THE TROPHIC CONDITIONS FOR AGRICULTURAL CROPS FROM THE VELJURILOR PLAIN

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ABSTRACT

The research was carried out over a period of 5 years (2019 – 2023), with the aim of determining and transposing on the map the soil taxonomic units of the Veljurilar Plain, quantifying the existing trophic conditions, cataloging the limiting and restrictive factors of agricultural production and establishing the main intervention directions for optimally ensuring the conditions for growth, development and fruiting of agricultural crops. In order to establish and determine the soil taxonomic units existing in the territory, their spatial extension and their transposition on the map, 60 main soil profiles, 120 secondary profiles and 220 control profiles were executed in the field. To determine the chemical parameters of the soils, 360 soil samples were taken and analyzed. The analyzes of the chemical parameters of the soils were carried out by spectrophotometry. The following were studied and quantified: the time variation of climatic parameters (air temperature, soil temperature, precipitation, relative air humidity, air current movements) and soil trophic conditions (nutrient content, current acidity – pH value, excess of moisture from precipitation, excess groundwater). Based on the results of the research, the limiting and restrictive factors of agricultural production were established and the main directions of intervention were drawn to ensure optimal trophic conditions for the growth, development and fruiting of agricultural crops: measures to conserve water in the soil and measures to increase soil fertility potential. The results of current research can be stored in data banks, which can be retrieved and used in agricultural practice by economic units with an agricultural profile. The research can be integrated into the National Soil Quality Monitoring System, within the International Environmental Quality Monitoring System.

Keywords: trophic conditions; climatic regime; so il types; fertility; limiting factor

INTRODUCTION

The research was carried out with the aim of establishing the soil units of the Veljurilor Plain and to know in detail the trophic conditions for agricultural crops in the Veljurilor Plain, to quantify the limiting and restrictive factors of agricultural production and to establish the main directions of intervention and impact limitation generated by these factors.

Changes in the elements of the climate regime: air temperature, soil temperature, precipitation, relative air humidity and air current movements, have determined considerable decreases in agricultural production. The quantification of climatic parameters will allow 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 [1]. The identification and evaluation of the restrictive and limiting factors of agricultural production and the measures that are required to limit the impact on production, constitute the main mechanism for sustainable agriculture [2,3].

The integrated research of the conditions for the development of agricultural crops in a certain area, the establishment and quantification of the limiting and restrictive factors of agricultural production and the establishment of the main directions of intervention to ensure the optimal conditions for the development of crop plants, are the basis of the practice of sustainable agriculture.

Geographically, the Veljurilor Plain is located in N-W Romania, being a subunit of the Crișurilor Plain (Figure 1, 2). Within the Crișurilor Plain, it occupies an area of 21088.1 ha, located in the central part. From a territorial and administrative point of view, the area of Câmpia Veljurilor overlaps territorially with the localities of Tinca, Tulca, Mădăras, Cefa, Gepiu, Sânicolau Român, Nojorid, Toboliu, Girişu de Criş, Sântandrei.

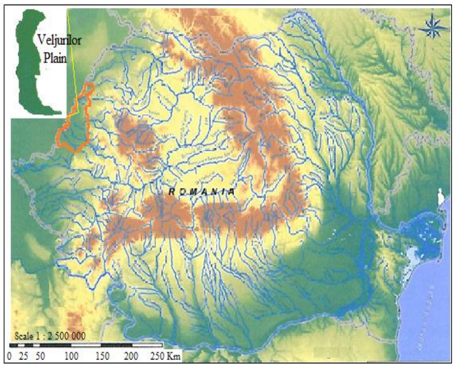

Fig. 1. Veljurilor Plain. Geographical location

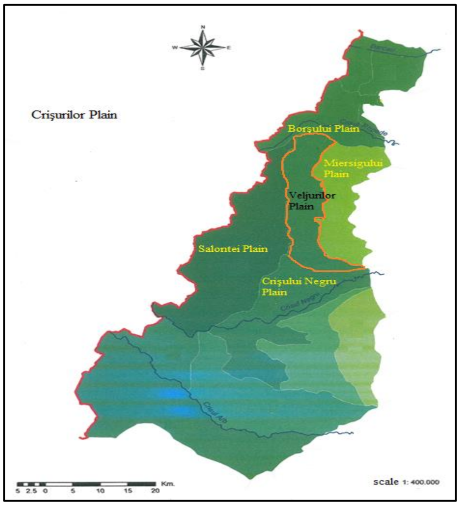

Fig. 2. Veljurilor Plain, subunit of the Crișurilor Plain (Posea, 2006)

The altitude of the plain is between 100 and 150 m. The climate regime is characterized by average annual temperatures of 11.7 °C and average annual precipitation of 650 mm (average values over the last 50 years) [4]. The distribution of precipitation during the year is uneven, presenting monthly variations.

Moisture deficit in the soil is recorded in the months of June - September, the frequency of drought periods being high in years with deficient amounts of precipitation. The parent materials on which the soil units were formed and evolved are represented by: loess, loessoid deposits, clays, marls, alluvial deposits. Surface deposits are represented by fluvial deposits, deluvial deposits, proluvial deposits, deluvial-proluvial deposits and marsh deposits (Figure 3) [5,6, 7]. The water table is generally located at depths greater than 5.5 m and presents a low degree of mineralization. In the low areas of the plain (in the area of the localities of Toboliu, Cheresig, Cefa, Inand, Homorog, Ianoșda) the groundwater is concentrated at depths of less than 3.5 m, influencing the physical-chemical and biological properties of the soils.

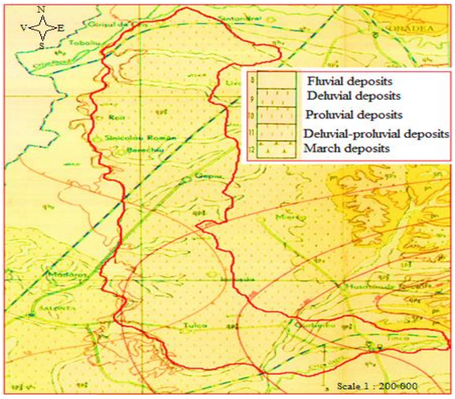

Fig. 3. The Map of surface deposits in the Veljurilor Plain

MATERIALS AND METHODS

The study was carried out over a period of 5 years: 2019 – 2023. The climatic parameters were studied and interpreted based on the meteorological data provided by the Bucharest National Meteorological Administration, Oradea Meteorological Station [12]. The following climatic parameters were taken into study: air temperature, soil temperature, precipitation, relative air humidity and air current movements. The research, the identification, spatial delimitation and mapping of soil taxonomic units was carried out by researching a number of 60 main soil profiles, 120 secondary profiles and 220 control profiles [8,9]. 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+) [10], later being transposed into the World Reference Base for Soil Resources (WRB-SR-1998) [11]. In order to establish the fertility potential of the soils, they were sampled a number of 360 soil samples, at 2 depths: 0 - 15 cm, respectively 15 - 30 cm. Analyzes were performed on current acidity (pH), total nitrogen, mobile phosphorus, mobile potassium[13].

The analyzes of the chemical parameters of the soils were carried out by spectrophotometry. The analyzes were carried out 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 carried out according to the standards and methodology developed by the National Institute for Pedology, Agrochemistry and Environmental Protection - ICPA Bucharest [8].

RESULTS AND DISCUSSION

The growth, development and fruiting of plants, presupposes the existence of appropriate vegetation conditions for the crops, by ensuring at an optimal level all the ecological factors that have a decisive effect on the level and quality of agricultural production. High yields can only be obtained through simultaneous and complex interventions on vegetation factors, one cannot intervene unilaterally, and the problems must be solved through appropriate interventions.

Soils of the Veljurilor Plain

The research, identification and spatial delimitation of soil taxonomic units belonging to the Veljurilor Plain was carried out in the period 2019-2022 (9), by carrying out a number of 60 main soil profiles, 120 secondary profiles and 220 control profiles. Following field research and subsequent correlation with laboratory results, 7 soil types were identified, surveyed and mapped in accordance with the World Reference Base for Soil Resources (WRB-SR-1998) [11]. After carrying out the pedological mapping works, the Map of the soil units of the Veljurilor Plain was created (Figure 4). Table 1 shows the soils of the Veljurilor Plain by territorial administrative units, soil types and surfaces [11].

Table 1.

Soils of the Veljurilor Plain by territorial administrative units, soil types and surfaces (World Reference Base for Soil Resources).

Soil type	Distribution area	Area - Ha
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9
Surfaces occupied by water, canals		56,1
Total agricultural area		12697,9
Areas of land occupied by constructions, roads		8391
TOTAL AREA		21.088,1

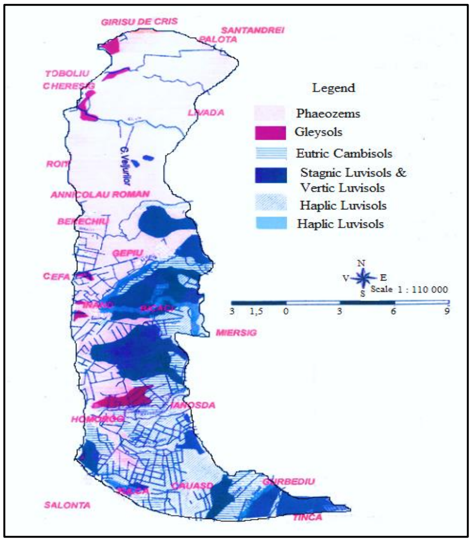

Fig. 4. Soil map of Veljurilor Plain

Limiting factors of agricultural production

Annually, in the Veljurilor Plain, agricultural production depends on and is under the influence of restrictive or limiting factors that manifest themselves with different intensities and condition the quality and level of the harvest. Monitoring and knowing the causes that generate them makes it possible to intervene to remedy the intensity of manifestation or remove the restrictive factor [15,17]. The main limiting or restrictive factors of agricultural production in the Veljurilor Plain are represented by: elements of the climate regime; excess moisture from precipitation; excess phreatic moisture [25]; current soil acidity (pH); low content in nutritional elements.

Climate regime

The climatic parameters were studied and interpreted on the basis of meteorological data provided by Bucharest National Meteorological Administration, Oradea Meteorological Station [12].

Air temperature

The average annual temperature for the entire duration of the research (2019 – 2023) was 12.4°C. There is an increase in the annual average temperature by 0.7°C compared to the average of the last 50 years (11.7°C). The highest value was presented in 2019 - +12.9°C and the lowest in 2021 - +11.6°C. Table 2 shows the average annual temperature values for the period 2019 –2023. Table 3 Shows the average monthly temperatures for the period 2019 –2023.

Table 2

Averange annual temperaturesfor the period 2019 – 2023

The year	Medium temperature annually	The minimum value registered	Maximum value recorded
2019	+12,9	-12,1 – 08.01.2019	+36,1–02.08.2019
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
2023	+13,2	-8,2 – 10.02.2023	+36,9 – 28.08.2023

Table 3

Average monthly temperatures for the period 2019 –2023

Month	Medium value	The minimum value registered	Maximum value recorded
January	+0,9	-13,9– 12.01.22	+14,9 – 01.01.23
February	+3,8	-12,9 – 13.12.21	+18,0 – 03.02.19
March	+6,8	-16,7 – 12.03.22	+20,9 – 31.03.19
April	+10,5	-3,1 – 01.04.20	+28,6 – 26.04.19
May	+15,5	+2,3 – 04.05.21	+28.4 – 11.05.21
June	+21,5	+6,3 – 02.06.20	+37,2 – 30.06.22
July	+23,1	+8,6 – 10.07.19	+38,7 – 23.07.22
August	+23,4	+10,2 – 19.08.21	+37,1 – 16.08.21
September	+18,3	+2,9 – 23.09.21	+32,7 – 01.09.19
October	+13,2	-0,9 – 08.10.23	+27,2 – 21.10.23
November	+7,4	-3,8 – 27.11.23	+23,9 – 04.11.21
December	+3,9	-7,0 – 23.12.21	+18,0 – 02.12.23

Table 4 shows the average monthly temperatures, according to years of research.

Table 4

Average monthly temperatures by years of research

Month	Medium value				
	2019	2020	2021	2022	2023
January	-0,9	-1,4	+1,8	-0,5	+5,4
February	+3,9	+4,6	+3,7	+4,4	+2,3
March	+8,7	+7,2	+5,0	+5,3	+7.9
April	+13,4	+11,2	+8,8	+9,7	+9,7
May	+14,8	+14,4	+14,6	+17,2	+16,8
June	+22,7	+20,0	+22,0	+22,9	+20,1
July	+21,5	+21,3	+24,9	+24,0	+23,7
August	+24,0	+23,3	+21,8	+24,2	+23,7
September	+18,1	+19,1	+17,3	+16,1	+21,0
October	+13,7	+12,9	+11,0	+12,9	+15,4
November	+10,9	+5,2	+6,5	+7,6	+6,9
December	+4,2	+4,9	+2,0	+4,0	+4,2

The average monthly temperature recorded the lowest values in January 2020 of -1.4℃ and the highest values in July 2021, +24.9°C. Figure 5 shows the average monthly temperatures during the bioactive period (March – October). Table 5 shows the average monthly temperatures recorded for the period from June to September, the period in which soil moisture deficit is frequently recorded.

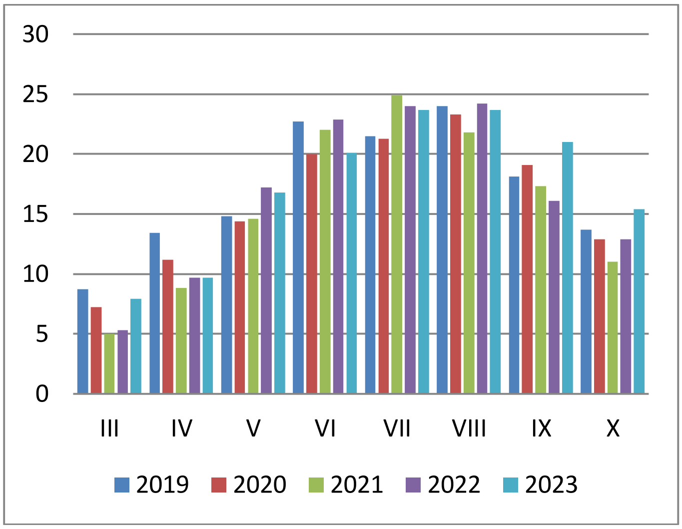

Fig. 5. Graph of average monthly temperatures recorded during the bioactive period March – October (2019 – 2023).

Table 5

Average monthly temperatures recorded for the period June-September, 2019 - 2023

Month	Monthly average temperature				
	2019	2020	2021	2022	2023
June	+22,7	+20,0	+22,0	+22,9	+20,1
July	+21,5	+21,3	+24,9	+24,0	+23,7
August	+24,0	+23,3	+21,8	+24,2	+23,7
September	+18,1	+19,1	+17,3	+16,1	+21,0

The highest average monthly temperatures were recorded in 2022 and the lowest in 2020. Figure 6 shows the average monthly temperatures recorded in the months of June - September (2019 - 2023), an interval characterized by the high frequency of drought periods.

Soil temperature

It depends on the amount of energy received from the sun, the thermophysical properties of the soil, the forms of macro and microrelief, the exposure, the type and presence of the vegetal carpet, the presence or absence of the snow cover, the morphological characteristics of the soil [26,31].

The multiannual average temperature recorded at the soil surface, for the period 2019 - 2022, was 11.64°C. Average monthly temperatures recorded at the soil surface are presented in Table 6.

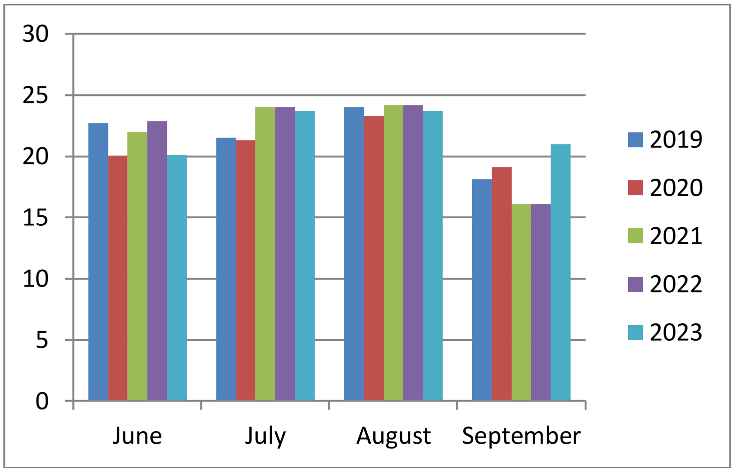

Fig. 6. Graph of average monthly temperatures

Table 6

Average monthly temperatures recorded at the soil surface (°C)
for the period 2019 – 2023

Oradea Weather Station	
Month	Recorded values - °C
January	-1,1
February	0,4
March	5,5
April	11,9
May	19,2
June	23,0
July	24,6
August	23,5
September	17,2
October	10,8
November	4,4
December	0,3

Precipitation

For the period 2019 - 2023, the average annual value of precipitation was 820.4 mm, a value higher than the average calculated for the last 50 years, of 650 mm. The amount of precipitation recorded values between 667 mm in 2021 and maximum values of 945 mm in 2020.

Table 7 shows the annual amounts of precipitation recorded for the period 2019 - 2023.

In the table 8 shows the recorded monthly rainfall, by research years: 2019, 2020, 2021, 2022 and 2023.

Table 7

The amount of annual precipitation recorded during the period 2019 – 2022

Period	Total amount of precipitation	Maximum value recorded - date	Share of days with precipitation
2019	835 mm	60,0 mm în 12 h 27.06.2019	158
2020	945 mm	39,9 mm în 6 h 22.06.2020	138
2021	667 mm	22,0 mm în 12 h 11.07.2021	150
2022	752 mm	27,0 mm în 12 h 02.09.2023	150
2023	903 mm	41,0 mm in 12h 12.07.2023	167

Table 8

Recorded monthly precipitation, by research years:
2019, 2020, 2021, 2022 and 2023

Month	Recorded monthly precipitation - mm				
	2019	2020	2021	2022	2023
I	92	25	86	24	68
II	17	75	76	31	36
III	23	65	28	19	42
IV	81	26	51	79	54
V	183	110	117	36	63
VI	182	182	6,2	40	65
VII	38	172	47	104	96
VIII	25	47	37	29	88
IX	55	46	12	213	79
X	17	102	6	6	44
XI	53	27	79	79	140
XII	65	68	92	93	129

For the entire research period 2019 – 2023, the highest values of precipitation amounts were recorded in September 2022, being 213 mm, and the lowest values in October 2021 and October 2022 - 6 mm.

Figure 7 shows the precipitation graph by months and years of research. Precipitation from the bioactive period March - October recorded an average of 67.87 mm, the lowest values were recorded in 2021 - 38.02 mm, and the highest in 2020 - 93.75 mm. Table 9 shows the precipitation values from the bioactive period March - October.

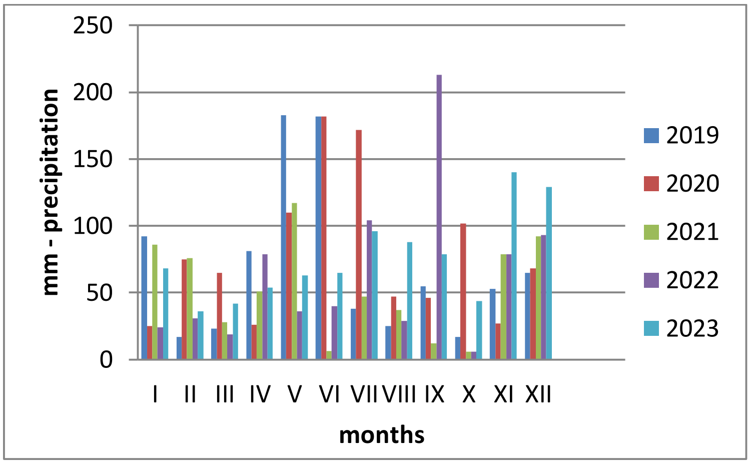

Fig. 7. Precipitation graph by months and years of research.

Table 9

Precipitation values from the bioactive period March – October

Period	Recorded monthly precipitation - mm				
	2019	2020	2021	2022	2023
March - October	75,5	93,75	38,02	65,75	66,4

In Figure 8, the rainfall values from the bioactive period are graphically presented, by months and years of study. The frequency of drought periods was high during the interval June - September.

Table 10 shows the amount of precipitation recorded in the period June - September, 2019 - 2023. Figure 9 represents the precipitation graph for the period June - September, 2019 - 2022

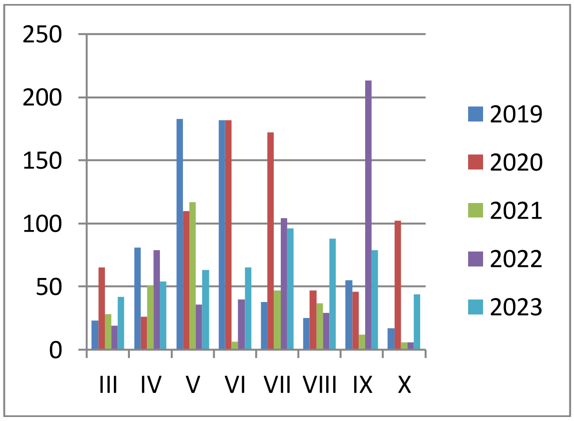

Fig. 8. Precipitation graph from the bioactive period March - October, by months and years of study

Table 10

The amount of precipitation recorded in the period
June - September by years of research

Period	The amount of precipitation	Maximum value (date)	The proportion of days with precipitation
2019	300 mm	60.0 in 12 h (27.06)	43
2020	447 mm	39.0 in 6 h (22.06)	44
2021	102 mm	22.0 in 12 h (11.07)	32
2022	386 mm	27.0 in 12 h (22.09)	49
2023	307 mm	41.0 in 12 h (12.07)	44

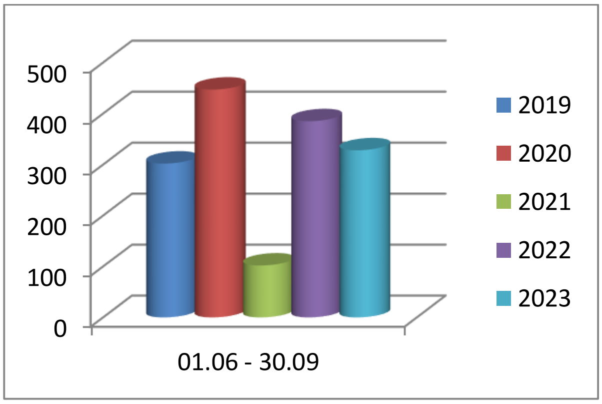

Fig. 9. Graphic representation of rainfall amounts for the period June - September, 2019 – 2022

The relative air humidity expressed in %, at 2 m above the ground, for the period 2019-2023, is presented in Table 11. The lowest values of the relative humidity of the air were recorded in 2022, between June - September.

Table 11

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

Month	2019	2020	2021	2022	2023
I	87	90	85	83	85
II	76	74	81	74	79
III	60	65	64	51	70
IV	62	50	69	68	72
V	70	66	72	63	70

VI	66	77	60	55	70
VII	62	72	61	50	64
VIII	61	63	62	59	65
IX	62	64	64	78	63
X	74	82	66	80	66
XI	86	90	84	89	83
XII	86	85	88	87	85

Movements of air currents

In the area of Veljurilor Plain, air currents in the East and South direction had the highest frequency, with values of 19.6% in the East direction and 13.5% in the South direction.

Table 12 shows the cardinal direction of air currents and frequency, for the entire study period 2019 –2023. Figure 10 shows the direction and frequency of air currents for the period 2019 - 2023.

Table 12

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

Direction	N	NNE	NE	ENE
Frequency	9.5 %	6.8 %	3.3 %	3.3 %
Direction	S	SSW	SW	WSW
Frequency	13.5 %	6.6 %	4.4 %	3.2 %
Direction	E	ESE	SE	SSE
Frequency	19.6 %	6.8 %	3.5 %	4.0 %
Direction	W	WNW	NW	NNW
Frequency	4.3 %	2.7 %	3.5 %	4.9 %

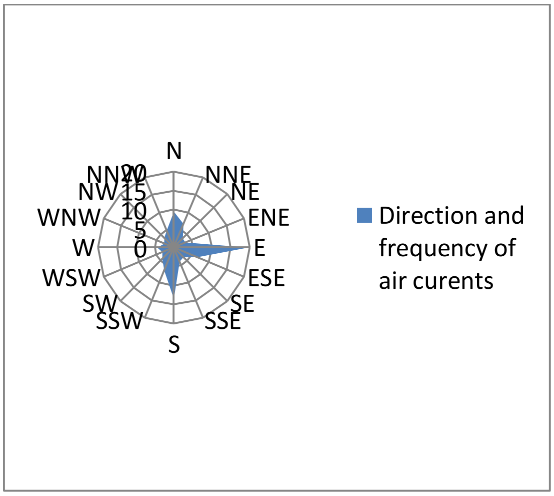

Fig. 10. Graphic representation of the cardinal direction of air currents and frequency, during the period 2019 –2023

In the Veljurilor Plain, the main limiting factor of agricultural production is represented by the rainfall regime. Following the monitoring of the precipitation regime over a period of 5 years, the results showed that periods of drought occur with a high frequency between the months of June – September [14].

Through the set of measures that are imposed, it is aimed that the soil stores the entire amount of water from the precipitation. This can be achieved through the practice of sustainable agriculture, so that through crop maintenance works a good conservation of soil water is ensured, preventing all ways of non-productive water loss [22]. On the 0-120 cm layer, water losses of 835 t/ha were recorded on the unplowed land and 181 t/ha on the summer plowed land [23].

Raising the fertility potential through the use of chemical and organic fertilizers improves the structuring state of the soils, increases the humus content and water retention in the soil for a longer period. The use of organic fertilizers increases the water storage capacity by 20%, humus retains 6 times more water, delaying the onset of drought by two weeks in periods of insufficient rainfall. Reducing water losses can also be done by reducing the degree of weeding of crops, weeds are large consumers of water [27].

Another effective method consists in cultivating earlier species and varieties (hybrids), with lower specific water consumption and which make good use of the little water available in the soil (specific consumption for millet is 311 mm, for sorghum 322 mm). Sowing at the optimal time for the plants to grow and develop normally in the early stages, without the water stress that occurs later, when the plants are less affected, helps to combat the effects of early drought [18]. At the same time, the density at sowing should be correlated with the existing water reserve in the soil and in the case of drought forecasts, lower densities should be ensured. Periodic checking of the water reserve of the soil, knowing that a reserve of 100 – 150 mm at a depth of 0 – 90 cm ensures the development of plants for a maximum period of 2 months. The most effective method of combating the effects of drought is the establishment of irrigation systems[19,28,33].

Excess moisture from precipitation

In the Veljurilor Plain, the excess rain moisture affects a total area of 3808.4 ha of agricultural land, in the localities: Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român. Soil surfaces affected by excess rain moisture are found with preference, on relief units with poor natural drainage, land surfaces are practically horizontal or very slightly inclined, covered with fine deposits, very little permeable (from terraces and high plains), such as in closed valleys or micro depressions that favor the accumulation and stagnation of water from precipitation [20].

The parental material of these soils is represented, as a rule, by deluvial-proluvial clays of Pleistocene age, which sometimes cover (a few meters deep) torrentially stratified gravels and sands. They can also appear on recent alluvial or deluvial-proluvial clay deposits (in the relatively young parts of the plain). These soils are naturally occupied by pastures and hayfields, in the floristic composition plants with low or no fodder value predominate (Carex sp., Juncus sp.), [21]. The stagnation of water re-sulting from precipitation leads to the deterioration of the aerohydric regime and deter-mines changes in the physical and chemical properties of the soil, thus creating unsuita-ble conditions for the development and fruiting of plants by inhibiting the respiration of the roots and changes in the chemistry of the soil.

Soils with excess rain moisture are soils that fall into classes of reduced workability and trafficability, there are long periods of time in which it is not possible to carry out work on the establishment and maintenance of agricultural crops.

Due to the excess moisture recorded in the spring, a large part of the seeds that reached the soil no longer germinate (20-30%), the plants develop unevenly, the harvests are generally small and of poor quality. They are soils with low natural fertility, the aerohydric regime of the soil, unfavorable for the development of cultivated plants, the low microbiological activity and the low content of nutrients contribute to this. On these soils, in the spring period, due to the stagnant water, a surplus of moisture is recorded in the surface horizon, unsuitable conditions are created for the germination and normal development of crop plants, and in the summer period (when the precipitation is low) the plants feel a pronounced lack of water due to the accentuated drying of the upper horizons [20].

For these soils, a differentiated agricultural technique and measures to eliminate the excess water that appears in the spring are required. It is recommended to carry out deep plowing to mobilize the soil at a greater depth, thus an improvement of the aerohyric regime of the soil takes place. On soils strongly affected by water stagnation, special drainage measures are recommended. An effective measure to increase the fertility potential is the application of organic fertilizers and mineral fertilizers [24].

Excess phreatic moisture

The excess of groundwater affects an area of 550.9 ha, located in the localities: Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog. These soils that were formed in relief conditions where the hydrostatic level of the phreatic aquifer layer is between 1 m and a maximum of 2 (2.5) m deep. They are soils that are generally characterized by a sensitive accentuation of the state of subsidence, towards the base of the profile, where the underground water is permanently or temporarily.

The influence of groundwater in the formation of Gleysols is stronger, due to the water table level between 1 and 2 (2.5) m deep. The annual variation of the humidity state of these soils is determined by the oscillations of the phreatic level (the phreatic wetting due to the capillary ascent of water from the phreatic water) highlights the alternating-exudative nature of the water regime of these soils.

Groundwater is generally poorly mineralized (0.5 - 1.5 g/l soluble salts), predominantly bicarbonate, rarely sulfate, chalco-magnesian or chalcosodic [20]. Negative effects due to the defective aerohydric regime are felt from seed germination, anaerobic conditions prevent the germination and sprouting of plants, the roots grow weakly and penetrate shallowly into the soil, toxic products accumulate in plants that create disturbances and decrease the capacity to absorb water and mineral salts, the weakening of the plants and implicitly the decrease in production [19]. The improvement and full utilization of the fertility potential of these soils can be achieved by: drainage works associated with underground drainage works, deep plowing, the administration of calcareous amendmentson moderately and strongly acidic gleysols, the administration of organic and mineral fertilizers. After carrying out the entire complex of measures, the following can be successfully cultivated: corn, autumn cereals, sugar beets, sunflowers, fodder plants, etc. After carrying out the drainage works, the natural fertility of gleysols improves considerably, as a result of the improvement of the aerohydric regime and, respectively, of the activation of the mineralization processes of the organic substance [20] The administration of chemical fertilizers with nitrogen must be carried out with caution, considering the critical depth of the groundwater and the fluctuations of the water table in the soil profile that, are recorded during the course of a year. The use of high doses of nitrogen fertilizers can lead to the pollution of the groundwater with nitrites and nitrates.

Current acidity (pH value).

Acid soils, due to the current acidity and the physical, physico-chemical and bio-logical properties that characterize them, present a low natural fertility potential, un-suitable for the development and fruiting of crop plants in accordance with the genetic potential.These soils are characterized by values of current acidity lower than 6.2, degree of saturation in bases < 75%, low values of the sum of exchangeable bases, high values of hydrolytic acidity and the dominance in the absorptive complex of H^+ and A^{3+} ions. In acidic pH conditions by the solubilization of hydroxides of Al, Mn, Fe, Bo, there is an increase in the mobile forms of Al^{3+}, Mn^{2+}, Fe^{3+}, Bo^{3+} and a decrease in the content of soluble phosphates and Mo accessible to plants.Aluminum, in acid soils, is found in ionic form – Al^{3+}, having a toxic effect on plants. The toxic action of aluminum is felt by plants at concentrations of 15 – 20 ppm, while the minimum limit of the toxic concentration of Al^{3+} absorbed by plants is 1 ppm (Al accu-mulates in plants at the root level). It also determines the immobilization of phosphorus in non-assimilable compounds and the reduction of the concentration of the soil solution in $H_2PO_4^-$. The high concentration of mobile aluminum in the soil solution prevents the absorption of other cations with a role in plant nutrition: Ca^{2+}, Mg^{2+}, K^+, and NH_4^+. The most sensitive crops to high concentrations of mobile aluminum are: wheat, alfalfa, clover, sugar beet. Tolerance shows corn, potato and lupine. The negative action of Al^{3+} ions is reduced by the presence of Ca ions. Increasing the content of Mn^{2+} favors its accumulation in plants, the metabolism of protein substances and carbohydrates being disturbed (Mn accumulates in the aerial part of plants). The excess of Mn is much more toxic than that of Al, especially in sugar beet and leguminous plants.

The negative effects of the acid reaction are manifested in soils through a series of unfavorable physical properties, the soils presenting a structure with poor hydrostability or are devoid of structure.

In the Veljurilor Plain, out of the total cultivated area of 12,697.9 Ha, the area oc-cupied by soils with moderate and strong acidity is 10 023.1 Ha, being represented by the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols, Vertic Lu-visols. These soils occupy areas in the localities: Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Tinca. Table 13 shows the units of moderately acidic and weakly acidic soils and the area they occupy within the Veljurilor Plain.Most cultivated plants grow and bear fruit at a pH value between 6.4 and 7.8. At values of pH between 6.8 and 7.2, plants meet the most favorable nutrition conditions with macro and micro elements. At values below 6.4 and above 7.8, plants suffer from nutritional disorders due to the passage of the assimilable forms of the nutritional elements into hard to assimilate or inaccessible forms and the mobilization of some compounds with toxic action for plants.

Table 13

Moderately acid and weakly acid soils of the Veljurilor Plain

Soil type	Distribution area	Value pH	Interpretation	Value Ah	Surface ha
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	5,9 – 6,3	Moderately acidic - weakly acidic	1,4 -3,3	2 448,6
Haplic luvisols	Inand, Bicaci, Tulca, Gurbediu	5,9 – 6,2	Moderately acidic - weakly acidic	3,1 – 5,2	3 296,4
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	5,7 – 5,9	Moderately acidic	4,1 – 6,8	3 808,0
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	6,2 – 6,4	Weakly acidic	2,7 – 3,1	469,7
TOTAL AREA 10 023,1					

In acidic soils, the reduction of the negative effects due to the presence of high concentrations of Al^{3+}, Mn^{2+}, Fe^{3+} and H^{+} ions in the soil solution can be achieved by using chemical fertilizers with a physiological acid reaction, by administering organic fertilizers and the administration of calcareous amendments, in the form of calcium carbonate ($CaCO_3$) or calcium oxide (CaO).

Soils with a low content of nutrients

Soils with low and medium content in total nitrogen

The chemical analyzes carried out on the soils of the Veljurilor Plain, revealed values of the supply in total nitrogen, expressed in ppm, between 32 ppm and 110 ppm, values corresponding to a supply from low to medium supply. Average N input shows Phaeozems soil type with values between 84 ppm and 110 ppm total nitrogen. The low and average values of the total nitrogen supply (%) correspond to the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols & Vertic Luvisols, Gleysols. These soils have values between 32 ppm total nitrogen and 64 ppm. The total area occupied by soils with low and medium content in total N is 10.023 ha. Table 14 shows the nitrogen supply status of the soils of the Veljurilor Plain.

Table 14

Nitrogen supply status of the soils of the Veljurilor Plain

Soil type	Distribution area	Area - ha	Total N - ppm Medium values	Reserve
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7	52 – 64	medium
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8	84 – 110	Medium-high
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6	36 – 64	Low-medium
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4	35 – 62	Low-medium
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4	32 – 57	Low-medium
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9	72 – 86	medium

Soils with low and medium phosphorus content

Following the analysis of the mobile phosphorus content of the soils of the Veljurilor Plain, they present values between 4 and 74 ppm, values that correspond to a state of supply from very poor to a good supply.

A good phosphorus supply (between 38.3 – 74.2 ppm) shows the soil type: Phaeozems. Low and very low supply in mobile P shows the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols & Vertic Luvisols, Gleysols, with values between 8.2 and 17.9 ppm.The total area occupied by soils with a low content in mobile phosphorus is 11.648.1 ha. In Table 15, the state of phosphorus supply of the soils of the Veljurilor Plain is presented.

Soils with low and medium potassium content

In order to assess the state of potassium supply of the soils of the Veljurilor Plain, analyzes were carried out regarding the mobile potassium content of the soils. Values ranging from 30 to 210 ppm were obtained. Good supply in potassium shows the type of soil: Phaeozems, showing supply values between 140 and 210 ppm.

Table 15

Phosphorus supply status of the soils of the Veljurilor Plain

Soil type	Distribution area	Area - ha	P – ppm Medium values	Reserve
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7	15,7 – 17,4	low
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8	38,3 – 74,2	Medium-high
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6	8,6 – 17,3	low
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4	8,2 – 15,6	low
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4	8,4 – 17,7	low
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9	8,2 – 17,9	low

Poor and medium supply in potassium shows the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols & Vertic Luvisols, Gleysols 30 – 120 ppm.The total area occupied by soils with a low content in mobile potassium is 4.278.1 ha. The soil potassium supply status of the soils of the Veljurilor Plain is presented in Table 16.

Table 16

Soil potassium supply status of the Veljurilor Plain soils

Soil type	Distribution area	Area - ha	K – ppm Medium values	reserve
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7	70 - 120	Medium
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8	140 - 210	Medium - high
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6	90 - 120	Medium
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4	70 - 110	Medium
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4	30 - 65	low
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9	90 – 120	Medium

Ensuring optimal conditions for the growth, development and fruiting of crop plants depends on the reserve of soil nutrients (17). Through the administration of chemical and organic fertilizers, the fund of nutrients in forms accessible to plants is ensured, the mobility and electrokinetic potential of different ions in the soil solution and the absorbent complex are increased, the ratio between different ions in the solution is changed, the mobility of other elements in hard-to-reach forms from the soil reserve is ensured. The chemical analyzes carried out on the soils of Veljurilor highlighted low values of the supply of nutrients in the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols, Vertic Luvisols, the total area being 10023 Ha. These soils react extremely favorably to the administration of mineral and organic fertilizers. Organic fertilizers are very effective, helping to improve the physical properties of the arable soil layer in addition to enriching the soil with nutrients. To restore assimilable nitrogen reserves, leguminous crops are indicated. On these soils, phosphorus fertilizers are poorly or moderately used, their effectiveness is increased by applying together with organic fertilizers. The use of chemical and organic fertilizers is the main means of increasing the fertility of these soils.

Recommended doses of chemical fertilizers are calculated in relation to the crop plant, specific consumption/ton of harvested product, expected production, the nutrient reserve of the soil [20].

CONCLUSIONS

The integrated research of local soil conditions, with climatic conditions and the requirements of agricultural crops in relation to vegetation factors, is part of the concept of practicing sustainable agriculture (29, 30). Carrying out research in which the limiting and restrictive factors of agricultural production are defined, cataloged and studied and the establishment of the main directions of intervention to ensure optimal conditions in relation to the requirements of agricultural crops constitute the basis of a sustainable agriculture. This research can be the basis for realizing programs to restore the fertility potential of soils in areas where intensive agriculture is practiced (16). The research carried out in the Veljurilor Plain can be stored in databases and used later by the units with an agricultural profile, for: choosing the assortment of agricultural crops with a high degree of adaptability to local soil and climate conditions; the introduction into agricultural practice of drought-resistant species, varieties and hybrids; carrying out cartograms with soil properties, technological indicators and production capacity; the correct application in units with an agricultural profile of a differentiated agricultural technique by correlating the physico-chemical properties of the soil with the requirements of the crop plants; the design of land improvement works and works to restore the soil's fertility potential; the design and establishment of irrigation systems considering the fluctuations of the pluviometric regime; the organization of the territory. The research can be integrated into the National Soil Quality Monitoring System, an integral part of the International Environmental Quality Monitoring System.

REFERENCES

1. Seppelt, R.; Koltz, S.; Peiter, E.; Volk, M. Agriculture and food security under a changing climate: An underestimated challenge. Iscience. 2022, 25, 1- 13. https://doi.org/10.1016/j.isci.2022.105551
2. Hatfield, J. L.; Boote, K. J., Kimball, B. A.; Ziska, L. H.; Izaurralde, R. C.; Ort, D.; & Wolfe, D. Climate impacts on agriculture: implications for crop production. Agronomy journal 2011, 103(2), 351-370. https://doi.org/10.2134/agronj2010.0303
3. National Meteorological Administration. A Guide to Adapting to the Effects of Climate Change. Available online: https://nap.nationalacademies.org/catalog/12783/adapting-to-the-impacts-of-climate-change
4. The natural setting of the Crişurilor Plain and the Crisene Hills. https://www.scrigroup.com/geografie/Cadrul-natural-al-Campiei-Cris33485.php
5. Huismans, R. S; Bertotti, G.; Ciulavu, D.; Sanders, C. A. E., Cloetingh, S. A. P. L.; Dinu, C. Structural evolution of the Transylvanian Basin (Romania): a sedimentary basin in the bend zone of the Carpathians. Tectonophysics. 1997, 272, 249-268. https://doi.org/10.1016/S0040-1951(96)00261-2
6. Map of relief units in Romania. Available online: https://www.geotutorials.ro/atlas-geografic/harti-romania/
7. Posea, G. Geografia fizică a României. https://www.academia.edu/6964997/Geografia_Fizica_a_Romaniei_Partea_2
8. Standards and Methodologies regarding Natural Resources and the Environment. Available online: https://icpa.ro/standarde/
9. Ispas, St.; Murătoreanu, G.; Leotescu, R.; Ciulei, S. Pedology, soil research in the field. Valahia University Press, Târgovişte, 2006. Available online:

https://scholar.google.ro/citations?user=fZYH0PYAAAAJ&hl=ro
10. The Romanian Soil Taxonomy System. Available online: https://ro.scribd.com/document/374689589/Sistemul-Roman-de-Taxonomie-a-Solurilor-2012-SRTS
11. World reference base for soil resources. Available online: https://www.fao.org/3/w8594e/w8594e00.htm
12. Archive of the Oradea Meteorological Station.The National Meteorological Administration. Available online: https://www.meteoromania.ro/
13. Monitoring the state of soil quality in Romania. Available online: https://www.icpa.ro/proiecte/Proiecte%20nationale/monitoring/atlasICPA.pdf
14. Combating Desertification in the EU. Available online: https://op.europa.eu/webpub/eca/special-reports/desertification-33-2018/en/
15. Rust, N.; Lunder, O. E.; Iversen, S.; Vella, S.; Oughton, E. A.; Breland, T. A.; Reed, M. S.; Perceived Causes and Solutions to Soil Degradation in the UK and Norway. Land. 2022, 11(1), 131. https://www.mdpi.com/1450308
16. MichaelT. Löbmann, Linda Maring Gundula Prokop, Jos Brils, Johannes Bender, Antonio Bispo, Katharina Helming.Systems knowledge for sustainable soil and land management, https://doi.org/10.1016/j.scitotenv.2022.153389
17. Raza, A.; Razzaq, A.; Mehmood, S. S.; Zou, X.; Zhang, X.; Lv, Y.; Xu, J. Impact of climate change on crops adaptation and strategies to tackle its outcome: A review. Plants 2019, 8(2), 34. https://doi.org/10.3390/plants8020034
18. Guide on the conservation and rational use of soil moisture. Available online: https://www.gwp.org/globalassets/global/gwp-cee_files/regional/idmp-guide-moldova-ro.pdf
19. Guide for the preparation of Drought Management Plans. Available online: https://climate-adapt.eea.europa.eu/en/metadata/guidances/guidelines-for-preparation-of-the-drought-management-plans
20. Berchez O.; Stanciu A.; Research on soil degradation in the Crişurilor plain, Research Article, International Journal of Multidisciplinary Research Updates 2021, 01(01), 026–036. https://doi.org/10.53430/ijmru.2021.1.1.0033
21. Sopotlieva D.; Apostolova I.; Dry Grassland Vegetation in the Transition Zone Between Two Biogeographic Regions. https://doi.org/10.2478/hacq-2014-0010

22. Drought monitoring in Romania. Available online: https://edo.jrc.ec.europa.eu/edora/docs/EDORA_2022061617/Alexandru_JRC_17june2022-Daniel-AGRORomania.pdf
23. Rusu Teodor, Horea Cacovean, Paula Moraru , Ileana Bogdan, Mara Sopterean, Doru Marin, Adrian Pop, Camelia coste, Rafael Marian, Soil Moisture and Temperature Regimes Monitoring in the Transylvanian Plain, Romania, Available online: https://journals.usamvcluj.ro/index.php/promediu/article/view/9883/8234
24. Dubiac Daniela, Variation of Crop Yield in Agrocoenoses under Influence of Climatic Factors, Available online: https://journals.usamvcluj.ro/index.php/promediu/article/view/9892
25. Sălăgean Tudor, Dardja Marcel, Hoble Adela, Studies upon Climatic Soil Moisture Indicators, Available online: https://journals.usamvcluj.ro/index.php/promediu/article/view/9934
26. Weidorf David, Haggard Beatrix, Rusu Teodor, Soil Temperatures of the Transylvanian Plain, Romania. Available online: http://dx.doi.org/10.15835/buasvmcn-agr:3979
27. Rusu Teodor, Weindorf David, Haggard Beatrix, Moraru Paula Ioana, Cacovean Horea, Ileana Bogdan, and Mara Lucia Sopterean, Soil Moisture and Temperature Monitoring for Sustainable Land and Water Management in Transylvanian Plain, Romania. Available online: https://meetingorganizer.copernicus.org/EGU2011/EGU2011-2690.pdf
28. Rusu Teodor, Moraru Paula, Coste Camelia, Cacovean Horea, Chetan Felicia, Chetan Cornel, Impact of climate change on climatic indicators in Transylvanian Plain, Romania. Available online: https://www.academia.edu/20196767/Impact_of_climate_change_on_climatic_indicators_in_Transylvanian_Plain_Romania
29. Rusu Teodor, Moraru Ioana Paula, Sopterean Maria Lucia, Climate Monitoring and Recommendations on the Optimum Sowing Period for the Main Crops in the Transylvanian Plain, Romania, Available online: https://www.researchgate.net/publication/258614910_Climate_Monitoring_and_Recommendations_on_the_Optimum_Sowing_Period_for_the_Main_Crops_in_the_Transylvanian_Plain_Romania
30. Rusu Teodor, Climate Monitoring and Water Resources Management for the Main Crops in the Transylvanian Plain, Romania. Available online:

https://www.academia.edu/64426320/Climate_Monitoring_and_Water_Resources_Management_for_the_Main_Crops_in_the_Transylvanian_Plain_Romania

31. Rusu Teodor, Weindorf David, Haggard Beatrix, Cacovean Horea , Moraru Paula Ioana, Pop Adrian, Pop Lavinia, and Sopterean Maria Lucia. Soil Temperatures, Water and Humus Conservation of the Transylvanian Plain, Romania. Available online: https://meetingorganizer.copernicus.org/EGU2010/EGU2010-1092-1.pdf
32. Haggard Beatrix, Rusu Teodor, Weindorf David, Sopterean Mara, Spatial Soil Temperature and Moisture Monitoring Across the Transylvanian Plain in Romania, https://www.researchgate.net/publication/357317069_Spatial_Soil_Temperature_and_Moisture_Monitoring_Across_the_Transylvanian_Plain_in_Romania
33. Rusu Teodor, Moraru Paula Ioana. Impact of climate change on crop land and technological recommendations for the main crops in Transylvanian plain, Romania. Available online: https://www.researchgate.net/publication/282053072_Impact_of_climate_change_on_crop_land_and_technological_recommendations_for_the_main_crops_in_Transylvanian_plain_Romania?_