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Rehabilitation of Degraded Irrigated Chernozems at Organo-Mineral Composts Use

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In Russia 8 % of area is irrigated by slight mineralized water. Ordinary heavily loam chernozems of Miusskaya irrigation system in Rostov region were investigated. After 10 years sprinkling irrigation by water of 1.5-1.8 g/l and SO_4-Na composition in 0-0.5 m layer alkalinization moderate degree appeared; compaction increased on 15-20 %, 10-15 % of humus and clay (the greatest decrease of smectite minerals) were lost, humification degree decreased For remediation of degraded soils followed experiments were carried out: the control, (dose in t/he) phosphogypsum - 10, manure - 40, composts: manure+phosphogypsum (M+Ph) 1:1 - 20, manure+glauconite (M+Gl) 2:1 - 30. Composts contain nutritious substances (% accordingly): P_2O - 0.9 and 0.3; K_2O – 0.2 and 4.8; gypsum - 42 and 3. Glauconite has 52 % of $FeSO_4$ and 0.6 % of $Al_2(SO_4)_3$. Composts exerted amelioration and fertilizing effects on soil: after three years dealkalinization occured in layer of 0-1 m, in 0-0.4 m layer content of humus and humic acids (HA) connected with calcium, humification degree and C_{HA}/C_{FA} ratio increased, fulvic acids (FA) reducted, labile minerals stabilization promoted barley and alfalfa yield enlarged on 67-83 %. Manure usage had only fertilizing effect.

Irrigation by salty waters results in soil degradation. In Russia 8 % of area is irrigated by water with mineralization more than 1 g/l. In Rostov region this area enlarges up 40 % from local irrigated area. Ordinary heavily loam chernozems of the Miusskaya irrigation system in Rostov region of Russia were investigated. After 10 years sprinkling irrigation of low saline water (1.5-1.8 g/l, SO_4-Na composition) followed soils changes in 0-0.5 m layer were occurred: alkalinization moderate degree appeared; compaction increased on 15-20 %, 10-15 % of humus and clay contents were lost; humification degree decreased. Purpose of our investigation was to show organic-mineral composts effect on fast recovery of degraded irrigated chernozems.

Methods. For remediation of degraded chernozem the followed experiments were carried out: the control, (dose in t/he) phosphogypsum - 10, manure - 40, composts: manure+phosphogypsum (M+Ph) 1:1 - 20, manure+glauconite (M+Gl) 2:1 - 30. Composts contain nutritious substances (% accordingly): P_2O - 0.9 and 0.3; K_2O – 0.2 and 4.8; gypsum - 42 and 3. Glauconite has 52 % of $FeSO_4$ and 0.6 % of $Al_2(SO_4)_3$.

Resuls and discussion. In our experiments followed results were received:

1. Per the first year of afteraction density, alkalinity and exchange sodium contents at Ph and M+Ph application considerably decreased in 0-1 m layer, at M+Gl usage - in 0-0.2 m (tabl.1, 2). After three years of these ameliorants apply dealkalinization occured in layer of 0-1 m. Manure usage had only fertilizing effect.

2. The humus content in 0-0.4 m layer increased on 0.1-0.3 %. The greatest humus enlargement was marked at 40 t/he manure application and 30 t/he compost M+Gl. Composts resulted in increasing humic acids (HA) content, connected with calcium, fulvic acids (FA) reduction, extension of humification degree from 44 to 53-57 and C_{HA}/C_{FA} ratio - from 1.5 to 2.5-2.6 (fig). Manure application led to increasing humin carbon at preservation of humus quality, is caused by presence of a plenty semihumification plant debries. At M+Gl using

the share of acid soluble fulvic acids, contacting by glauconite iron grew. In all experiences the catalaze activity, represented one of the tests of humification process increased (tabl . 3).

3. At low salty water irrigation the clay stock reduction in upper soil horizons was caused by all clay minerals loss, but the greatest decrease of smectite minerals occured. Depletion of upper horizons by clay was due to formation of clay minerals sodium form, that strengthened them peptization, migration, destruction and labile minerals conversion into super fine form facilitated also them transformation in illite at potassium plenty. Part of humus and clay was precipitated in carbonate layers. The composts usage promoted labile minerals stabilization.

Thus reduction effect of organo-mineral composts on the degraded chernozem began per the first year of use and was prolonged not less than 5 years.

4. Composts exerted amelioration and fertilizing effects on soil, resulted in the increase of barley and alfalfa yield on 67-83 % (tabl.4). The fast return of costs at composts application was shown.

Table 1. Exchangeable cations and cation exchange capacity (CEC) of irrigated chernozems

Plot	Depth, cm	Mmol/100 g				% from CEC		
		CEC	Ca^{2+}	Mg^{2+}	Na^{+}	Ca^{2+}	Mg^{2+}	Na^{+}
Control	0-20	61±6	46±4	12±1	3,1±1	75±2	20±1	5±2
	20-40	66±4	46±4	12±2	3,1±1	75±2	20±3	5±2
	40-60	64±4	46±4	10±2	3,2±1	78±2	17±2	5±2
	60-80	60±4	46±4	12±2	2,4±1	76±2	20±2	4±2
	80-100	58±4	44±4	12±2	1,6±1	76±2	21±2	3±1
Phospho-gypsum, 10 t/he	0-20	57	44	12	0,8	77	21	1
	20-40	61	46	14	0,8	76	23	1
	40-60	59	46	12	0,7	78	20	1
	60-80	57	46	10	1,1	81	18	2
	80-100	53	42	10	1,2	79	19	2
Manure, 40 t/he	0-20	61	46	12	2,9	76	20	5
	20-40	59	46	10	2,9	78	17	5
	40-60	59	46	10	2,9	78	17	5
	60-80	59	46	10	2,6	78	17	4
	80-100	55	44	8	2,8	80	15	5
Manure + glauconite 2:01 30 t/he	0-20	53	42	10	0,9	79	19	2
	20-40	59	46	12	0,9	78	20	2
	40-60	57	46	10	0,8	81	18	1
	60-80	57	46	10	0,7	81	18	1
	80-100	59	46	12	0,8	78	20	1
Manure + phospho-gypsum, 1:01 20 t/he	0-20	53	46	6	0,6	87	11	1
	20-40	57	48	8	0,6	85	14	1
	40-60	57	48	8	0,8	85	14	1
	60-80	59	46	12	0,6	78	20	1
	80-100	61	46	14	0,8	76	23	1

Table 2. Catalase activity of chernozems in various reduction variants, O_2, cm^3/min/g

Depth, cm	Control	Phosphogypsum, 10 t/he	Manure, 40 t/he	Manure + glauconite	Manure + phosphogypsum
0-20	7.5	12.9	12.8	8.7	10.0
20-40	7.5	10.8	11.4	9.5	9.3
40-60	6.9	11.8	8.2	8.0	7.5

Table 3. Effect of ameliorants on chemical properties of irrigated chernozems

Plot	Depth, cm	pH	Alkalinity, HCO_3>Ca+Mg mg-eqv/100 g	Soda resistance, mg-eqv/100 g
Control	0-20	8,3±0,2	0,65±0,11>0,62*±0,12	18±1
	0-100	8,2±0,2	0,74±0,10>0,68±0,11	18±1
First year after land-reclamation measure use				
Phosphogypsum, 10 t/he	0-20	7,6	0,46<0,80	34
	0-100	7,7	0,73<0,90	30
Phosphogypsum, + manure, 1:1, 20 t/he	0-20	7,6	0,46<0,80	Non determ.
	0-100	7,7	0,73<0,90	
Manure + glauconite, 2:1, 30 t/he	0-20	7,6	0,42<0,85	34
	0-100	7,7	0,55<0,80	30
Manure, 40 t/he	0-20	8,0	0.45>0.40	27
	0-100	8,0	0.57>0.47	16
Third year after land-reclamation measure use				
Phosphogypsum, 10 t/he	0-20	7,5	0,42<0,80	34
	0-100	7,3	0,46<0,72	33
Manure + glauconite, 2:1, 30 t/he	0-20	7,3	0,38<0,70	30
	0-100	7,5	0,47<0,92	30

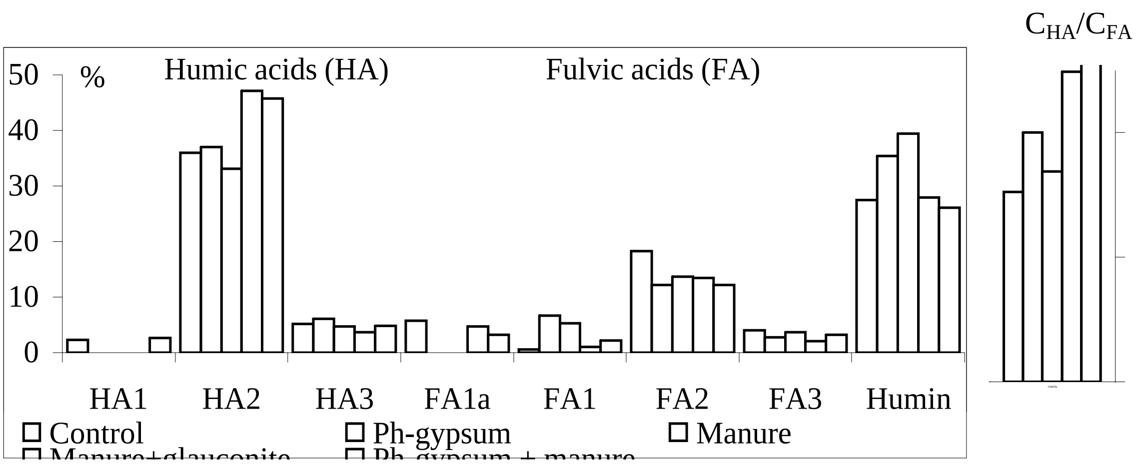

Fig. Humus composition in plow horizon of irrigated chernozems at different

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recovering measures.

Table 4. Productivity of agricultural plants on the reduced chernozems

Plot	Summer barley, 1st yr			Alfalfa, 2nd yr			Alfalfa, 5th yr			Increase for 5yrs, %
	crop	crop increase		crop	crop increase		crop	crop increase		
	t/he	t/he	%	t/he	t/he	%	t/he	t/he	%	
Control	2,2			9,6			10,8			
Phosphogypsum	3,5	1,3	6	14,4	4,8	50	15,6	4,8	4,4	5,1
Manure	2,5	3	1,5	10,2	8	8	11,2	4	3	9
Manure+phosphogypsum	3,7	1,5	7,2	17,6	8	8,3	18	7,2	6,7	7,4
Manure+glauconite	3,6	1,5	6,8	16	6,4	6,7	16,8	6	5,6	6,4