SOME BASIC PRINCIPLES OF AN EXPERIMENT OF ALKALI SOIL AMELIORATION

M. DZUBAY—J. JUHÁSZ

Before starting the experiment, the area of the experiment must be chosen. The chemical, physical and environmental conditions of it must be examined and also whether irrigation water is available or dry farming is to be done.

Once a soil satisfying the requirements is found, a soil map of the area must be made. In this case it is satisfactory to use a network of 20 m meshes. In this we indicate the location of the different types of soil on the basis of on-site and laboratory examinations. (See Figure.)

The area chosen for the experiment lies in Nagykunság on the edge of the loess land in the NE part of the country.

This loess land is a relatively high flat ground. Its surface is dissected in places by long ago filled-up river beds, creeks and flatlands (5). From the point of view of pedogenesis, the parent rock is, besides the alluvia already mentioned, lowland loess in the higher, and loessial silty loam in the lower places. The latter — which constitutes also the mother rock of the experimental area — is very variable owing to the different hydrographic conditions, leaching, alkalinization and gleization.

The experimental area — as generally on alkali soils — is dissected. The formation of banks is connected with characteristic erosional formations on these soils. Such a formation of the microrelief reacts on the alkali soil forming processes (4).

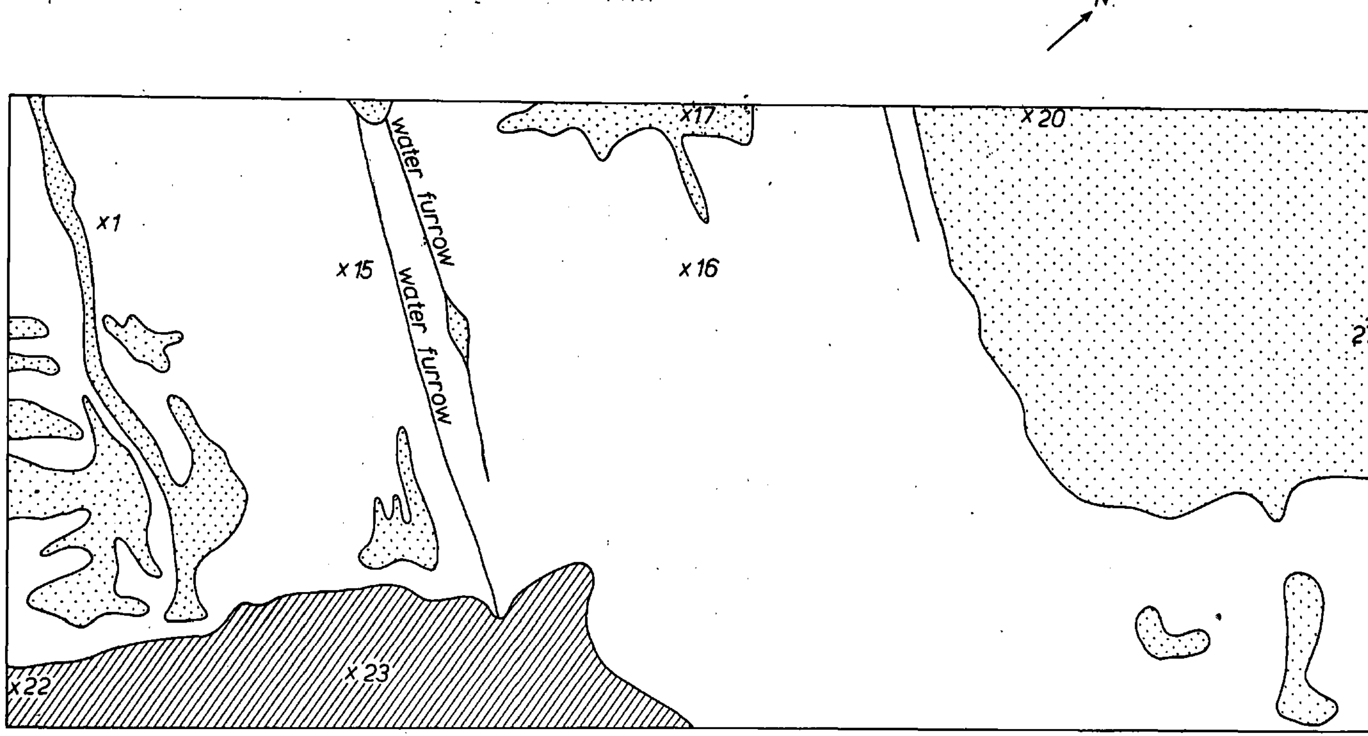
As concerns the climatic factors, the area lies in a region which is the most extreme part of the country. It is known as one of the warmest regions of the Great Hungarian Plain. Its precipitation varies between 500—530 mm annually, with the highest value in June and the lowest in winter. In the autumn there is slightly more rainfall here than in the spring.

The area examined by us receives an average annual total of 2000 sunshine hours and occasionally much more. Farther north in the region the annual total of sunshine hours is already under 2000. Thus the sunshine average of the southern parts is somewhat better than that of the whole country. The average annual total of global radiation is around 100 Kcal cm^{-2}.

The temperatures in the region are very extreme. The winter is cold, the summer is — except on the north-eastern edges of the area — warmer than the nationwide average. Severe frosts are frequent here in the winter. The mean temperature in January varies between —2.5 and —22 °C. The annual average minimum temperature varies between —19 and —22 °C, but occasionally temperatures even ten degrees lower occur.

The summer is moderately warm. The annual average mean temperature in July

MAP



x place of soil sampling ▭ acid alkali soil ⬚ bank alkali soil ▨ meadow soil

Scale 1:1000

is between 20 and 22° C. In spite of this, warming up is intense in places, especially in the area examined, where the average annual temperature maxima are around 35 °C.

The winds of the area are very changeable. The prevailing wind is from the N—NE, but a S—SW wind is also frequent.

The annual average wind velocity is 2—3 m/sec. The annual average of the wind-storm hours is between 145—180. In the southern parts of the region only 20—25 stormy days can be expected on average

The annual average number of rainfall hours is 1300—1800. On the basis of the average of 50 years (1901—1950) — examining the monthly and annual amounts of precipitation —, we come to the conclusion that in the annual variation two waves of precipitation can be found: the maxima of May-June and October-November on the one hand and the minima of January-February and August-September on the other. This regularity[1] does not prevail in every year because the distribution of the precipitation in space and time is unstable, and besides this there is considerable variation in the extreme values.

The soil temperature is also very extreme. In winter it is cold, in summer warm. In the winter frosts are common. The mean soil temperature in January varies between —3 and 0.1 °C at 2 cm depth. In summer the soil surface is warm. The mean temperature at 2 cm depth under the surface is between 35.4 and 29.8 °C on average.

The results of the analysis of soil samples are shown in the Table. On the basis of on-site observations and the data of the analysis, the following facts can be established:

The examined area of Karcagpuszta comprises 72.000 sq m (See Figure). About 67%, i.e. 4.8 hectares of this are alkali soil. According to genetic classification, it is deep meadow solonetz. In the Table it is characterized by bore No. 15. It is Solonchak-line medium-deep meadow solonetz. (In the Table bores 1 and 16.) A further 25% of the area is basic alkali soil. According to genetic classification it is shallow meadow solonetz. In the Table it is characterized by bores 17, 20 and 27. (Dotted lines in the Figure.) Besides the afore-mentioned subtypes and varieties we find also soils belonging to another principal type. These are deep carbonate meadow soils (0.6 ha) with medium deep humus layer and their deep salt variety, which have formed on loess clay. They constitute about 8% of the area, and are characterized by bores 22 and 23 in the Table. (Hatched part in the Figure.)

Characteristically there is generally high acidity in the 0—10 cm layer of the alkali soils of the area. The chemical reaction of the 10—20 cm layer is approximately neutral. Due to this fact, the hydrolytic acidity is high.

$CaCO_3$ occurs under 20 or 50—60 cm in the dominant subtypes. In the eroded parts and in patches it can be found already at 10 or 30 cm depth.

Alkalinity against phenolphtalein as soda % in middle deep subtypes can be found only below 60 cm, while in the shallow and eroded parts it can be found already at 30—40 cm depth.

The total salt percentage, measured on the basis of electric conductivity, generally reaches 0,35% and occasionally even 0,85% in the 0—60 cm deep layer. According to the analyses these water-soluble salts are first of all chlorides and sulphates and only to a lesser extent carbonates.

On the basis of the chemical properties described it can be established that in the area examined there are such subtypes of alkali soils as cannot at present be economically ameliorated according to the literature.

	Soil No	sample Depth cm	pH H_2O	pH KCl	Hidr. acid. Y_1	Total salt % conductivity	Alkalirity against phenolphtalein as soda %	CaCO %	Sticky number	Capillary rise 5^h	Capillary rise 20^h
On area of average quality	1/a	0—5	6,5	5,3	16,5	0,03	—	—	44	8	25
ground water under pressure	b	5—12	6,9	5,5	11,5	0,05	—	—	45	5	15
2 m 80 cm deep	c	12—20	7,2	6,0	7,8	0,13	—	—	52	—	—
Festuca pseudovina	d	20—40	7,5	6,2	4,3	0,23	—	—	65	—	5
Achillea millefolium	e	40—50	8,0	6,8		0,46	—	—	72	—	5
	f	50—70	8,5	7,3		0,47	0,04	0,1	78	—	15
	g	70—90	8,9	7,8		0,44	0,12	12,3	70	10	25
	h	90—120	9,1	7,8		0,34	0,16	9,5	81	5	20
	i	120—150	9,3	7,9		0,34	0,16	8,4	80	—	15
On an area of average quality	15/a	0—10	5,9	4,6	20,4	0,03	—	—	42	25	43
as former boring	b	10—20	6,3	6,0	12,0	0,03	—	—	45	—	20
Festuca pseudovina	c	20—30	6,8	5,6	5,8	0,08	—	—	50	—	7
Achillea millefolium	d	30—40	7,1	5,9	3,4	0,14	—	—	55	—	3
	é	40—50	7,4	6,2		0,21	—	—	59	—	—
	f	50—60	7,4	6,4		—.29	—	—	65	—	2
Festuca pseudovina	16/a	0—10	5,9	4,9	14,8	0,08	—	—	42	—	10
Achillea millefolium	b	10—20	6,7	5,4	6,6	0,15	—	—	48	—	—
Artemisia salina	c	20—30	6,9	5,9	3,1	0,34	—	—	58	—	—
	d	30—40	7,5	6,3	1,5	0,47	—	—	69	—	—
	é	40—50	7,7	6,6		0,70	—	—	65	—	8
	f	50—60	7,9	7,0		0,85	—	0,1	68	—	12
On an eroded area of average quality	17/a	0—10	6,8	5,7	6,8	0,21	—	—	46	—	—
Foot of bank	b	10—20	7,1	6,0	3,3	0,40	—	—	56	10	12
	c	20—30	7,1	6,3	1,8	0,75	—	—	63	—	—
	d	30—40	7,3	6,5	1,3	0,90	—	—	67	—	6
	é	40—50	7,6	6,7		0,91	—	—	67	—	3
	f	50—60	8,1	7,3		0,76	—	2,1	67	—	3
As above	20/a	0— 5	7,0	5,9	9,3	0,13	—	—	39	—	3
	b	5—10	7,1	5,9	6,3	0,20	—	0,1	45	—	3
	c	10—20	7,2	6,5	1,9	0,60	—	0,1	59	—	3
	d	20—30	7,9	7,1		0,81	—	0,1	59	—	5
	é	30—40	7,1	7,6		0,51	0,18	7,2	64	—	—

	Soil No	sample Depth cm	pH H$_2$O	pH KCL	Hidr. acid. Y_1	Total salt % conductivity	Alkalirity against phenolphtalein as soda %	$CaCo_3$ %	Sticky number	Capillary rise 5^h	Capillary rise 20^h	
On an area of average												
quality	22/a	0—10	5,6	5,1	19,5	0,04	—	—	49	45	85	4,0
Cikoria intibus	b	10—20	5,9	5,1	14,8	0,05	—	—	40	30	62	4,0
Festuca pratensis	c	20—30	6,1	5,2	9,1	0,06	—	—	58	15	31	2,9
	d	30—40	6,3	5,4	7,5	0,07	—	—	58	8	20	2,4
	é	40—50	6,5	5,6	6,1	0,08	—	—	58	15	29	1,5
	f	50—60	6,8	6,0	3,9	0,11	—	0,1	58	25	52	1,3
	g	60—70	7,4	6,8	1,4	0,12	—	8,1	57	50	108	0,9
	h	70—80	7,5	6,9		0,11	—	11,0	56	58	160	
	i	80—90	7,7	7,1		0,11	—	13,6	55	60	167	
	j	90—100	7,9	7,0		0,07	—	14,0	54	60	160	
	k	100—110	8,1	7,1		0,04	—	11,7	50	115	234	
	l	110—120	8,1	7,1		0,04	—	9,4	45	105	250	
Achillea millefolium	23/a	0—10	5,8	5,2	21,8	0,03	—	—	52	75	128	4,3
	b	10—20	6,1	5,5	11,9	0,06	—	—	52	95	148	3,5
	c	20—30	6,2	5,5	8,5	0,07	—	—	61	15	34	3,0
	d	30—40	6,6	5,8	5,4	0,10	—	—	61	15	22	2,0
	é	40—50	6,8	6,1	3,3	0,14	—	—	59	15	25	1,0
	f	50—60	7,3	6,7	1,5	0,20	—	2,1	59	25	64	1,0
On an eroded area of												
average quality	27/a	0—10	7,2	6,1	4,5	0,15	—	—	42	12	18	3,8
Top of bank	b	10—20	7,5	6,4		0,25	—	—	48	—	3	2,7
Festuca pseudovina	c	20—30	7,6	6,4		0,57	—	—	56	—	—	1,8
Achillea millefolium	d	30—40	8,0	6,9		0,70	—	0,1	62	—	—	1,5
Artemisia monogina	é	40—50	9,2	7,3		0,65	0,16	4,9	62	—	—	0,8
	f	50—60	9,1	7,3		0,45	0,21	11,0	70	—	—	
Humic surface soil	28/a	0—60	7,1	6,4	6,1	0,12	—	—	58	18	50	2,2
	b	70—140	8,0	7,8		0,10	—	7,5	55	77	187	
Loessial subsoil	c	140—160	8,0	7,1		0,05	—	1,4	50	130	278	
	d	160—190	8,1	7,0		0,07	—	5’2	60	50	125	

Under similar conditions on our experimental ground in Szentes, we harvested 140—240 long cwt of hay per hectare depending on the type of grass association and using chemical amelioration and irrigation

On the basis of the soil analyses the area should be ameliorated using the good quality loessial subsoil at a distance of 500 m. (See bore 28 in the table.)

Besides amelioration with loessial subsoil additional techniques will be needed when the experiment designed is complex.

For instance drainage, amelioration of the subsoil, loosening of the soil, etc. In such a case additional soil analyses are necessary.

The order of the operations should be: first drainage. The drainage tubes must be laid 70 cm deep in the soil and at 5 m distance from each other. This depth is necessary because loosening of the subsoil takes place 60 cm deep.

The next technical operation is chemical amelioration of the 20—40 cm soil layer.

This is followed by amelioration of the surface soil, the 0—20 cm layer, with loessial subsoil and a humic upper soil layer.

Finally the chemical material-introducing device fitted on a subsoil loosener is employed as the concluding phase[1]of the complex chemical amelioration.

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