EVOLUTION OF THE ECOPEDOLOGICAL FEATURES OF CAMBIC CHERNOZEM FROM VINGA HIGH PLAIN IN CONSERVATIVE AND CONVENTIONAL TILLAGE SYSTEMS

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Abstract: *The research made is falling on the line to develop an sustainable agricultural system, responding to local requirements for establishing a scientific database necessary for the development of technology and measures of agroecosystems integrated management. Conservative systems are based on less intensive loosening soil through different methods without return and only furrow the soil surface while maintaining a certain amount of plant debris, often seen as environmental protection strategies. The system of soil conservation means any soil work that lets you keep debris on the soil surface or near surface and / or maintenance of granular soil surface to reduce soil erosion and improved water relations with soil. The passing to no-till cultivation system radically changes the content of technological elements, that simplifies the technology by the suppression of soil work, so the impact on the agricultural ecosystem is different from that of conventional technology, first decreases the pressure on agricultural ecosystem and on the other apear new interactions, new disrupt the new balance or imbalances.The research made in the world concerning no-till technology get some information about the implications of this system of agricultural cultivation on the environment, showed that the impact varies from one area to another, depending on climatic and soil conditions encountered, agricultural management. The researches regarding the evolution of the agro-ecosystems quality and productivity from the Vinga High Plain in the no-till crop system tries to highlight the quality and quantity changes emerged in the agricultural ecosystem. The aim of the research carried out has its origins in the current scientific and practical concerns increasingly to identify and put in place of a system of tillage, agronomic efficient, low energy and financial cost, environmental and soil conservation, to replace the classic system. There are presented some aspects regarding the physical - geographical characterization necessary for the experimental field localization. Here are briefly introduced the geology and lithology of surface materials, clime conditions, land drainage etc., as defining elements for edaphic resources' main characteristics. To determine physical, chemical and biological properties of cambic chernozem from Aradul Nou more samples were collected in both natural settlement (to determine the bulk density, total porosity, compactation degree) and in disturbed settlement (to determine other properties). Also, regarding the soil conditions have been determined the defining characteristics for the ecosystems productivity, granulated structure and humus content. In close relation with the first two aspects have been established the main physical, chemical and biological properties of the cambic chernozem from Aradul Nou. In order to determine the complex relation that take place between different soil characteristics and agro-ecosystems components, the researches were conducted both on field and laboratory.*

Key word: *physical, chemical, conservative, conventional, tillage*

INTRODUCTION

Appeared in the Mesolithic Era as a way of producing the needs for everyday life by cultivating plants and husbandry, agriculture became at the same time with the evolution of humans and society a branch of the material production, which involves all the works and methods used for obtaining alimentary products and some prime matters by using the soil in

this purpose (ȚĂRĂU D. and all., 2008).

The conventional tillage system, generalized for crop cultivation in our country, includes a large number of works designed to make conditions more favorable for crop sowing and plant development.

This agriculture system disrupt, often very serious, the balance in agricultural ecosystems, produce crops pollution, soil pollution and groundwater or surface water pollution and is very often too expensive in comparison with the financial possibilities of the farmers.

Conservative systems are based on less intensive loosening soil through different methods without return and furrow the soil surface only while maintaining a certain amount of plant debris, often seen as environmental protection strategies.

The system of soil conservation means any soil work that lets you keep debris on the soil surface or near surface and / or maintenance of granular soil surface to reduce soil erosion and improved water relations with soil.

Unconventional tillage system, thought the idea of optimal in terms of technological, economic and environmental, for certain area, unit or parcel, is the basis of the cultivation technologies of alternative and sustainable agriculture (DUMITRU ELISABETA and all., 1990).

The no-till technology belongs to the agricultural systems that have the role to conserve the soil, being known in the modern agriculture from the 1950s when on the American continent were settled up the technologies with minimum works in order to find some practical methods for reducing and stopping the soil erosion, a phenomenon that was more and more aggressive on the fields cultivated as an conventional system (MONICA ANDRU, 2004).

The passing to no-till system change the structure of technological elements, through less soil works, so the impact on agro-system is different comparing with conventional tillage, first lessing the intervention pressure on agro-system ant secondly appears new interactions, new equilibriums and disequilibriums.

MATERIAL AND METHODS

The experimental field was placed on a cambic cernozem, with a medium content of clay, dominant in the Prodagro West Arad agro-centre and representative for a large surface in the Banat-Crisana Plain, the experiment being situated at approximately 500 m SW from the Andagra farm, located on the Arad cadastral territory, coordinates $46^0$7’55” N latitude and $21^0$17’45” E longitude, 115 m altitude.

The experimental factors are: Factor A – the technological system (A1 – without deep soil working, A2 – with deep soil working), Factor B - the culture system (B1- classic culture system, B2- No-till culture system), Factor C- fertilizers doses (C1- N_0 P_0 K_0, C2- N_{80} P_{80} K_{80}, C3- N_{160} P_{80} K_{80}).

The research of the ecopedologic conditions was made according to “The methodology of elaborating of pedological studies”, vol. I, II and III elaborated by the ICPA Bucharest in 1987, completed with specific elements from the Romanian System of Soils Taxonomy (SRSTS-2003).

To determine physical, chemical and biological properties of cambic chernozem from Aradul Nou more samples were collected in both natural settlement (to determine the bulk density, total porosity, compactation degree) and in disturbed settlement (to determine other properties).

The preparation, analysis of probes and interpretation of results was done in OSPA Timisoara and USAMVB Timisoara labs.

RESULTS AND DISCUSSIONS

Vinga high plain is the oldest and the most complex among Banat-Crisana plains and extends south of Mures everglade, west of Lipova hills, north of Bega low plain, east of Galatca plain. It is formed at the convergence of hills glacisist, shaped by a net of flowing waters and erosion valleys (ȚĂRĂU D., and all., 2008).

From the geo-morphological point of view the perimeter on which are located the experiments belongs to the large physical –geographic unity called the Vinga High Plain.

Relief present itself as a succession of high plain , almost even, with altitudes between 95-200 m , separated by wide valleys, rather deep, collected quite in exclusivity by Berecsau river (and less by Mures river).

The zone between the rivers are well individuated in 5 steps layed in fan shape: Seceani (180 m), Alios (160 m), Vinga (150 m), Calacea (130 m), Satchinez (100 m) realized by Mures river at different geological moments an partly tectonically influenced.

The overall look is the piedmont plain which descends to the northwest by step (which originated with the withdrawal of the Pannonian lake) with the line passes several times without overheads terrace (which is characteristic in connection with the Mures meadow and Aranca plain) (ȚĂRĂU D., and all., 2003).

Hydrographically, the perimeter where the experiment is placed belongs to the hydrographic basin of Mures river which flows at about 2-3 km north from this. The pedo-phreatic levels are at 5,1 – 10 m depth (they don't interfere in the pedo-genesis processes) in flat areas and between 1,5 – 3,0 m depth in the valleys.

The climate is a temperate-continental one with Mediterranean influences, the medium multi-annual temperature being of $10,4^0$C and the multi-annual rainfall 593,5 mm .

Among terrestrial-edaphic factors and conditions, determining factor in the production capacity of land, soil conditions are a major component, with multiple events both in terms of their characteristics and how to store the influence of other environmental factors.

Soil characteristics can exert influence on the development of root systems, mineral nutrition, providing the required heat treatment and conduct aerohidric main physiological processes and plants act both directly and indirectly on the state of soil fertility.

Under soil conditions can be delineated certain characteristics that may be conducive to productivity of land and other properties derived from the first. Features such as size and composition of humus content are crucial features, while the cation exchange capacity is determined by the first two and mineralogical nature of clay.

As a result of the cosmic-atmospheric and telluric factors intervention, under a vegetation specific to the forest steppe, in the zone were created cambium cherrnozems, specific to the researched perimeter.

Soil's texture, a very stable physical feature, is medium clay on the whole profile. The Bulk Density (DA) has medium values in the worked layer from the classic system, high in the first 10 cm in no-till system and very high in the middling third of the soil profile in the two systems.

We can notice an increase in bulk density values, both in the range 0-10 cm and 10-20 cm range, in the classical system leading from 1.36 - 1.38 to the 1.50 - 1.58 and in no-tillage system from 1.53 - 1.57 from 1.62 - 1.73, both variants and in the variants without deep work of soil. And for the other intervals is similar upward trend (table 1).

Crop plants are good conditions for root system development, when the total porosity has ranged between 48-60% of soil capillary porosity is 30-36% and noncapillary of 18-24% (DUMITRU ELISABETA and all., 2004).

The Total Porosity (PT) has low values in the 0 – 33 cm interval, and also in the 45 – 96 cm one. The aeration porosity, which represents all the pores occupied with air when the

soil is in optimum humidity conditions, has very low values, excepting the worked layer from the classic system, where it has low values and the first 10 cm depth in No-till system where the values are very low.

Table 1

Values of bulk density (Da) on a cambic chernozem from Aradul Nou

Technological system		Culture	Depth(cm)									
			3-8		15-20		40-45		60-65		80-85	
			2007	2010	2007	2010	2007	2010	2007	2010	2007	2010
Without deep work of soil	No-tillage	Maize	1,57	1,51	1,60	1,77	1,61	1,55	1,61	1,65	1,59	1,68
		Soybean	1,56	1,62	1,56	1,63	1,58	1,63	1,57	1,64	1,55	1,70
		Wheat	1,53	1,73	1,53	1,71	1,63	1,60	1,52	1,61	1,50	1,75
	Classic	Wheat	1,38	1,57	1,57	1,76	1,59	1,60	1,58	1,67	1,59	1,67
		Soybean	1,39	1,57	1,54	1,75	1,59	1,65	1,52	1,60	1,58	1,66
		Maize	1,36	1,56	1,54	1,59	1,60	1,58	1,53	1,66	1,56	1,67
With deep work of soil	No-tillage	Maize	1,57	1,66	1,60	1,73	1,61	1,59	1,61	1,65	1,59	1,59
		Soybean	1,56	1,66	1,56	1,51	1,58	1,63	1,57	1,65	1,55	1,68
		Wheat	1,53	1,53	1,53	1,61	1,63	1,60	1,52	1,62	1,50	1,64
	Classic	Wheat	1,38	1,59	1,57	1,72	1,59	1,53	1,58	1,68	1,59	1,55
		Soybean	1,39	1,50	1,54	1,73	1,59	1,68	1,52	1,74	1,58	1,68
		Maize	1,36	1,58	1,54	1,62	1,60	1,63	1,53	1,64	1,56	1,58

The highest values of total porosity (table 2), the range of 0-10 cm were recorded in the classical system, with values ranging from 40.3 to 40.68% in the variants without deep work and 39.54 to 42.97% in the variants with deep work of soil, compared with no-tillage system, where there were slightly smaller values (34.22 to 38.40% in the variants without deep work and from 36.88 to 41.82% in variants with deep work).

Table 2

Values of total porosity (PT) on a cambic chernozem from Aradul Nou

Technological system		Culture	Depth(cm)									
			3-8		15-20		40-45		60-65		80-85	
			2007	2010	2007	2010	2007	2010	2007	2010	2007	2010
Without deep work of soil	No-tillage	Maize	40,30	42,59	39,16	32,70	39,25	41,51	39,02	37,50	40,23	36,84
		Soybean	40,68	38,40	40,68	38,02	40,38	38,49	40,53	37,88	41,73	36,09
		Wheat	41,83	34,22	41,83	34,98	38,49	39,62	42,42	39,02	43,61	34,21
	Classic	Wheat	47,53	40,30	40,30	33,08	40,00	39,62	40,15	36,74	40,23	37,22
		Soybean	47,15	40,30	41,44	33,46	40,00	37,74	42,42	39,39	40,60	37,59
		Maize	48,29	40,68	41,44	39,54	39,62	40,37	42,05	37,12	41,35	37,22
With deep work of soil	No-tillage	Maize	40,30	36,88	39,16	34,22	39,25	40,00	39,02	37,50	40,23	40,23
		Soybean	40,68	36,88	40,68	42,59	40,38	38,49	40,53	37,50	41,73	36,84
		Wheat	41,83	41,82	41,83	38,78	38,49	39,62	42,42	38,64	43,61	38,35
	Classic	Wheat	47,53	39,54	40,30	34,60	40,00	42,26	40,15	36,36	40,23	41,73
		Soybean	47,15	42,97	41,44	34,22	40,00	36,60	42,42	34,09	40,60	38,34
		Maize	48,29	39,92	41,44	38,40	39,62	38,49	42,05	37,88	41,35	40,60

In variants planted with soybeans in no-till system were higher values on the horizon 10-20 cm. For other intervals, total porosity values presented are much more uniform in both classical and no-tillage system, with and without deep work of soil.Compared with results from 2007, we can observe a decrease of values in all experimental variants, the variants from classical system beying bigger than others, in the variants with and without deep work of soil.

Aeration porosity have very small values with exception of the classic variants (which has small values) and the first 10 cm of no-tillage system (the values are very small).

Compared with baseline, there is a decrease of aeration porosity in all experimental

variants, bigger in the variants cultivated in classical system, with and without deep work of soil (table 3).

Table 3

Values of aeration porosity (PA) on a cambic chernozem from Aradul Nou

Technological system		Culture	Depth(cm)									
			3-8		15-20		40-45		60-65		80-85	
			2007	2010	2007	2010	2007	2010	2007	2010	2007	2010
Without deep work of soil	No-tillage	Maize	-0,67	+3,8	-2,60	-13,49	-2,78	+0,59	-3,09	-5,57	-1,27	-7,00
		Soybean	-0,03	-3,88	-0,03	-4,52	-0,86	-4,54	-0,53	-4,92	1,27	-8,28
		Wheat	1,89	-10,93	1,89	-9,65	-4,05	-2,62	2,68	-3,00	4,46	-11,47
	Classic	Wheat	11,51	-0,68	-0,67	-12,86	-1,50	-2,62	-1,17	-6,85	-1,27	-6,37
		Soybean	10,87	-0,68	1,25	-12,22	-1,50	-5,82	2,68	-2,37	-0,64	-5,74
		Maize	12,79	-0,04	1,25	-1,97	-2,14	-1,34	2,04	-6,21	0,64	-6,37
With deep work of soil	No-tillage	Maize	-0,67	-6,45	-2,60	-10,95	-2,78	-1,98	-3,09	-5,57	-1,27	-1,27
		Soybean	-0,03	-6,45	-0,03	-2,56	-0,86	-4,54	-0,53	-5,57	1,27	-7,00
		Wheat	1,89	-1,88	1,89	-3,24	-4,05	-2,62	2,68	-3,64	4,46	-4,45
	Classic	Wheat	11,51	-1,96	-0,67	-10,12	-1,50	+1,87	-1,17	-7,49	-1,27	+1,28
		Soybean	10,87	+3,80	1,25	-10,93	-1,50	-7,75	2,68	-11,34	-0,64	-5,51
		Maize	12,79	-1,31	1,25	-3,88	-2,14	-4,54	2,04	-4,92	0,64	-0,64

In the top layer of soil (0-10 cm) the aeration porosity have extremely low values of both the plots cultivated in no-tillage and classical system with and without scarification, having values between - 10.93% in the variant cultivated in no-tillage system with wheat without deep work of soil and 3.8% in version planted with corn in no-tillage system without deep work and in variant cultivated with soybean in the classical system with deep work.

Between 10-30 cm depth the aeration porosity have extremely low values of both the variants cultivated in the classical system and for those grown in no-tillage, with values ranging from -13.49% in variant with maize cultivated in no-tillage with deep work and -1.97% in variant cultivated with corn in the classical system without deep work of soil.

The degree of soil compaction is the general indicator of the status of settlement of the soil profile, which in practice reflects the state of aeration or compaction (compression) of agricultural soils (GUŞ P., A. PUSCU, 1999).

To appreciate the real status of the settlement of the soil, the absolute values of bulk density or total porosity can not be interpreted properly, because their practical significance is different from soil to soil depending on his texture.

Indicator that includes both bulk density (total porosity) and takes into account the soil texture is the degree of compaction. Compaction is the process by which soil bulk density increases above optimal values and total porosity falls below normal.

Soil compaction occurs under the influence of two factors: natural factors (natural compaction) which is due to factors or processes of pedogenesis and artificial factors (compaction artificial or anthropogenic). Anthropogenic compaction occurs due to excessive traffic, irrationally, with agricultural machinery, agricultural land and is performed on the specific type of intensive agriculture.

The negative effects of compaction are multiple: reduced water holding capacity and especially the permeability, reduced aeration, degrades soil structure and with this and other physical attributes. As a consequence of worsening the characteristics of the soil, reduces capacity, sometimes decreased yields by up to 50% compared uncompacted soil.

The compaction degree at depth of 0-10 cm have high values indicating a strong compaction, with values ranging from 18.66% in the variant grown with wheat in no-tillage

system with deep work and 33.45% in the version planted with wheat in no-tillage system without deep work of soil, except the variants with corn in no-tillage system without deep work and variant cultivated with soybean in the classical system with deep work of soil showing medium values, indicating a moderate soil compaction (table 4).

Table 4

Values of compactation degree (GT) on a cambic chernozem from Aradul Nou

Technological system		Culture	Depth(cm)									
			3-8		15-20		40-45		60-65		80-85	
			2007	2010	2007	2010	2007	2010	2007	2010	2007	2010
Without deep work of soil	No-tillage	Maize	20,10	17,17	23,72	36,30	24,83	20,19	23,99	26,96	21,76	28,35
		Soybean	20,89	25,32	20,76	25,94	22,21	25,85	21,06	26,22	18,84	29,81
		Wheat	18,65	33,45	18,52	31,86	25,85	23,68	17,37	23,99	15,19	33,47
	Classic	Wheat	7,57	21,63	21,50	35,56	22,94	23,68	21,79	28,44	21,76	27,62
		Soybean	8,30	21,63	19,28	34,83	22,94	27,29	17,37	23,28	21,04	26,89
		Maize	6,08	20,89	19,28	22,98	23,67	22,23	18,10	27,70	19,58	27,62
With deep work of soil	No-tillage	Maize	20,10	28,28	23,72	33,35	24,83	22,94	23,99	26,96	21,76	21,76
		Soybean	20,89	25,28	20,76	17,04	22,21	25,85	21,06	26,96	18,84	28,24
		Wheat	18,65	18,66	18,52	24,46	25,85	23,68	17,37	24,73	15,19	25,42
	Classic	Wheat	7,57	23,10	21,50	32,60	22,94	18,59	21,79	29,18	21,76	18,84
		Soybean	8,30	16,43	19,28	33,34	22,94	29,49	17,37	33,60	21,04	25,44
		Maize	6,08	22,36	19,28	25,20	23,67	25,85	18,10	26,22	19,58	21,04

The data show that the degree of compaction values are higher for parcels without deep work, cultivated in no-tillage compared with the plots cultivated in the classical system.

At 10-30 cm depth degree of compaction is strong in both variants grown in the classical system and for those grown in no-tillage, with values ranging from 22.98% in variant cultivated with corn in the classical system without deep work and -36.30% in variant cultivated with corn in no-tillage system without deep work of soil.

Degree of compaction values obtained at the end of experimental point show the positive effect of deep work of soil, but show the existence of small differences between the variants with and without deep work of soil (DICU D., 2010).

About the chemical properties of the cambic chernozem from Aradul Nou, we can made the following remarks:

The analyzed soil has an acid reaction (5,9 – 6,8) in the first 80 cm of the soil profile, neutral between 80- 125 cm and low alkaline between 125 – 200 cm depth.

The mobile phosphorus content (P) in the worked soil (Ap) has medium values (35,0 ppm) at the limit of alert threshold (concerning the nutrition lack) the mobile potassium supply (K) having medium values (153 ppm), values which are lower on with the profile.

The humus reserve in the first 50 cm is high, and the natrium index (I.N.) has medium values in the worked layer (Ap) and also in the 0 – 45 cm layer.

One can notice a decrease in pH values from the weak acid values to strong acid values. In terms of nitrogen content it is found between the same limits of interpretation as in 2007. Phosphorus and potassium content can be seen a small increase in the content of these elements, but still surrounding the same limits of interpretation (table 5).

In addition to monitoring the physical and chemical properties of soil, we aimed to obtain data on the biological activity respectively lumbricidae activity at this level, which were extracted for this purpose according to specific methodology, in soils cultivated with different types of plants, in version control and mineral fertilization variants.

The earthworms, through their boring work into the soil produce internal changes in

the morphology of the soil, creating large pores, with very important role in the processes of water and air movement and plant root system development.

Table 5

Evolution of the main agrochemical properties of the cambic chernozem from Aradul Nou

Technological system		Culture	pH		IN (ppm)		P (ppm)		K (ppm)	
			2007	2010	2007	2010	2007	2010	2007	2010
Without deep work of soil	No-tillage	Maize	6,18	5,25	2,50	2,41	40	70,0	250	184,7
		Soybean	6,20	5,86	2,60	2,88	38	26,0	260	295,6
		Wheat	6,22	5,72	2,45	2,92	65	86,0	260	324,8
	Classic	Wheat	6,26	5,67	2,20	2,46	33	70,0	260	205,7
		Soybean	5,95	5,58	2,10	2,49	40	53,0	230	248,9
		Maize	5,85	5,52	2,40	2,20	47	33,0	270	203,7
With deep work of soil	No-tillage	Maize	6,18	5,59	2,50	2,76	40	23,0	250	285,1
		Soybean	6,20	5,74	2,60	3,24	38	62,0	260	197,6
		Wheat	6,22	5,78	2,45	2,49	65	19,0	260	232,7
	Classic	Wheat	6,26	5,89	2,20	3,08	33	32,0	260	203,4
		Soybean	5,95	5,92	2,10	2,56	40	19,2	230	221,3
		Maize	5,85	5,95	2,40	2,28	47	32,6	270	214,7

At the same time by moving in the soil they eat considerable quantities of soil removed him in a state of humificare submitted, and a mixture of fine mineral particles and organic structural mycro-agregats united natural quality called coprolite, multiplication and movement in soil is conditioned by their need for oxygen, water and food.

Measurements on the earthworms present shows that their number is higher in variants with soy grown in the no-tilage system than the number of individuals identified in corn and soybean crops (table 6).

Table 6

Dynamics of number and biomass of lumbricidae on a cambic chernozem from Aradul Nou

Technological system		Culture	2008		2009		2010	
			Number (pieces/m^2)	Biomass (g/m^2)	Number (pieces/m^2)	Biomass (g/m^2)	Number (pieces/m^2)	Biomass (g/m^2)
Without deep work of soil	No-tillage	Maize	15	7,28	10	7,15	11	14,28
		Soybean	28	10,25	21	13,25	34	51,82
		Wheat	13	8,14	5	4,14	15	36,59
	Classic	Wheat	11	7,47	6	5,41	4	2,37
		Soybean	9	7,13	14	9,34	13	15,42
		Maize	12	6,83	8	6,27	17	33,02
With deep work of soil	No-tillage	Maize	16	6,81	9	6,81	7	9,8
		Soybean	25	10,94	18	10,78	11	15,88
		Wheat	15	8,20	8	5,20	6	14,2
	Classic	Wheat	11	8,37	7	4,37	4	3,58
		Soybean	9	6,88	16	9,81	5	7,64
		Maize	10	7,93	10	7,93	6	13,04

Comparing the results obtained from the three cultures is noted that the dynamics of earthworms recorded have higher values in the soybean crop to maize and wheat, in both tillage systems, these results are attributed to the fact that earthworms prefer soils with a low degree of disturbance by farm machinery.

CONCLUSIONS

Cultivating the agricultural fields by using incomplete and incoherent technologies seriously damages both quantitatively and qualitatively not only the production but especially the soil resources, the practice proving that, in order to function the little or large agricultural farms, the main condition is the choice of the most suitable technologies.

The results obtained in the soil and climate conditions mentioned, although not allow

for a clear formulation of recommendations in the culture systems tested, but the background information gathered is extremely valuable for scientific substantiation of appropriate technologies in the future for climatic conditions specific of the area in which investigations were undertaken as well as similar areas, conservative tillage systems representing alternatives to conventional tillage systems by the effects of conservation of soil properties and yields

In terms of crop suitability to no-till system, soil texture has some restrictions due to clay - clay and secondary compaction, without excluding the possibility of adopting no-till practices.

Yields obtained by applying the conservative systems, can achieve differentiated results that show, at least close if not superior to classical ones. Choosing the system should be made, as appropriate, depending on plant, soil and climate specific conditions.

The research supports the ability to promote no-till technology in production established itself selective implementation, where conditions are suitable ecopedological this system of agriculture, under effective management.

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