RESEARCH REGARDING THE MELIORATION AND AGROTECHNICS OF THE SALINIZATION SOILS FROM SOCODOR, ROMANIA

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Abstract

Salinized soils from Western Romania occupies approximately 120,000 hectares (40% of the area of salinized soils). The research concerning the melioration and agrotechnics of these soils was carried out in Socodor, Arad County and Diosig, Bihor County.

Research from Socodor is the longest (1957-1998) and is the most known; in existing research center have took the work well known researchers: Vlas I., head of the Center, Colibaș, I., Maria Colibaș, Bundik L., Ilona Bronț, etc.

The paper presents a brief summary of the research regarding the agrotechnics of the salinization soils: types, dosages and combinations of amendments, the behaviour of the various plant species. Also are presented the results obtained in the melioration field through scrubbing salts and their evacuation through drainage; the drains were located at a distance of 5 m, 10 m, 15 m, 20 m, 25 m, at depth of 1,0 m and 1.5 m with ballast or peat as a filter material; the yield results obtained in this field in winter wheat, Lolium multiflorum and sorghum for grain are comparable with the results obtained in the area on unsalinized soils.

Key words: salinization soil, phosphogypsum, sugar lime, silte lignit, manure, green manure, irrigation, drainage

INTRODUCTION

Salty soils occupies in Romania an area about of 300,000 hectares, while another 200.000 hectares have pronounced salinization and alkalinization characters. About 40% of these areas are found in the west country (Colibaș I., 1974, Colibaș M., 1974, Domuța, 2011, Oprea et al 1071).

Early researches began on weakly productive soils, on white alkali soils from Arad County in 1957 after the establishment of the Experimental Center for the Salty Soils Amelioration „Eng. Ene Constantin". After the death of the young agronomist engineer the researches have been continued by the Olăreanu P. briefly and then by Vlas Ioan. In 1959 at the Socodor Center were employed eng. Maria Colibaş and eng. Iuliu Colibaş. (Colibaş I, Colibaş M, 1961,1965)

In 1959 and 1960, Colibaş Iuliu and Maria Colibaş have designed and located on solonetz from Socodor, Mădăras and Salonta a number of 15 experiments that were pursued for 3-10 years the over time effect of agrochemical meliorative methods of these soils (amendments, fertilizers, works, plants resistant to alkalization and salinization). The amendments used were: phosphogypsum, sugar lime, furfurol residue, sulphur, granulated slag of blast furnace from Hunedoara and wastewater from the sulfuric acid production from Zlatna. As fertilizers in high doses and different combinations between them on different funds amendment were used: ammonium sulfate, ammonium nitrate, urea, superphosphate, potassium salt and semi fermented manure (Colibaș M., Colibaș I., 1965, 1983, 1988, Colibaș M., et al 1976, 1981, Sandu, 1964).

In 1970 the research on salty melioration have entered in a new stage since the Academy of Agricultural and Forestry Sciences, through Research Institute for Technological Engineering, Irrigation and Drainage Băneasa-Giurgiu set up an melioration field of salty soil by applying of a technologies complex on drained background at Socodor within the Agro-zootechnical Research Station Oradea as it was called then the Agricultural Development and Research Station Oradea. At Socodor besides those remember researcher, have conducted researches Bundik Ladislau (land reclamation), Bronț Ilona (laboratory analysis), Bontău Ioan (the behaviour of the fodder plants and of the medicinal plants on salty soils), Ștefan Costan (sorghum melioration) (Bundik., 1988).

In 1985 started the draining-drainage works from the Ierului Valley perimeter. It was designed the pilot field from Diosig, and since 1988 it carries out researches on salty soil melioration; at Diosig, Nicu Cornel Sabău conducted researches until 1994.

MATERIAL AND RESEARCH METHOD

Researches from Socodor were performed on different solonetz types. The main physico-chemical properties of one of the representative types of the solonetz are presented in the table 1.

Table 1

The main physical and chemical properties of the solonetz from research field Socodor

Nr crt.	Horizon / Depth, cm	A	B			B/C	C		D
		0-7	7-22	22-45	45-65	65-80	80-117	117-140	140
1	Clay (0.002 mm)	33.0	41.2	49.8	45.7	44.9	42.8	43.4	44.2
2	Bulk density g/cm^3	1.07	1.50	1.56	1.50	1.48	1.45	1.45	1.40
3	Reaction (pH in H_2O)	6.85	9.00	9.50	9.60	10.10	10.25	9.50	9.40
4	Soluble salt, mg/100 g soil	102.0	316.0	1606.0	1835.0	1160.0	846.0	831.0	548.0
5	Exchangeable base me/100 g soil	15.35	15.89	22.95	21.73	22.65	20.18	20.18	16.99
6	Exchangeable Na^+ me/100 g soil	1.81	0.48	0.92	12.21	11.57	7.49	7.49	5.72
7	Exchangeable hidrogen me/100 g soil	2.80	1.60	0.70	-	-	-	-	-
8	Cation-exchange capacity, me/100 g soil	18.15	17.49	23.65	22.18	22.65	20.18	20.00	16.99
9	Exchangeable natrium %T	10.00	27.2	39.3	55.08	51.09	37.14	34.08	33.72
10	Humus %	4.02	2.13	1.70	1.21	-	-	-	-

After 1970's, on 32 acres at Socodor have arranged 2 research fields, one with sealed ceramic tubes (horizontal drainage) and the other with the pumping wells (vertical drainage (Bundik, 1974). Horizontal drainage included the variants with the distance between drains of 5,10, 15, 20 and 25 m and drains depths posing of 1.0 and 1.5 m. Also, have been performed leveling capillary works, scarification, phosphogypsum amendment, leaching irrigation (1.500 m^3/ha to I leaching and 2,500 m^3/ha to leachings II, III and IV).

RESULTS OBTAINED

Synthesis of the research results carried out by Colibaș I., and Maria Colibaș

The best results were obtained by applying the phosphogypsum at a dose of 20 tons/ha (corresponding dose for the replacement of adsorbed sodium on the ploughing layer depth) in combination with ammonium sulphate at a dose of 120 kg/ha nitrogen, obtaining

sorghum for brooms productions up to 2,300 kg/ha grains and 1,000 kg/ha panicles, sudangrass up to 28 t/ha green mass and grain 2,100-3,870 kg/ha (Colibas I., 1965). Was researched the salinization and alkalinization tolerance of plant species (25 wheat varieties and 18 other cropping plant species).

Through the application of 15-20 t/ha phosphogypsum, N 40-120 and P 54-96 kg/ha with and without 30 t/ha manure has managed to achieve in these conditions, an increase of six times of the wheat production (from 560 kg/ha on the untreated soil to 3,870 kg/ha), yields of 1,800 kg/ha of barley or rye, 2,320 kg/ha representing increase with 2-3 times of the yield, 2,050 kg/ha millet, 44 t/ha beet, 700 kg/ha sunflowers, 18 q/ha sweet pea (six times increase), 14 t/ha green mass Pucinelia, major yields were obtained at the beans, saffron and coriander.

The research of green fertilizers have highlighted important possibilities to increase production on these soils. Thus, the incorporation in the soil of 8-18 t/ha green mass melilot, 16-23 t/ha of white lupin or 20-35 t/ha sunflower in conditions of phosphogypsum and mineral fertilizers amendment, has increased yield of wheat with 1,030, 1,320, respectively with 1,610 kg/ha versus single application of mineral fertilizers ($N_{40}P_{54}$), and that of sorghum with 270-1,030 kg/ha (Colibas I., 1965). In order to improve yields on natural meadows of *Festuca pseudorina*, good results have been obtained by applying to the soil surface 200 kg ammonium sulphate plus 300 kg/ha superphosphate, increasing the yield from 1,000 to 3,100 kg/ha of hay.

Knowledge of the properties of these soils and of the experiments results in the field of various meliorative measures, have allowed differentiated establishment according to main pedomeliorative indices, of the methods to be applied, methods made available to the Institut for Studies and Projects for Land Reclamation Bucharest in a comprehensive synthesis work providing important design indices for land reclamation works from Mureş-Crasna area (Colibas I., 1988). For determining the economical efficiency of agrochemical meliorative methods were pursued in the stationary residual effect of until the ten year of the amendments and fertilizers application, the recommended treatments proving to be economical and energy efficient. The best results have been expanded into yield.

Thus, at Agricultural State Enterprise Salonta, Barmod farm, on the saline and alkalic soils it was applied amendment on an area of 2,000 hectares by applying to our recommendations amendment, fertilization, agrotechnical levelling and scarification works obtaining the average yield on three year of 18 t/ha green mass, forage crops.

The results synthesis of research carried out by Vlas I. and Ilona Bronț

In order to obtain higher yields on cultivated plants it is necessary to apply meliorative measures. The amendments tested (phosphogypsum, gypsum, lignite silt, sulfur) but also the combination between phosphogypsum or sugar lime with manure determined higher yield increases compared to the control in winter wheat and Sudangrass (tables 2, 3, 4).

Table 2

The influence of the different limes on yields in winter wheat and sudangrass, in the conditions from Socodor

Variant	Winter wheat		Sudangras	
	Yield		Yield	
	Kg/ha	%	kg/ha m.v.	%
Control, not amendet	646	100	4,440	100
Sugar lime 25 t/ha	735	104	8,673	195
Gypsum, 15 t/ha	811	125	8,635	194
Lignite silt, 40 t/ha	767	118	6,647	149
Gypsum 5 t/ha + Lignite silt 20 t/ha	751	116	9,855	221
Gypsum 5 t/ha + Lignite silt 15 t/ha + sugar lime 5 t/ha	765	188	9,973	224

Table 3

Lime and chemical fertilizers influence on sudangrass in the conditions from Socodor

Variant	Yield	
	kg/ha	%
Control, untreated	12,000	100
Sulphur 2,5 t/ha + $N_{96}P_{54}$	14,900	124
phosphogypsum, 30 t/ha + $N_{96}P_{54}$	17,800	148
Sulphure 1,25 t/ha + phosphogypsum 15 t/ha + $N_{96}P_{54}$	17,000	141
Lignite silt 30 t/ha + $N_{96}P_{54}$	14,100	117
Lignite silt 10 t/ha + sulphur 0,833 t/ha + phosphogypsum 10 t/ha + $N_{96}P_{54}$	16,700	139

Table 4

Phosphogypsum, sugar lime, manure and chemical fertilizers influence on yield in winter wheat and sudangrass in the conditions from Socodor

Variant (treatment)	Winter wheat		Sudangrass	
	Kg/ha	%	Kg/ha	%
Control, untreated	560	100	3,290	100
Manure 60 t/ha + sugar lime 40 t/ha	920	165	4,820	146
phosphogipsum 20 t/ha + sugar lime 20 t/ha	1.050	187	6,130	186
Manure 60 t/ha + phosphogipsum 40 t/ha	1.280	126	7,580	230
phosphogipsum 20 t/ha + sugar lime 20 t/ha + $N_{80}P_{90}$	1.360	241	8,590	261

In an experience carried out in the period 1964-1966 was studied the initial application of all doses of phosphogypsum, alone or associated with manure and nitrogen. The largest yield of wheat has been obtained in the variant with 8.0 t/ha phosphogypsum, 40 t/ha manure and 40 kg/ha nitrogen active substance. At the Sudangrass the greatest green mass yield has been in the variant with phosphogypsum 4 t/ha initially applied, manure 40 t/ha and 40 kg/ha nitrogen active substance (table 5) (Vlas; Colibas I., 1965; Vlas, Colibaş 1988; Vlas et al 1967, 1989).

Table 5

The influence of the different lime doses, manure and nitrogen on yield in winter wheat and sudangrass, in the conditions from Socodor

Variant (treatment)	Winter wheat		Sudangrass	
	Kg/ha	%	Kg/ha	%
Control, not amendet, not fertilized	560	100	6640	100
Control not amendet, G 40 t/ha + N_{40}	1,360	241	11,360	170
F 0.5 t/ha annual + G 40 t/ha + N_{40}	1,650	292	12,280	185
F 1.0 t/ha annual + G 40 t/ha + N_{40}	1,990	353	14,520	219
F 4t/ha initialy + G 40 t/ha + N_{40}	1,940	343	14,920	224
F 8 t/ha initialy + G 40 t/ha + N_{40}	2,020	358	14,460	218
F 4 t/ha initialy + F 1 t/ha annual + G 40 t/ha + N_{40}	1,730	306	13,210	199
F 8 t/ha initialy + F 1 t/ha annual + G 40 t/ha + N_{40}	1,780	316	11,610	174
F 4 t/ha initialy + F 1t/ha annual	940	166	8280	124
F 8 t/ha initialy + F 1 t/ha annual	810	144	8800	132

Among crop plants, the highest tolerance to the salinity have sorghum, millet, wheat, Sudangrass, autumn mash, perennial herbs *(Lolium perene, Dactylis glomerata, Puccinellia distans)* and others who have achieved superior yields toward the unmeliorated control; through the application of a complex technologyes on the drained soil have improved the chemical properties of the soil by reducing the alkalinity (pH values were reduced by 0.2-1.0 units), as the residue has dropped from 0.200-0.300 g/100 g soil at 0.100-0.180 g/100 g soil at presented variants (Vlas I., 1961).

Residue increases are observed in the variants with high doses (133 t/ha) of phosphogypsum (V-2 C-2). Exchangeable Na was reduced by 50% in all the studied variants from 5 to 10 me/100 g soil at 2-5 me/100 g soil, and Na as a percentage of T is 5-15%, mainly on the depth of 0-20 cm and below it, the soil being weak to moderate solonetzed. Hydric soil regime under natural conditions is an exsudativ type while is deficient on spontaneous and cultivated plant growth and development. Through the meliorative measures application the hydric regime was significantly improved on depth 0-60 cm from the initial situation, hovering within the active humidity at field capacity or more than these limits (Vlas I., 1965). Yields on cultivated plants have increased through the application of technologies complex towards agrochemical measures from 1,500 – 2,000 kg/ha to 3,100 kg/ha wheat, from 2,000 kg/ha to 3,500 kg/ha in grain sorghum, etc. In the case of permanent grassland, through the application of meliorative measures and fertilization with nitrogen and complexes, yields were obtained from over 4,600 kg/ha dry substance with phosphogypsum and manure. The economical effect of the meliorative measures on the yields differ depending on the complexity of the meliorative measures showing that most economical are the variants with larger distances between drains (V-4 and V-5), the period of amortization is shorter in the case of sorghum, etc.

The synthesis of the research results carried out by Bundik L. and Bronț Ilona

Groundwater level has been below the posing depth of the drains in most of the time, the drains collecting the meteoric or irrigation water who percolat in loosened horizons through the soil scarification. In the leaching period were executed through drains water volumes representing 25.1-47.9% of applied water. Duration of the water evacuation through drains increased with increasing of the distance between drains, and the maximum specific flow variables ranging between 1.10 and 8.78 liters/s/ha were higher in variants

with the distance of 5 m between the drains (Bundik L., Teodoru O., 1974; Bundik L., Bronț I., 1988; Bundik et all 1988).

Table 6

The elements of the solonetz leaching in the drainage field Socodor

Variant	Leaching norm m^3/ha	Duration of evacuation days	Water volumes evacuated through drains		Maximum flow	
			m^3/ha	% leaching norm	l/s	l/s/ha
V - 1' h=1.5 m d = 5 m	13,400	50	4,388	33.6	0.72	8.78
V - 2' h=1.5 m d = 10 m	12,255	70	5,102	41.6	0.94	5.73
V - 3' h=1.5 m d = 10 m	13,180	72	5,881	44.6	1.24	7.57
V - 4' h=1.5 m d = 20 m	13,710	107	6,564	47.9	1.75	5.36
V - 5' h=1.5 m d = 25 m	10,880	70	3,663	33.7	1.86	4.54
V - 6' h=1.0 m d = 5 m	13,300	55	4,495	33.8	0.62	7.57
V - 7' h=1.0 m d = 10 m	13,680	147	4,556	33.6	0.38	2.39
V - 8' h=1.0 m d = 20 m	13,535	130	3,397	25.1	0.36	1.10
V - 9' h=1.5 m d = 10 m b = 20	13,650	65	5,713	41.9	0.86	5.15
V - 10' h=1.0 m d = 15 m Ø 70	13,250	82	6,355	47.9	1.34	5.44

The volume of water discharged from the rainfall during the l.X.1977-30.IX.1985 represents 3.7-22.0 % of the rainfall; at increasing of the distance between drains from 5 m to 20 m in the posing variants at 1 m depth the discharged volumes decreased with 6% from the rainfall amount and for the depth of 1.5 m increasing of the distance between drains from 5 to 25 m led to a decrease of discharge with 8.4% of the rainfall amount. The water discharged through drains had an average of total content of salts of 2.43-9.36 g/l; at high doses of amendments (133 t/ha in V-2), were evacuated higher concentrations (9.36 g/l in V-2). Elevated levels of sulphates and sodium compared to the others ions, shows the process of replacement of the Na from the soil complex as well as calcium and leaching of the formed sodium sulphate (Bundik L., 1974).

For an effective leaching, applied watering norm must ensure the evacuation of at least 25-30% of it, thus at the same time high concentrations of at least 2-3 g/l in the evacuated water being performed. Improvement of soil chemical properties led to yields of 2,030-3,410 kg/ha wheat, 9,690-15,130 kg/ha at *Lolium multiflorum* hay, 2,810-6,330 kg/ha grain sorghum yields comparable to those obtained by agricultural units in the region on normal soils. Drainage by pumping wells although assures the descent of groundwater level under the critical depth, due to the very low permeability of the upper soil horizons water in excess not percolate from the upper part of the soil profile in the aquifer from which it pumps. Water of drainage wells is satisfactory for irrigation and leaching.

Shaping the land into wide strips (1 = 100 m) with a cross slope of l% by applying along complex meliorative measures (amendments, scarification, leachings), in the first step to the complex melioration were obtained meliorative effects similar to those from drainage field through tubes, decorating costs being much smaller in the case of modelling. The yields obtained in the modelled plots, reflects soil improvements (Bundik, 1988).

CONCLUSIONS

Research on melioration and salty soils agrotechnic from Western Romania were conducted mainly in Socodor and were achieved in 1957. Along the years, Ene C., Olăreanu P., Vlas I., Colibaş I., Colibaş M., Bundik L., Bronţ I., Bontău I., Costan Şt., studied the solonetz melioration using the different phpsphogypsum doses initial or annual applied - lignite silt, sugar lime, manure and green manure (melilot, lupin, sunflower). Was also studied the behaviour of 18 crop plants (wheat, barley, Sudangrass, etc.)

On the 32 landscaped acres with tubular ceramic drainage (10 variants with drains at 1.5 and 1.0 m depth set at 5, 10, 15, 20 and 25 m distance with ballast or peat drain layer of 5 or 10 cm thickness and drains diameter of 5 to 7 cm) of the amount of water used to leaching (10,880-13,710 m^3/ha) was evacuated 25.1-47.9%; discharged water had a total content of salts of 2.43-9.36 g/l. In the meliorative by leaching solonetz variants were obtained yields (2,030-3,410 kg/ha to wheat and 9,690-15,130 kg of hay at *Lolium multiflorum*, 2,810-6,330 kg/ha at grain sorghum) comparable to the yields obtained in area.

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