THE RESULTS REGARDING THE POSSIBILITIES OF ECOLOGICAL RECONSTRUCTION OF THE SOILS POLLUTED WITH PETROLEUM OBTAINED AT SUPLACU DE BARCĂU – PREMISE FOR ACCOMPLISHING SOME WIDER PROGRAMS

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Suplacu de Barcău is situated in an area in which the multianuall average of precipitations is of 619 mm (following the meteorologic station Nusfalau situated at 10 km away) and an annual average temparature of 10□. For the cold season (X -III) the multianual avearge of precipitations is of 205,6 mm, and for the warm season (IV - IX) of 413,4 mm. The soil on which is placed the experiment is an albic pseudogleizated luvisoil, with phreatic water at the depth greater than 10 m.

The researches from Suplacu de Barcău were placed in 1993, in the laboratory of Pedology and territorial improvement, in a topic coordinated by the lecturer dr. eng. Maria Sandor in the program of researches „Monitoring of the quality of soil".

In the following is presented a synthesis of the results obtained in the period 1993-1999.

Climatic indices of the initial field before the placing of the experiment are presented as the following:

- the reaction of the soil on the ploughed layer had values between 4,9 and 5,2 units pH, being strongly acid; on the soil layer from 20 – 40 cm depth, the reaction of the soil is maintained in the same field (pH = 4,99 – 5,21).

- the mineral nitrogen accesible has values between 3,3 ppm şi 10,1 ppm on the ploughed layer and on the layer between 20 – 40 cm the values are between 3,4 and 7,8 ppm. By the content in $N - NO_3 + N - NH_4$ the soil has a mediocre supply.

- the mobile Phosphorus has values between 41 and 50 ppm, the supply with this element being good.

- the mobile Potassium has values between 99 and 127 ppm on the ploughed layer and between 105 and 155 ppm. The supply of the soil with mobile Potassium is good.

In the first year of effect 1993 the production of hay millet has varied between 36,5 q/ha for the version without aeration with the ripper and without organic or mineral fertilization and 86,6 q/ha in the version with

ripping, 50 t/ha farmyard manure and the maximum dose of mineral fertilizers ($N_{300}P_{240}K_{210}$).

The factor deep aeration by ripping, in the first year of effect, influences the average increase of 4,2 q/ha. We should mention that the degree of pollution of the ripped lots was maximum in two of three repetitions.

The factor of organic fertilization accomplishes significant increases of 17,7 – 18,8 q/ha at the doses of 50 and 100 t/ha and distinctly significant at 26,9 q/ha for the dose of 150 t/ha farmyard manure, on the ground without deep aeration.

The increases accomplished on the ground with ripping are all distinctly significant, between 20,5 – 22,7 q/ha.

The ground of mineral fertilization on the ground without deep aeration accomplishes a very significant increase of 22,2 q/ha at the maximum dose of $N_{300}P_{240}K_{210.}$ On the ground of ripping were obtained significant increases of 11,8 q/ha (21%) at the dose of $N_{200}P_{160}K_{140}$ and very significant of 20,3 q/ha (37%) at the maximum dose.

Table 1

The influence of some measures of remaking of degraded soils with petroleum residues on the millet harvest (hay, q/ha), Suplacu de Barcău, 1993 (first year of research)

B = Doses of organic fertilization – t/ha	**C= Doses of mineral fertilization**				**The average of organic fertilization**		
	c - 0	**c - 1**	**c - 2**	**c - 3**	**q/ha**	**%**	**dif.**
a – 1 Without deep aeration							
b - 0	36.5	38.4	43.6	59.2	44.4	100	-
b - 1	52.2	64.1	58.5	78.2	63.2	142	18.8^{x}
b - 2	54.0	56.3	65.0	73.3	62.1	140	17.7^{x}
b - 3	58.9	75.5	71.1	79.8	71.3	160	26.9^{xx}
The average of mineral fertiliz.	50.4	58.6	59.5	72.6	60.3		
q/ha %	100	116	118	114			
Difference q/ha	-	8.2	9.1	22.2^{xxx}			
a – 2 Deep aeration with the ripper							
b - 0	37.5	40.0	52.6	63.3	48.3	100	-
b - 1	50.4	65.7	72.4	86.6	68.8	152	20.5^{xx}
b - 2	63.0	69.2	70.5	76.8	69.9	145	21.6^{xx}
b - 3	69.0	69.0	71.7	74.5	71.0	147	22.7^{xx}
The average of mineral fertiliz.	55.0	61.0	66.8	75.3	64.5		
q/ha %	100	111	121	137			
Difference q/ha	-	6.0	11.8^{x}	20.3^{xxx}			

DL	5%	1%	0.1%
A to A	51.0	117.77	374.77
B to B	14.76	20.72	29.25
C to C	10.57	14.10	18.36
B to A	20.86	29.28	41.34
A to B	52.09	110.98	327.60
C to A	14.95	19.94	25.96
C to B	21.14	28.19	36.71
B to C	23.49	31.89	42.90
A to C	92.15	201.97	614.77
C to A and B	29.91	39.88	51.93
B to A and C	33.22	45.10	60.67
A to B and C	56.17	105.76	274.47

b0 = 0 t/ha manure
b1 = 50 t/ha manure
b2 = 100 t/ha manure
b3 = 150 t/ha. manure
c0 = $N_0P_0K_0$
c1 = $N_{100}P_{80}K_{70}$
c2 = $N_{200}P_{160}K_{140}$
c3 = $N_{300}P_{240}K_{210.}$

In the second year of effect 1994 due to the dryness, the millet arised very weakly and the crop was compromised.

In the third year of effect 1995, the harvest of millet (hay) obtained on the albic pseudogleizated luvisoil polluted with petroleum from Suplacu de Barcău has increased together with the increase of the dose of farmyard manure used, respectively together with the increase of doses of chemical fertilizers used. The deep aeration with the ripper has determined the increase of production of millet in all the versions studied.

Table 2

The influence of some measures of remaking of degraded soils with petroleum residues on the millet harvest (hay, q/ha), Suplacu de Barcău, 1995 (third year of research)

B = Doses of organic fertilization – t/ha	**C= Doses of mineral fertilization**				**The average of organic fertilization**		
	c - 0	**c - 1**		**c - 0**	**c - 1**		**c - 0**
a – 1 Without deep aeration							
b - 0	35.2	4.7	43.8	50.2	42.5	100	-
b - 1	40.5	46.2	50.0	55.7	48.1	113	5.6
b - 2	44.5	50.0	53.0	59.5	51.7	122	9.2
b - 3	47.0	53.5	57.0	62.5	55.0	129	12.5
The average of mineral fertiliz.	41.8	47.6	50.9	57.0			
q/ha %	100	114	122	136			
Difference q/ha	-	5.8	9.1	15.2			
a – 2 Deep aeration with the ripper							
b - 0	39.5	45.2	48.5	54.0	46.8	100	-
b - 1	45.0	52.5	54.7	61.5	53.4	114	6.6
b - 2	49.5	55.2	57.0	63.0	56.2	120	9.4
b - 3	52.2	58.5	61.2	65.0	59.2	126	12.4
The average of mineral fertiliz.	46.5	52.8	55.3	60.9			
q/ha %	100	113	119	131			
Difference q/ha	-	6.3	8.8	14.4			

DL	5%	1%	0.1%
A to A	4.43	10.23	32.55
B to B	6.19	8.69	12.27
C to C	2.65	3.54	4.61

b0 = 0 t/ha manure
b1 = 50 t/ha manure
b2 = 100 t/ha manure
b3 = 150 t/ha. manure
c0 = $N_0P_0K_0$
c1 = $N_{100}P_{80}K_{70}$
c2 = $N_{200}P_{160}K_{140}$
c3 = $N_{300}P_{240}K_{210.}$

In 1996, due to the improving of the condition of fertility of the polluted soil the field of research was cultivated with wheat, Delia soil. In 1995 after the harvest of the millet, there were good conditions for the preparing of the field for wheat. The applying of the manure and of the chemical fertilizers has determined the obtaining of increases of production assured statistically in all the cases. In the versions deeply aerated with the ripper were obtained greater productions than the productions obtained on the agricultural ground without deep aeration (Tab. 3).

Table 3

The influence of some measures of remaking of degraded soils with petroleum residues on the wheat harvest (hay, q/ha), Suplacu de Barcău, 1996 (fourth year of research)

B = Doses of organic fertilization – t/ha		C= Doses of mineral fertilization				The average of organic fertilization		
		c - 0	c - 1	c - 2	c - 3	q/ha	%	dif.
		$N_0P_0K_0$	$N_{100}P_{80}K_{70}$	$N_{200}P_{160}K_{140}$	$N_{300}P_{240}K_{210.}$			
a – 1 Without deep aeration								
b0	0 t/ha manure	10.8	16.2	19.1	19.6	16.4	100	-
b1	50 t/ha manure	14.2	20.6	22.9	22.5	20.0	122	3.6^{xx}
b2	100 t/ha manure	16.4	22.1	24.3	24.8	21.9	133	5.5^{xxx}
b3	150 t/ha manure	18.5	22.6	24.8	22.9	22.2	135	5.8^{xxx}
The average of mineral fertiliz.		15.0	20.4	22.8	22.4	20.1		
q/ha %		100	136	152	149			
Difference q/ha		-	5.4^{xxx}	7.8^{xxx}	7.4^{xxx}			
a – 2 Deep aeration with the ripper								
b0	0 t/ha manure	14.0	20.4	23.4	24.2	20.5	100	-
b1	50 t/ha manure	17.6	27.6	30.3	29.6	26.3	128	5.8^{xxx}
b2	100 t/ha manure	20.8	27.4	25.6	26.8	25.1	122	4.6^{xxx}
b3	150 t/ha manure	22.9	27.1	28.9	27.1	26.5	129	6.0^{xxx}
The average of mineral fertiliz.		18.8	25.6	27.0	26.9	24.6		
q/ha %		100	136	144	144			
Difference q/ha		-	6.8^{xxx}	8.2^{xxx}	8.1^{xxx}			

	DL 5%	1%	0.1%	
3.86 8.93 -				A to A
B to B	2.10	2.96	4.17	
C to C	0.90	1.21	1.58	

Table 4

The influence of some measures of remaking of degraded soils with petroleum residues on the wheat harvest (hay. q/ha) Suplacu de Barcău, 1997 (fifth year of research)

B = Doses of organic fertilization – t/ha		C= Doses of mineral fertilization				The average of organic fertilization		
		c - 0	c - 1	c - 2	c - 3	q/ha	%	dif.
		$N_0P_0K_0$	$N_{100}P_{80}K_{70}$	$N_{200}P_{160}K_{140}$	$N_{300}P_{240}K_{210.}$			
a – 1 Without deep aeration								
b0	0 t/ha manure	12.8	17.2	20.6	22.2	18.2	100	-
b1	50 t/ha manure	17.4	22.2	24.0	24.4	22.0	121	3.8^{xxx}
b2	100 t/ha manure	20.9	24.5	26.0	27.2	24.6	135	6.4^{xxx}
b3	150 t/ha manure	22.0	24.4	26.6	27.1	25.0	137	6.8^{xxx}
The average of mineral fertiliz.			22.1	24.3	25.2	22.4		
q/ha %			121	133	138			
Difference q/ha			3.8^{xxx}	6.0^{xxx}	6.9^{xxx}			
a – 2 Deep aeration with the ripper								
b0	0 t/ha manure	16.1	19.0	24.1	25.3	21.1	100	-
b1	50 t/ha manure	21.4	25.8	28.7	29.8	26.4	125	5.3^{xxx}
b2	100 t/ha manure	23.9	27.7	28.1	28.4	27.0	128	5.9^{xxx}
b3	150 t/ha manure	25.3	27.8	29.7	30.1	28.2	134	7.1^{xxx}
The average of mineral fertiliz.			25.1	27.6	28.4	25.7		
q/ha %			116	127	131			
Difference q/ha			3.4^{xxx}	5.9^{xxx}	6.7^{xxx}			

	DL 5%	1%	0.1%	
2.89 6.68 21.25				A to A
B to B	1.19	1.67	2.36	
C to C	1.32	1.75	2.29	

In 1997 the productions of wheat were smaller than in the previous year but the sense of the differences is the same (Tab. 4).

In 1998. the sixth year of research. the research field was cultivated with clover. Also for this crop. the production of hay has increased togther with the increase of the dose of manure. respectively of the dose of chemical fertilizers. Also the ripping has determined the obtaining of some greater production than the productions obtained in the nonripping versions (Tab. 5).

Table 5

The influence of some measures of remaking of degraded soils with petroleum residues on the clover harvest (kg/ha) Suplacu de Barcău, 1998 (sixth year of research)

B = Doses of organic fertilization – t/ha		**C= Doses of mineral fertilization**				**The average of organic fertilization**		
						kg/ha	**%**	**dif.**
		$N_0P_0K_0$	$N_{100}P_{80}K_{70}$	$N_{200}P_{160}K_{140}$	$N_{300}P_{240}K_{210.}$			
a – 1 Without deep aeration								
b0	0 t/ha manure	1920	2280	2490	3200	2472	100	-
b1	50 t/ha manure	2050	2500	2740	3410	2675	108	203
b2	100 t/ha manure	2430	2630	2810	3640	2877	116	405
b3	150 t/ha manure	2600	2550	2930	3680	2940	119	468
The average of mineral fertiliz. q/ha			2490	2742	3482	2741		
%			111	122	155			
Difference q/ha			250	292	1232			
a – 2 Deep aeration with the ripper								
b0	0 t/ha manure	2600	2720	3030	3520	2967	100	-
b1	50 t/ha manure	2720	2900	3200	3840	3165	107	198
b2	100 t/ha manure	2860	2880	3440	4000	3295	111	228
b3	150 t/ha manure	2910	3050	4010	4800	3692	124	725
The average of mineral fertiliz. q/ha			2887	3420	4040	3280		
%			104	123	146			
Difference q/ha			115	648	1268			

In 1999. the production of clover was greater than in 1998 but the sense of the difference wast the same (Tab. 6).

In 1995 were harvested samples from the soil from each lot (192 samples) on two depths (0-20 and 20-40 cm). to which was determined: the pH value. $N\text{-}NO_3$. $N\text{-}NH_4$. P and mobile K.

- The results obtained in 1995

a. Modifications of some chemical indices of the soil under the influence of deep aerationand organic and mineral fertilization.

a1- The reaction of the soi lis generally moderated acid in the layer 0-20 cm (pH = 5.41 – 5.43) and strongly acid (pH = 4.88 – 5.00) on the depth of 20-40 cm.

- Factor A – the deep aeration by ripping. influences decreases of the reaction of the soil especially on the ploughed layer (from pH 5.72 to pH 5.21) without passing the soil from a field of pH in another one. so remaining in the moderated acid field. This influence is owed to the mixture by mobilization of the inferior layer more acid with the superior one. On the depth from 20-40 cm. this influence is practicaly non significant (pH 5.06 in a-l compared to 5.02 in a-2.

- Factor B – the organic fertilization with manure. has a benefic action in atenuation of the tendency of acidification of the soil. due to the mineral fertilization. The good influence of the manure in correcting the acid reaction of the soil. is intensified with the increase of the manure dose applied (from 50 to l00 and 150 t/ha). the soild reaching to pH of 6.0 in the ploughed layer. at the great dose of manure.

- Factor C – the mineral fertilization. in the absence of the applying of manure. influences a tendency of accentuation of acidification of the soil (the soil remaining in the same field of pH moderated acid). This tendency is more underlined on the mobilized soil by deep aeration (a-2).

a2 – The content of the soil in mineral nitrogen (nitric and ammoniacal). The nitric and ammoniacal nitrogen. soluble forms in the soil. present values that indicate on the ploughed layer and on the layer from 20-40 cm a small content. in the absence of applying the manure and mineral fertilizers (l.6 - 1.7 ppm) $N\text{-}NO_3$ respectively 5.3 - 5.5 ppm $N\text{-}NH_4$. so in b-o. c-o)

The ripping influences generally the encoragement of the processes of nitrification from the soil. influences the obtaining of increased harvest and so a greter consumption of nitrogen for their accomplishment. so that in the aerated lots. the content of mineral nitrogen (nitric and ammoniacal) is sometimes reduced. fact more obvious on the layer of soil from 20-40 cm).

Table 6

The influence of some measures of remaking of degraded soils with petroleum residues on the clover harvest (kg/ha) Suplacu de Barcău, 1999 (culture in second year)

B = Doses of organic fertilization – t/ha		**C= Doses of mineral fertilization**				**The average of organic fertilization**		
		$N_0P_0K_0$	$N_{100}P_{80}K_{70}$	$N_{200}P_{160}K_{140}$	$N_{300}P_{240}K_{210.}$	**kg/ha**	**%**	**dif.**
a – 1 Without deep aeration								
b0	0 t/ha manure	2250	2583	2774	3507	2778	100	-
b1	50 t/ha manure	2375	2795	3033	3702	2976	107	198
b2	100 t/ha manure	2761	2913	3117	3941	3183	114	405
b3	150 t/ha manure	2906	2987	3302	3998	3298	119	520
The average of mineral fertiliz. q/ha %			2819	3056	3787	3059		
			246	483	1214			
Difference q/ha			109	119	147			
a – 2 Deep aeration with the ripper								
b0	0 t/ha manure	2902	3013	3325	3813	3263	100	-
b1	50 t/ha manure	3076	3222	3507	4102	3477	106	214
b2	100 t/ha manure	3194	3495	3772	4306	3692	113	429
b3	150 t/ha manure	3401	3609	3995	5132	4034	124	771
The average of mineral fertiliz. q/ha %			3335	3650	4338	3616		
			106	116	138			
Difference q/ha			192	507	1195			

The organic fertilization influences faborably the accumulation of the mineral nitrogen in the soil. compared to the first two doses applied. 50 and

100 t/ha. For the dose of 150 t/ha. where the harvest was also greater. the content in soluble nitrogen is more reduced. on both layers of soil researched (0 – 20 and 20 – 40 cm).

The mineral fertilization influences generally increases of the content in nitric and ammoniacal nitrogen from the soil. progresivelly with the increase of the doses of fertilizers with nitrogen applied. Is observed also here the fact that on the ground of organic fertilization with 150 t/ha manure. so where the increases of harvest were the greatest and so the consumption of soluble nitrogen. greater. the reserve of nitric and ammoniacal nitrogen decreases on both layers of soil reserached.

a3. – The content in mobile Phosphorus indicates generally a good supply of the soil with this element. it being enframed in the class. of great content (43.8 - 44.1 ppm in the ploughed layer) in the field without applying of manure and mineral fertilizers.

The deep aeration influenced on the layers of soil researched (up to 40 cm depth) a better mobilization of the Phosphorus from the soil. respectively the average content on the lots with rippind increases from 72.2 to 77.9 ppm P on the ploughed layer and from 30.4 to 35.9 ppm P on the layer of soil from 20 – 40 cm depth.

The organic fertilization. applied each year. for three years. increases the content of mobile P from the soil from 44.1 to 75.9 ppm on the ploughed layer and from 15.1 to 27.9 ppm on the depth from 20 – 40 cm.

The mineral fertilization increases the content in mobile Phosphorus generally progressively with the increase of the dose of fertilizers with Phosphorus applied. on all the grounds of fertilization with manure.

a4. – The content of the soil in mobile Potassium in placed in the class with a small content being between 105.4 - 125.4 ppm K in the ploughed layer between 51.2 - 54.8 ppm K on the layer of soild from 20-40 cm.

The deep aeration influenced favorably this content. especially under the depth of the ploughed depth where it increases from 95.8 to l00.4 ppm.

The organic fertilization favores the accumulation of the Potassium in the soil. the content of this element passing from the class of small content (l05.l ppm K in the layer ploughed without manure applying). to the class of great content (226.5 ppm K at the dose of l00 t/ha manure) and at the class of very large content (308.6 ppm K) for the applying of the dose of 150 t/ha manure. each year. for three years.

The mineral fertilization with fertilizers with Potassium in annual doses of 70-210 kg/ha s.a. has favored the supply with K of the soil on the depth of the ploughed layer where the content in K has increased from 105 – 127 ppm on the ground without manure and registered very significant increases applied on grounds of organic fertilization. where the content in Potassium reaches at very large class of over 300 ppm K.

In conclusion. After three years of research. the applying of the organic and mineral fertilization and of deep aeration proved to be very efficient measures for the increase of the fertility of the soils polluted with residues.

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