea Grigore, 2006). The groundwater is located at depths less than 3.5 m in the low areas of the plain, in the area of the localities: Tinca, Tulca, Ciumeghiu, Sepreuş, Mişca, influencing the processes of soil formation and evolution. In the northern and central part of the plain, groundwater located at critical depths has a low degree of mineralization, below 0.3 g/l of soluble salts. In the central-southern part of the plain, the water has a high degree of mineralization, above 3 g/l of soluble salts, of a chloride and sulfate nature, due to the presence in depth of a layer of calco-sodium mud, influencing the physico-chemical properties of the soils. In the rest of the territory, groundwater is located at depths greater than 3.5 m without influencing the physico-chemical and hydrological properties of the soils.

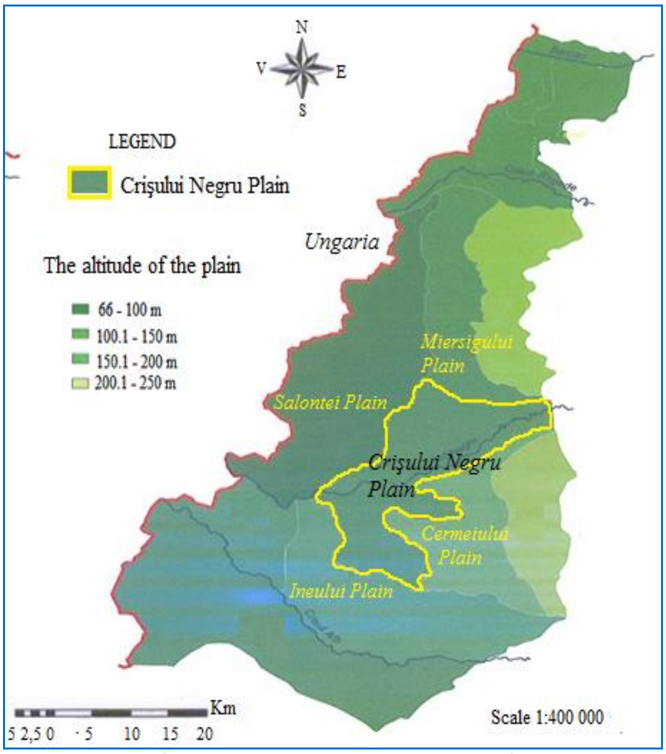

Figure 2. **Crişului Negru Plain, subunit of the Crişurilor Plain. Altitudes**. (Source: processing after G. Posea).

Figure 3 shows the map of surface deposits in the Crişului Negru Plain.

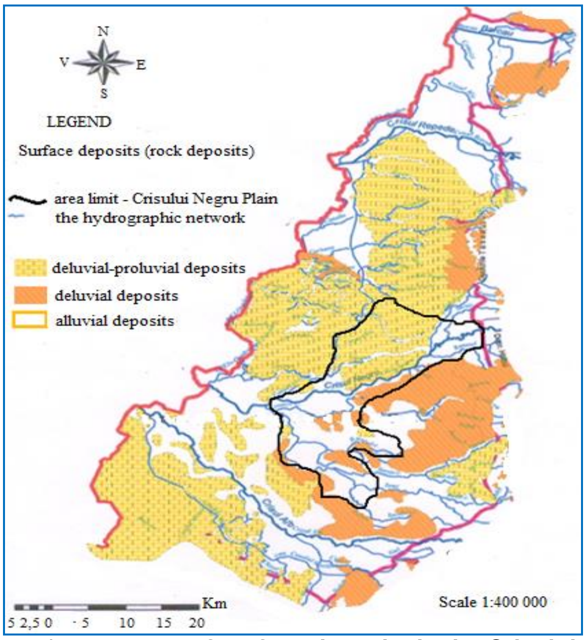

Figure 3. **Map of surface deposits in the Crişului Negru Plain** (Source: Geographical Atlas of Romania 1972-1978).

MATERIAL AND METHODS

The climatic parameters were studied and interpreted based on meteorological data provided by the National Meteorological Agency Bucharest, Holod Meteorological Station (Meteoromania, 2024). The following climatic parameters were taken into consideration: air temperature, soil temperature, precipitation, relative air humidity, direction and speed of air currents, presence and thickness of the snow cover during the cold period of the year (Rusu et al. 2014). The study was conducted for a period of 5 years: 2019 – 2023. The research, identification and spatial delimitation of the taxonomic units of soils belonging to the Crişului Negru Plain was carried out during the period 2019-2023, by researching a number of 80 main soil profiles, 160 secondary profiles and 240 control profiles, located in the field in accordance with the pedological norms of soil research. The identification of soil taxonomic units was carried out at the level of class, type and subtype of soil based on the Romanian Soil Taxonomy System 2012+ (SRTS - 1012+) (The Romanian Soil Taxonomy System, 2012), subsequently transposed into the World Soil Resources Reference Base (WRB-SR-1998) (World reference base for soil resources, 1998). To establish the fertility potential, a number of 240 soil samples were analyzed, taken at two depths: 0 - 15 cm, respectively 15 - 30 cm. The analyses of the chemical parameters of the soils were performed by spectrophotometry.The chemical parameters analyzed were: current acidity (pH), total nitrogen, mobile phosphorus, mobile potassium (Dumitru Mihai et al., 2011). The analyses of the soil samples taken were performed in the Pedology Laboratory of the Faculty of Environmental Protection, University of Oradea. The methods of analysis of agrochemical indicators, data processing and interpretation were performed according to the standards and methodology developed by the National Institute of Pedology, Agrochemistry and Environmental Protection - ICPA Bucharest (Dumitru et al, 2011).

RESULTS AND DISCUSSION

1.1. Climatic parameters of the Crişului Negru Plain

Climate, through its elements: precipitation, air temperature, soil temperature, relative air humidity and air current movements represent the basic factor in the development of agricultural crops in the Crişului Negru Plain (Alexandru Daniel, 2020; Rusu Teodor et al. 2019). The study area is included in the Cf climatic province, Cfbx subprovince, with the average of the warmest month between 20 and 22 degrees Celsius and with the maximum precipitation at the beginning of summer. The values of the De Martone aridity indices oscillate between 25 and 30 (Weidorf David et al., 2009). The climatic parameters were studied and interpreted based on the meteorological data provided by the National Agency for National Health and Natural Resources Bucharest, Holod Meteorological Station. The following climatic parameters were taken into consideration: air temperature, precipitation, relative air humidity, direction and speed of air currents, presence and thickness of the snow cover during the cold period of the year (Salagean Tudor, 2013). The study was carried out for a period of 5 years: 2019 – 2023.

1.1.1. Air temperature

The average annual temperature for the entire duration of the research was 12.°C. The minimum value recorded was −16.5°C (25.01.2022) and the maximum was +38.6°C. The highest value of the average annual temperature was recorded in 2019, being +12.5°C, and the lowest in 2021, being +11.3°C. Table 1 presents the average annual temperature values for the period 2019–2023.

Table 1.

Average annual temperatures for the period 2019 – 2023

Period	Medium temperature annually	The minimum value registered	Maximum value recorded
Multiannual mean temperature			
2019 - 2023	+12.0	-16.5 (25.01.2022)	+38.6 (23.07.2022)
Average annual temperature			
2019	+12.5	-13.8 (08.01.2019)	+35.7 (13.08.2019)
2020	+11.6	-11.0 (08.01.2020)	+33.5 (30.08.2020)
2021	+11.3	-14.3 (16.01.2021)	+37.2 (01.08.2021)
2022	+11.9	-16.5 (25.01.2022)	+38.6 (23.07.2022)
2023	+12.6	-11.5 (10.02.2023)	+36.9 (28.08.2023)

Monthly precipitation recorded during the period 2019 - 2023 had minimum values of 12 mm for March - 2022 and maximum values of 194 mm for September - 2022. **Table 2** presents the monthly precipitation recorded by months and years of research, for the period 2019 -2023.

Figure 4 presents the graph of recorded monthly precipitation for the research period 2019 – 2023.

Table 2.

Precipitation recorded during 2019 – 2023, by research year and month.

Period	2019	2020	2021	2022	2023
January	82	20	84	31	55
February	16	78	61	33	66
March	18	44	22	12	66
April	65	19	55	75	34
May	158	58	87	34	58
June	90	163	16	38	55
July	30	72	32	40	73
August	42	67	45	48	36
September	31	26	55	194	34
October	19	102	20	17	19
November	46	16	68	88	129
December	53	55	104	67	97

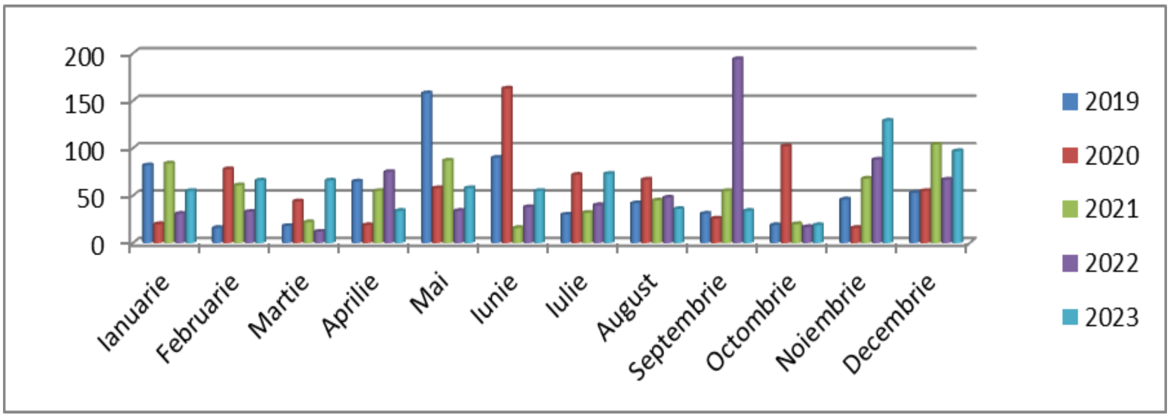

Figure 4 **Graph of recorded monthly precipitation for the research period 2019 – 2023**.

The research period 2019 – 2023 in terms of the presence of precipitation in the form of snowfall is characterized by small amounts.

Table 5 presents the average height of the snow layer for the study period 2019 –2023.

1.1.2. Relative air humidity

The relative air humidity expressed in %, at 2 m above the ground, for the period 2019 – 2023, showed an average of 74%. The lowest values were recorded in 2022 – 72% and the highest values in 2023 – 75%.

Tables 6 and Table 7 present the relative air humidity expressed in %, at 2 m above the ground, for the period 2019 –2023. Relative air humidity showed the lowest values in March 2022 - 53% and maximum values in January 2020 - 90%.

Figure 5 shows the graph of relative air humidity, by months and years of research.

Table 5

Average snow depth for the research period 2019 – 2023.

Period	Month	Average thickness	Maximum thickness - cm
2019	January	4.5 cm	15 cm, (13.01.2019)
2020	January	0.2 cm	2 cm, (05.01.2020)
2021	January	6.6 cm	15 cm, (14.01.2021)
	February	0.5 cm	1 cm, (11.02.2021), (12.02.2021), (13.02.2021)
	December	0.2 cm	1 cm, (21.12.2021), (27.12.2021) (28.12.2021)
2022	January	3.5 cm	9 (09.01.2022)
	February	0.2 cm	1 (02.02.2022), (03.02.2022)
	December	0.9 cm	1 (12.12.2022), (13.12.2022), (14.12.2022)
2023	January	1.5 cm	2 (31.01.2023)
	February	5.7 cm	12 cm, (04.02.2023)
	March	1.0 cm	1 cm, (28.03.2023)
	November	3.3 cm	7 cm, (27.11.2023)
	December	6.0 cm	6 cm, (23.12.2023)

Table 6.

Relative air humidity expressed in %, at 2 m above the ground, for the period 2019 – 2023

eriod	Average value - %	Minimum value - %
	Multiannual relative humidity	
2019 - 2023	74	13
	Annual relative humidity	
2019	73	18
2020	74	17
2021	73	20
2022	72	13
2023	72	22

Table 7.

Relative air humidity expressed in %, at 2 m above ground, for the period 2019 –2023, by months and years of research

Period	2019	2020	2021	2022	2023
January	88	90	85	83	87
February	71	74	81	75	81
March	58	66	64	53	70
April	62	52	70	69	74
May	82	68	71	67	74
June	76	78	63	61	73
July	70	75	64	54	68
August	68	70	65	67	68
September	67	68	73	81	69
October	72	82	72	83	69
November	78	89	84	89	82
December	83	82	88	87	85

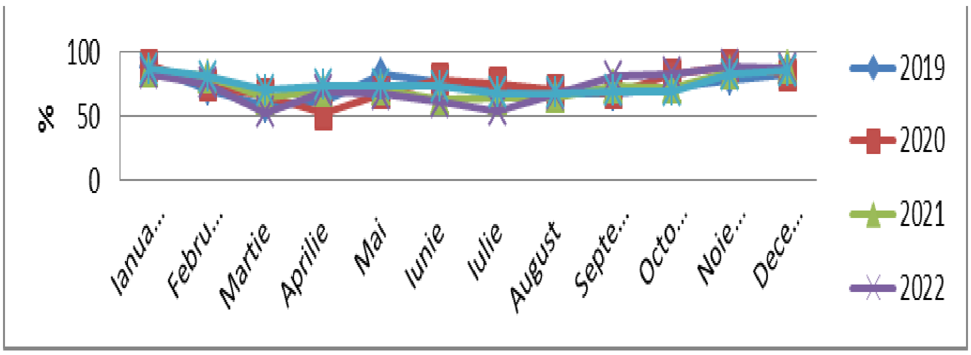

Figure 5 **Relative air humidity graph, for the period 2019 – 2023, by months and years of research.**

1.1.3. Air currents

In the Crişului Negru Plain area, the highest frequency of air currents was in the NE direction with values of 15.6%, ENE with 12.1% and N direction with 12.9%. **Table 8** and **Table 9** present the cardinal direction of the air currents and the frequency, for the research period 2019 –2023. The cardinal direction and frequency of air currents by research year is presented in **Figure 6**.

Table 8.

Cardinal direction of air currents and frequency, for the entire research period 2019 –2023.

2019 - 2023	N	NNE	NE	ENE	E	ESE	SE	SSE
	12.9 %	11.2 %	15.6 %	12.1 %	5.7 %	1.7 %	1.8 %	1.6 %
	S	SSW	SW	WSW	W	WNW	NW	NNW
	4.1 %	4.5 %	6.9 %	6.6 %	5.4 %	2.2 %	2.5 %	5.2 %

Table 9.

Cardinal direction of air currents and frequency, for the period 2019 –2023, by research year.

2019	N	NNE	NE	ENE	E	ESE	SE	SSE
	13.2 %	11.1 %	16.2 %	12.3 %	6.1 %	1.5 %	1.9 %	1.4 %
	S	SSW	SW	WSW	W	WNW	NW	NNW
	3.8 %	4.1 %	6.7 %	6.3 %	5.2 %	2.1 %	2.4 %	5.7 %
2020	N	NNE	NE	ENE	E	ESE	SE	SSE
	12.7 %	10.3 %	15.0 %	12.0 %	5.8 %	1.9 %	2.0 %	2.0 %
	S	SSW	SW	WSW	W	WNW	NW	NNW
	4.8 %	4.5 %	7.1 %	6.3 %	5.5 %	2.4 %	2.8 %	5.0 %
2021	N	NNE	NE	ENE	E	ESE	SE	SSE
	13.6 %	10.9 %	15.2 %	12.1 %	5.9 %	1.6 %	1.8 %	1.6 %
	S	SSW	SW	WSW	W	WNW	NW	NNW
	4.0 %	4.5 %	7.0 %	5.9 %	5.3 %	2.3 %	2.6 %	5.8 %
2022	N	NNE	NE	ENE	E	ESE	SE	SSE
	13.3 %	12.8 %	16.2 %	12.0 %	5.0 %	1.4 %	1.4 %	1.5 %
	S	SSW	SW	WSW	W	WNW	NW	NNW
	3.5 %	4.4 %	6.6 %	6.7 %	5.9 %	2.3 %	2.3 %	4.9 %
2023	N	NNE	NE	ENE	E	ESE	SE	SSE
	6.7 %	7.5 %	16.7 %	12.1 %	6.3 %	1.5 %	1.3 %	1.9 %
	S	SSW	SW	WSW	W	WNW	NW	NNW
	8.6 %	4.3 %	9.2 %	12.5 %	6.4 %	1.5 %	1.0 %	2.4 %

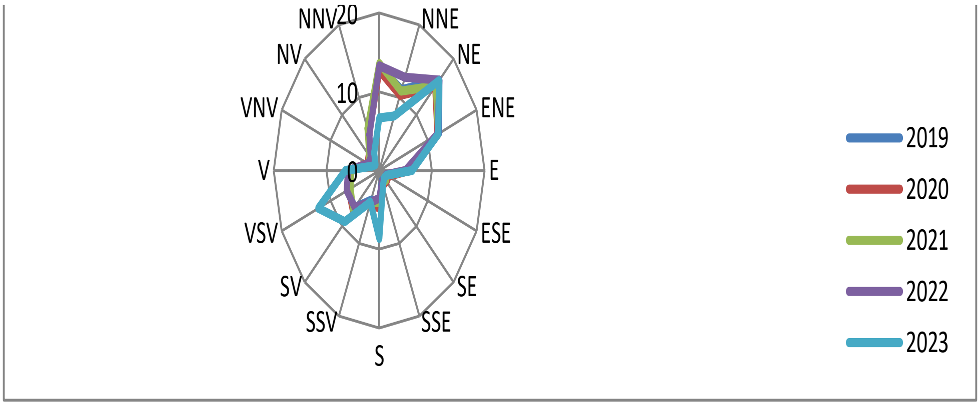

Figure 6. **Cardinal direction and frequency of air currents by research year**.

In 2023, a change in the direction and frequency of air currents is noted, the most frequent winds are in the direction of NE, ENE, VSV, SW and S.

1.2. Soils of the Veljurilor Plain

The research, identification and spatial delimitation of the taxonomic units of soils belonging to the Crişului Negru Plain was carried out during the period 2019-2023, by researching a number of 80 main soil profiles, over 160 secondary profiles and over 240 control profiles. Following the pedological mapping work, there were 7 soil types and 33 subtypes in the Crişului Negru Plain area. The determination of the soil units was carried out in accordance with the World Soil Resources Reference Base (WRB-SR-1998) (**Table 10**) [7]. The map of soil units in the Crişului Negru Plain is presented in **Figure 7**.

Table 10.

Soil units at soil type and subtype level identified in the Crişului Negru Plain area (according to WRB-SR).

Soil type - WRB-SR	Soil subtype - WRB-SR
Fluvisols FL	Eutric Fluvisols FLeu
	Haplic Fluvisols FLha
	Gleyic Fluvisols FLgl
	Vertic Fluvisols Flvr
	Mollic Fluvisols Flmo
Phaeozems PH	Haplic Phaeozems PHha
	Fluvic Phaeozems PHfv
	Stagni Phaeozems PHst
	Luvic Phaeozems PHlv
	Gleyic Phaeozems PHgl
Cambisols CM	Eutric Cambisols CMeu
	Fluvi-eutric Cambisols CMeu-fv
	Gleyi-eutric Cambisols CMeu-gl
	Mollic Cambisols CMmo
	Stagni-eutric CambisolsCMeu-st
	Eutri-vertic Cambisols CMeu-vr
Luvisols LV	Haplic Luvisols LVha
	Stagnic Luvisols LVst
	Vertic Luvisols LVvr
	Gleyic Luvisols LVgl
Vertisols – VR	Pellic Vertisols VRpe, Haplic Vertisols VRha
	Gleyi-pellic Vertisols VRpe-gl
	Stagni-pellic Vertisols VRpe-st
	Stagni-chromic Vertisols VRcr-gl
Gleyisols - GL	Eutric Gleysols GLeu
	Haplic Gleysols GLha
	Mollic Gleysols GLmo
	Fluvic Gleysols GLfv
Solonetz – SN	Haplic Solonetz SNha
	Albic Solonetz Nab
	Endosalic Solonetz SNszn
	Hyposalic Solonetz SNszw
	Gleyic Solonetz SNgl
	Vertic Solonetz SNvs

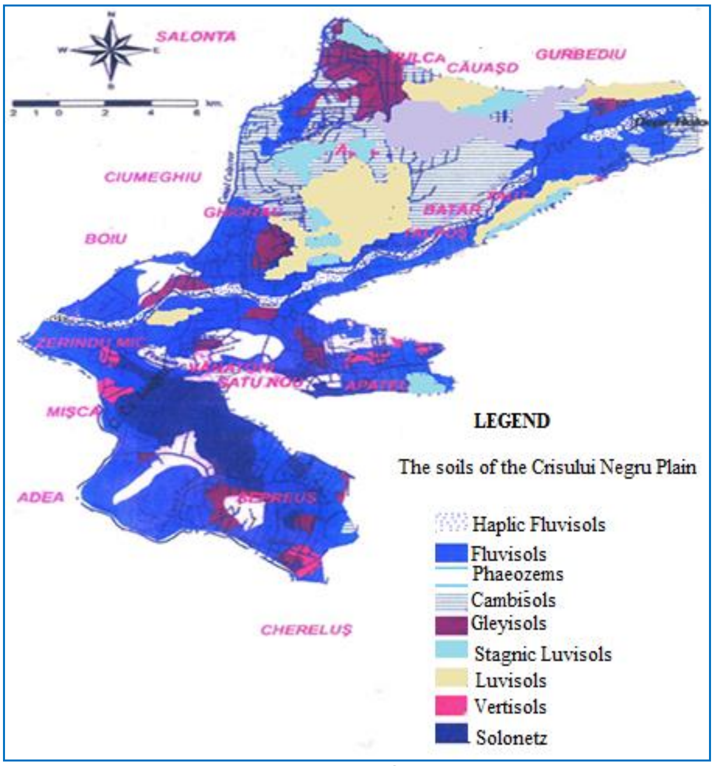

Figure 7. **Map of soil units in the Crişului Negru Plain.**

The total area of the Crişului Negru Plain is 34,823.3 ha, located in the territory of the localities: Tulca, Tinca, Batăr, Ciumeghiu, Avram Iancu, Mişca, Apateu, Sintea Mare, Sepreuş. The largest areas are occupied by Aluviosols – 18,930.4 ha, Phaeozems occupy 2,296.3 ha, Cambisols 5,766.7 ha, Gleyisols 2,652.5 ha, Luvisols 2,309.1 ha, Solonetz 2,128.8 ha, Vertisols 521.4 ha, Stagnic Luvisols & Stagnic Cambisols 217.8 ha. **Table 11** presents the soil cover of the Crişului Negru Plain, by territorial administrative units, classes, soil types and areas.

Table 11.

Soil cover of the Crişului Negru Plain by classes, soil types (according to WRB-SR), administrative territorial units and areas.

Soil type	Distribution area	Surface (Ha)
Fluvisols	Tinca, Batăr, Ciumeghiu, Mişca, Sepreuş	18930,4
Phaeozems	Tinca, Ciumeghiu, Mişca, Sepreuş	2296,3
Cambisols	Tulca, Tinca, Batăr, Sepreuş, Ciumeghiu	5766,7
Luvisols	Tulca, Tinca, Batăr, Ciumeghiu, Mişca, Avram Iancu	2309,1
Vertisols	Apateu, Sepreuş, Mişca	521,4
Gleyisols	Tulca, Tinca, Batăr, Ciumeghiu, Apateu, Sepreuş,	2652,5
Stagnic Cambisols & Stagnic Luvisols	Batăr, Ciumeghiu, Mişca, Sepreuş	217,8
Solonetz	Tinca, Tulca, Mişca, Sintea Mare, Sepreuş	2128,8

1.3. Limiting factors of agricultural production in the Crişului Negru Plain

The main limiting or restrictive factors of agricultural production in the Crişului Negru Plain are represented by: climatic regime, excess of pluvial moisture, excess of groundwater moisture, current acidity of soils, low content of nutritional elements, high percentage of exchangeable Na adsorbed at the level of the adsorbent complex and high content of soluble salts (Löbmann. Michael et al., 2022).

1.3.1. Climatic regim

a. Air temperature

The average annual temperature for the entire duration of the research was 12.°C. The values of the average annual temperatures from the bioactive period April - October are presented in **Table 12**. The highest average temperatures for the bioactive period were recorded in 2023, being 17.9°C. ‚The values of the average monthly temperatures during the bioactive period, for the research period 2019 – 2023 are presented in **Table 13. Figure 8** shows the graph of monthly average temperature values during the bioactive period.

Table 12.

Average annual temperature values from the bioactive period April – October, 2019 – 2023.

Period	2019	2020	2021	2022	2023
2019 – 2023, April - October	17,6	16,9	16,5	17,4	17,9

Table 13.

Average monthly temperature values during the bioactive period, for the research period 2019 – 2023.

Period	2019	2020	2021	2022	2023
April	+13.0	+10.9	+8.7	+9.6	+9.3
May	+14.5	+14.2	+14.5	+16.6	+16.0
June	+22.1	+19.5	+21.4	+21.8	+19.7
July	+20.9	+20.8	+24.2	+23.1	+22.9
August	+22.9	+22.1	+21.0	+22.8	+22.9
September	+17.3	+18.3	+16.2	+15.6	+19.9
October	+12.9	+12.5	+10.0	+12.4	+14.7

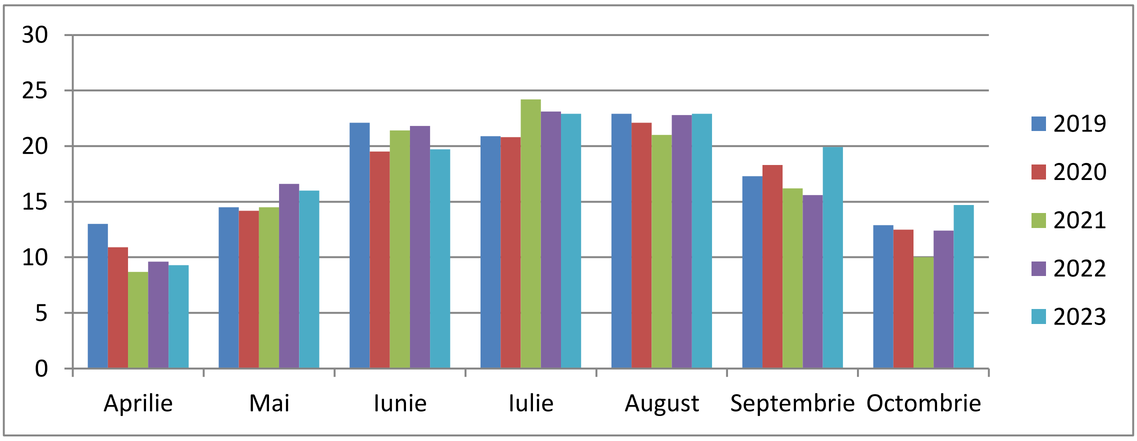

Figure 8. **Graph of monthly average temperature values from the bioactive period, 2019 – 2023.**

Table 14.

Average monthly temperature values for the summer period, June – August, by study years.

Period	2019	2020	2021	2022	2023
2019 – 2023, June - August	21.9	20.8	22.2	22.5	21.8

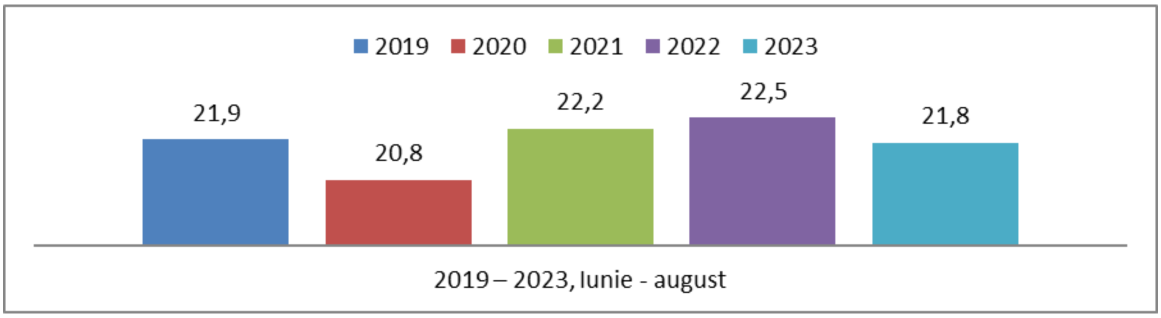

Figure 9. **Graph of average temperature values for the summer period, June – August**

For the summer period, June – August, the highest values were recorded in 2022 – 22.5 °C and the lowest values in 2020 – 20.8 °C.

b. Precipitation

The multiannual average of precipitation for the period 2019 – 2023 was 680 mm, with annual precipitation ranging between 647 mm in 2021 and 721 mm for 2020.

Table 15 presents the monthly precipitation for the bioactive period April – October, 2019 - 2023. Figure 10 presents the monthly precipitation graph for the bioactive period April – October, 2019 – 2023.

Table 15.

Monthly precipitation for the bioactive period April - October, 2019 - 2023

Period	2019	2020	2021	2022	2023
April	65	19	55	75	34
May	158	58	87	34	58
June	90	163	16	38	55
July	30	72	32	40	73
August	42	67	45	48	36
September	31	26	55	194	34
October	19	102	20	17	19

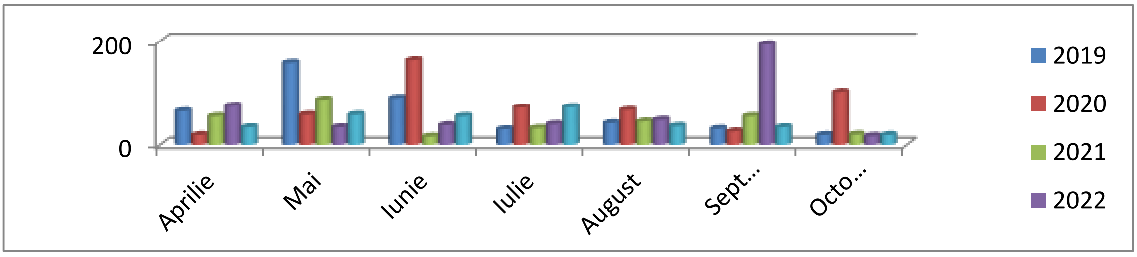

Figure 10. **Monthly precipitation graph for the bioactive period April – October, 2019 - 2023.**

Table 16.

Precipitation recorded during the bioactive period April - October 2019 - 2023, by research year

Period	2019	2020	2021	2022	2023
2019 – 2023, April - October	435	507	310	446	309

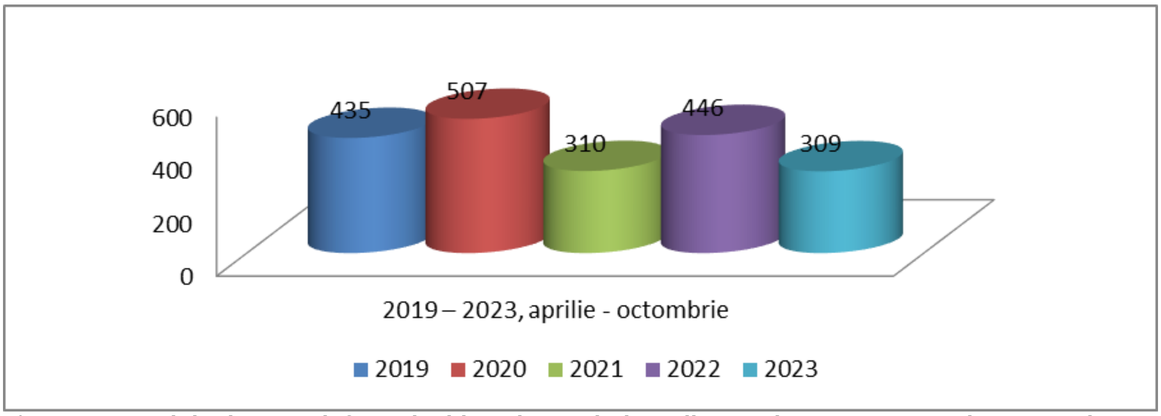

Figure 11. **Precipitation graph from the bioactive period, April - October, 2019 - 2023, by research year.**

Table 17.

Precipitation values for the summer period, 2019 – 2023.

Period	2019	2020	2021	2022	2023
2019 – 2023, June - August	162	166	93	126	164

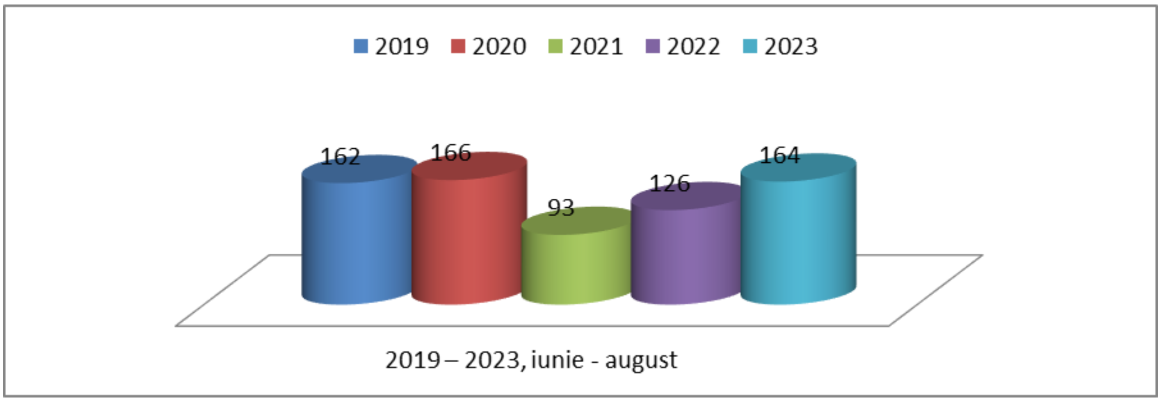

Figure 12 **Summer precipitation graph, June – August, 2019 – 2023**

In the Crişului Negru Plain area, the highest frequency was for air currents in the NE direction with values of 15.6%, ENE with 12.1% and N direction with 12.9%.

Table 18 and **Figure 13** present the cardinal direction of air currents and their frequency for the entire research period 2019 – 2023.

Table 18.

Cardinal direction of air currents and frequency, for the entire research period 2019 – 2023

2019 - 2023	N	NNE	NE	ENE	E	ESE	SE	SSE
	12.9 %	11.2 %	15.6 %	12.1 %	5.7 %	1.7 %	1.8 %	1.6 %
	S	SSW	SW	WSW	W	WNW	NW	NNW
	4.1 %	4.5 %	6.9 %	6.6 %	5.4 %	2.2 %	2.5 %	5.2 %

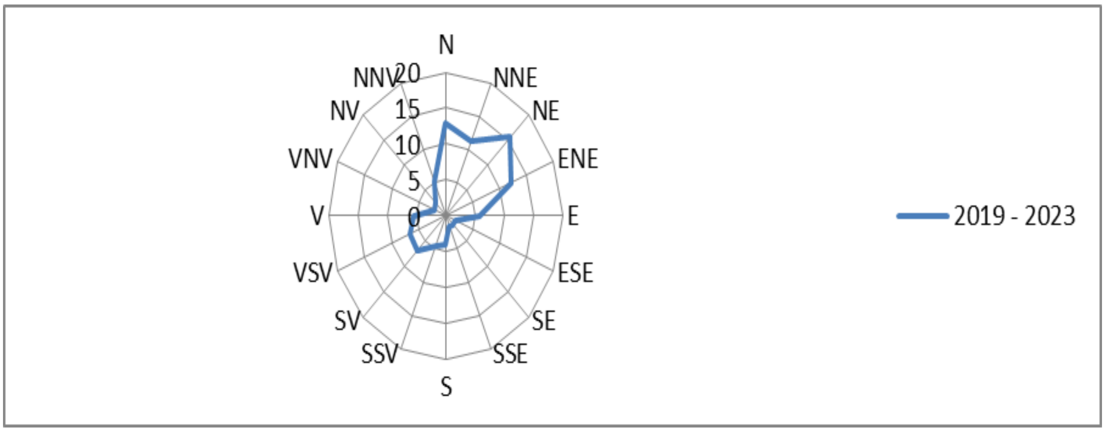

Figure 13. Direction and frequency of air currents for the researchperiod 2019-2023

1.3.2. Excess humidity

a. Excess pluvial humidity

In the Crişului Negru Plain, excess pluvial humidity affects a total area of 217.8 ha, in the area of the localities of Batăr, Ciumeghiu, Mişca, Sepreuş.

These soil units (Stagnic Cambisols & Stagnic Luvisols) are naturally occupied by pastures and hayfields, in the floristic composition plants with low or no fodder value predominate (Carex sp., Juncus sp.). However, they can also be used for agricultural crops (corn, autumn and spring cereals, sunflower, sugar beet, fodder plants, etc.). The cultivation of fruit trees and vines is contraindicated, since excess humidity inhibits root respiration, causing premature death of the plants. Excess moisture in the spring period causes uneven emergence of crop plants and uneven ripening, with yields generally being small and of inferior quality. The natural fertility of these soils is low due to the poor aerohydric regime of the soil, unfavorable for the growth and fruiting of agricultural crops. The excess moisture is recorded in the spring period, and in the summer period the plants experience a pronounced lack of water due to the pronounced drying of the upper horizons. **b. Excess groundwater moisture**

Excess moisture affects an area of 2652.5 Ha, located in the area of the localities: Tulca, Tinca, Batăr, Ciumeghiu, Apateu, Sepreuş. The parent material of these soils, formed under the incidence of excess groundwater moisture, is predominantly composed of clay-clay or clayey deposits of fluvial or fluvio-lacustrine origin; on loess and loessoid deposits. They appear in relief conditions in which the hydrostatic level of the groundwater aquifer is between 1 m and a maximum of 3 (3.5) m deep. In these soils, the annual variation in the profile of the moisture state highlights the phreatic moistening (through capillary rise) and the alterno-exudative character of the water regime. Groundwater is generally poorly mineralized (0.5 – 1.5 g/l soluble salts), predominantly bicarbonate, rarely sulfate, calco-magnesium or calco-sodium. The high humidity at the base of the profile ensures a relatively good water supply for crop plants even in the dry season of the year. These are soils that are generally characterized by a significant increase in the state of subsidence towards the base of the profile, where the groundwater is permanently or temporarily located. Negative effects due to the defective aerohydric regime are felt from the germination of seeds, anaerobic conditions hinder the germination and emergence of plants, roots grow poorly and penetrate superficially into the soil, toxic products accumulate in plants that create disorders and a decrease in the absorption capacity of water and mineral salts, resulting in plant weakness and, implicitly, a decrease in production. Gleyisols have a high fertility potential that cannot be exploited due to the poor aerohydric regime, they are predominantly used as pastures and hayfields. **1.3.3. Current acidity (pH value)**

In the Crişului Negru Plain, the total area occupied by soils with an acidic and weakly acidic reaction is 27,754.4 Ha, of which approximately 3,048.3 Ha have a pH value between 5.5 and 6.2. The total area occupied by soils with an alkaline and weakly alkaline reaction is 2,128.8 Ha, with a pH value between 7.9 and 8.7. Table 19 presents the areas of acidic and weakly acidic soils and the area they occupy in the Crişului Negru Plain

Table 19.

Moderately acidic and weakly acidic soils from the Crişului Negru Plain.

Soil type	Distribution area	Limits pH	Surface Ha
Fluvisols	Tinca, Batăr, Ciumeghiu, Mişca, Sepreuş	6,2 – 6,5	18930,4
Cambisols	Tulca, Tinca, Batăr, Sepreuş, Ciumeghiu	6,2 – 6,6	5766,7
Luvisols	Tulca, Tinca, Batăr, Ciumeghiu, Mişca, Avram Iancu	5,5 – 6,2	2309,1
Vertisols	Apateu, Sepreuş, Mişca	5,8 – 6,2	521,4
Stagnic Cambisols & Stagnic Luvisols	Batăr, Ciumeghiu, Mişca, Sepreuş	5,8 – 6,2	217,8
TOTAL AREA – ACID AND WEAKLY ACID SOILS			27745,4
Solonetz	Tinca, Tulca, Mişca, Sintea Mare, Sepreuş	7,9 – 8,7	2128,8
TOTAL AREA – BASIC SOILS			2128,8

1.3.4. Soils with low content in nutrients
a. Soils with low and medium supply in total nitrogen

Following the analysis and reporting of the results regarding the N content of the soils in the Crişului Negru Plain, it presents values ranging from 0.07 – 0.19 %. Out of the total area of 34823.3 ha, about 32527 ha present a soil supply with nitrogen accessible to plants from low to medium. Low supply is represented by the areas occupied by the soil types: Luvisols, Vertisols, Stagnic Cambisols & Stagnic Luvisols, Soloetz, the total area being 5177 ha. Cambisols present a supply from low to medium. Out of the total area of 5766.7 ha, about 40% have a low supply.

Table 20 presents the nitrogen content expressed in % of soil units from the Crişului Negru Plain and the assessment of the current state of soil supply with nitrogen accessible to plants

Table 20.

Nitrogen content expressed in % of soil units from the Crişului Negru Plain and assessment of the current state of soil supply with nitrogen accessible to plants.

Soil type	Distribution area	Surface Ha	Content in total N - %	Reserve
Fluvisols	Tinca, Batăr, Ciumeghiu, Mişca, Sepreuş	18930,4	0,11 – 0,16	middle
Phaeozems	Tinca, Ciumeghiu, Mişca, Sepreuş	2296,3	0,16 – 0,19	normal
Cambisols	Tulca, Tinca, Batăr, Sepreuş, Ciumeghiu	5766,7	0,09 – 0,14	Low - medium
Luvisols	Tulca, Tinca, Batăr, Ciumeghiu, Mişca, Avram Iancu	2309,1	0,07 – 0,085	low
Vertisols	Apateu, Sepreuş, Mişca	521,4	0,08 – 0,09	low
Gleyisols	Tulca, Tinca, Batăr, Ciumeghiu, Apateu, Sepreuş,	2652,5	0,11 – 0,15	middle
Stagnic Cambisols & Stagnic Luvisols	Batăr, Ciumeghiu, Mişca, Sepreuş	217,8	0,08 – 0,09	low
Solonetz	Tinca, Tulca, Mişca, Sintea Mare, Sepreuş	2128,8	0,07 – 0,09	low
SOILS WITH LOW SUPPLY				5177 ha
LOW SUPPLY SOILS - MEDIUM				5866,7 ha
SOILS WITH MEDIUM SUPPLY				21582,9 ha
SOILS WITH NORMAL SUPPLY				2296,3

b. Soils with low and medium supply of mobile phosphorus

Of the total area of 34823.3 ha: 23879.2 ha have a medium supply of mobile phosphorus, 7210 ha have a low supply and 3733.2 ha have a very low supply. Low and very low supply are the following soil types: Cambisols, Vertisols, Luvisols, Solonetz, Stagnic Cambisols & Stagnic Luvisols. Medium supply are the following soil types: Fluvisols, Phaeozems, Gleyisols.

Table 21 presents the state of mobile phosphorus supply of the soils of the Crişului Negru Plain.

Table 21.

Mobile potassium supply status of soils in the Crişului Negru Plain.

Soil type	Distribution area	Surface Ha	K – ppm Medium values	Reserve
Fluvisols	Tinca, Batăr, Ciumeghiu, Mişca, Sepreuş	18930,4	120 - 140	Medium - high
Phaeozems	Tinca, Ciumeghiu, Mişca, Sepreuş	2296,3	135 - 150	Medium - high
Cambisols	Tulca, Tinca, Batăr, Sepreuş, Ciumeghiu	5766,7	90 - 110	middle
Luvisols	Tulca, Tinca, Batăr, Ciumeghiu, Mişca, Avram Iancu	2309,1	60 - 65	low
Vertisols	Apateu, Sepreuş, Mişca	521,4	60 - 65	low
Gleyisols	Tulca, Tinca, Batăr, Ciumeghiu, Apateu, Sepreuş,	2652,5	70 - 100	middle
Stagnic Cambisols & Stagnic Luvisols	Batăr, Ciumeghiu, Mişca, Sepreuş	217,8	60 - 65	low
Solonetz	Tinca, Tulca, Mişca, Sintea Mare, Sepreuş	2128,8	80 - 90	middle
SOILS WITH LOW SUPPLY				3050,3 ha
SOILS WITH MEDIUM SUPPLY				10548 ha
SOILS WITH GOOD SUPPLY				21226,7 ha

1.3.5. High percentage of exchangeable Na adsorbed at the level of the adsorbent complex and high content of soluble salts

Solonetz are soils that present in the Ao horizon small quantities or only traces of easily soluble salts, being instead characterized by a high content of exchangeable Na, over 17 - 20% of the total basic cations adsorbed in the complex (Ca^{2+}, Mg^{2+}, K^+, Na^+) and a strongly basic reaction in the intermediate horizon (B), due to the presence of exchangeable sodium in a high proportion. The high alkalinity is also given by the high content of Na_2CO_3, recorded at the level of this horizon. The solonets from the Crişului Negru Plain were formed and evolved under the incidence of an aquifer layer with a high content of soluble salts of a chloride and sulfate nature due to the existence in depth of a calc-sodium mud. Due to the exchangeable Na and the higher percentage in clay, the wilting coefficient is high and the water permeability is low. Thus, plants also suffer from water insufficiency due to its strong retention by the soil and reduced circulation, the place of water around the roots consumed by plants is completed with great delay by the water located in the immediate vicinity. The reaction of these soils is strongly alkaline at the level of the Ao horizon, the pH value oscillates between 8.5 – 9.7 affecting the growth, development and fruiting processes of agricultural crops, the assortment of crops that succeed on these soils being restricted.

CONCLUSIONS

The studies and research carried out in the Crişului Negru Plain are of importance in the agricultural practice of the Crişurilor Plain. Based on these studies, the following were established: the soil units in the Crişului Negru Plain area and the occupied areas, the areas of soil affected by excess pluvial or groundwater humidity, the areas of soil with strong and moderate acidity, respectively the areas of soil with an alkaline reaction and the areas of soil with a low content of nutritional elements. The research can be used in the organization of the territory, the design of land improvement works, the design of works to restore the fertility potential of the soils, the establishment of the assortment of crop plants and the correct application of a differentiated agrotechnics by correlating the physical and chemical properties of the soil with the requirements of the crop plants.

Data on the climatic regime can be used in the design and establishment of irrigation systems, taking into account the fluctuations of the rainfall regime. Under the conditions of frequent climate changes, soil water is the decisive factor in the level and quality of crops (Rusu Teodor et al, 2012) in the Crişului Negru Plain. Under such conditions, the success of an agricultural crop depends on how the accumulation and conservation of water in the soil could be managed.

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