Egypt. J. Agric. Res. , 73 (1), 1995.

IMPORTANCE OF LEACHING WATER REGIME AND ORGANIC MANURING ON RECLAIMING AND CULTIVATING SALINE-SODIC SOIL IN EGYPT

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(Manuscript received 26 July 1993)

Abstract

Two field trials in an area of 30 feddans of barren saline-sodic soil, were subjected to different leaching water regimes for six months. The soils were prepared for barley and rice cultivation for three successive seasons, 1989-92, in the presence of different rates of organic manure. Soil and irrigation-drainage water samples were periodically analysed.

Leaching water (comprising its regime and its quality) is the principal limiting factor for reclaiming such soil. After 4 years of reclamation, soil salinity as well sodicity decreased from 38.5 to 4.9 dS,m and from 18.5 to 8.87%. Organic manure addition is the most important factor for facilitating chemical reclaiming processes through improving the structure and nutritional status. Barley and rice yields are increased seasonally which reflect pre improvement.

INTRODUCTION

Reclaiming and cultivating each m^2 of the desert in Egypt is a real winning and achievement. In a compnehensive review about land reclamation and improvement Balba (1980) stated the following facts : 1- Land reclamation is the principal way to solve Egypt problems in various fields. 2- Salt affected soils are characterized by the highest salt concentration which led to the unproductive satus of these soils. 3- Barley plants are tolerant to higher salinity (up to EC 16 dS.m) and higher sodicity (up to ESP 60%). 4- The efficiency of leaching processes of such soils depends on some factors, i.e. the amount of leaching water as well as its salt concentration and ionic composition. 5- The amount of leaching water could be determined by various methods, i.e. mathematical equations, computing salt balance, using the column theory and the experience. 6- The underground leaching process requires about 8400 m^3/fed of water and to be effective. it should be conducted during periods of autumn and winter. 7- The time required for leaching depends on soil permeability, it needs 2-3 months in permeable loamy soil and extends to 2 years in heavy textured soils. 8- The continuous submergence for leaching of such soils should be followed when the available water is a limiting factor, better soil permeability and saline underground water is near surface, but the intermittent submergence gives better results when leaching water is available, soil permeability is bad and the water table is deep. 9- The benefit of applying organic manure is related to improving soil permeability and infertility through good chemical reactions which increase availability of many nutrients.

El-Attar and Amer (1981) found that the use of fairly saline water improved the permeability of the clayey soil. The use of the drainge water of an adj SAR values of 25 led to a decrease of soil-ESP from 27 to 8 for a fairly permeable soil but increased the ESP of impermeable soils. Kandil *et al.* (1988) found that using organic manuring for 14 years for Tahrir Province soil, resulted in some development in their physical, chemical and biological properties. El-Sherbieny *et al.* (1989) reported that the residual effect of organic manure led to higher increase in N and Zn uptake by barley plants grown on both sandy and calcareous soil. Negm and El-Gayar (1989) found that soil salinity and soluble Na decreased proportionally by soil leaching. Barley grain yield was reduced by high chloride salinity and soil alkalinity. Genaidy *et al.* (1989) showed that continuous flooding resulted in high rice yield and soil salinity reduction, but intermittent flooding led to high water use efficiency . Ibrahim (1990) reported that the soil near El-Burullos is characterized by very high sodium adsorption ratio (SAR) and the ground water is highly saline and its SAR is close to 100. Genaidy and Hegazy (1991) found better rice yields in salinity saline-sodic soil as a result of adding organic manure in the presence of gypsum application.

The objectives of the present work are to reclaim and cultivate an area of 30 feddans, in two experimental sites of saline-sodic soils by using two different water regimes of leaching water and three different rates of organic manure.

MATERIALS AND METHODS

The work was carried out to reclaim an area of 30 feddans representing a vast area of 7000 feddans of a desert uncultivated saline-sodic soils from the dried area of El-Burullos Lake in the Northern Delta Region. That sites were divided to 36 plots. Each area of the plot was 0.3 feddan. A good system of irrigation canals and open drains of suitable dimensions were eatablished in each field. The important physical and chemical properties of the soil in the two sites (0-30 cm depth) were determined according to Richards (1954) and Black (1965) as listed in Table 1.

The soil of the two experimental sites was subjected to the irrigation leaching water, chemically varied, for six months from March to September, 1989 by two systems. The first was continuous submergence, which meant that the soil was submerged with leaching water all the time except one week every one month. The second was intermittent submergence which meant that the soil was submerged one week and drained one week.

After the main leaching processes, the soil of the two fields was prepared to barley (Hordium vulgare, L. Giza 124 variety) cultivation for 1989/1990 season. Organic manure (as animal manure of 0, 20 and 40 m^3/fed treatment) was mixed with the soil during ploughing, to make with water regime treatments a factorial experiment in Comp. Rand Block Design in 3 replicates, Barley was sown on 20/11/1989 and irrigation depended principally on rain water except planting and flowering stages. Harvesting was recorded on 5/5/1990, i.e. after 165 days.

The two experimental sites were then prepared for rice (Oryza sativa, L. Giza 176 variety) cultivation by sowing method on 1/6/1990, where the water regime and the residual effect of organic. Harvesting was done on 20/10/1990, i.e. after 140 days.

Also the residual effect was studied by repeating the above mentioned experiment during the seasons of 1990/1991, 1991/1992. After harvesting of each crop, representative soil and irrigation-drainage water samples were periodically analysed according to (Richards, 1954 and Black, 1965). All the obtainable yield data

Table 1. Some selected soil characteristics of the two experimental sites before reclamation-1989 (composite samples of the surface layer 0-30 cm).

Soil characteristics	Site A	Site B
Soil texture class	Sand 15.5%, silt 34.6% and clay 50.07% Clay Loam	
SP	82.00	86.00
CEC (meq/100 g)	39.80	38.00
ESP	17.30	20.80
GR (ton/fed)	12.00	13.17
O.M. (%)	1.19	0.80
Soil-pH	7.81	7.89
EC_0(dS.m-1)	27.00	50.00
Soluble cations (meg/L) :		
Ca++	48.70	105.90
Mg++	68.40	12.90
Na+	153.10	278.00
K+	1.30	2.50
SAR	20.01	26.17
Soluble anions (meg/L) :		
CO_3^{--}	0.00	0.00
HCO_3^-	2.80	7.00
CL^-	97.60	249.60
SO_4^{--}	171.10	251.50
Available-N (ppm)(K2SO4 ext.)	13.00	15.00
Available-P(ppm)(Olsen ext.)	2.50	2.80
Available-K(ppm)(Am.acetate ext	300.00	350.00
	0.30	0.15

were statistically analysed according to Snedicor and Chocran (1971).

RESULTS AND DISCUSSION

I- Soil initial state

Table 1 reveals that the saline-sodic soils are clay loam in texture and have high salinity indices EC's (27-50 $dS.m^{-1}$), high SAR (20-26.2) and high ESP (17.3-20.8) and low available forms of N, P, K, Zn nutrients. The unproductive status of such soil is certainly due to the dreadful effect of the highest level of soluble salts (highest osmotic pressure), bad specific effect of N, low organic matter and low available nutrients (Richards 1954, Balba 1980). On the other hand, these desert soils are of clay loam texture having high CEC which would allow good fertility in future cultivation after removing the highest soluble salts by periodical leaching processes.

II- Irrigation and drainage water qualities

Table 2 gives the chemical composition of irrigation leaching and drainage waters at the two experimental sites which indicate that the salinity index (EC) was reduced seasonally through leaching processes. For irrigation water, EC's for 2nd and 3rd season have benn reduced to (73.1%,68.7%), (76.25, 87.10%) from the initial state at first season. For drainage water, EC's were lowered by about (45.3%), (18.72%), (86.71%, 88.73%) relative to the first season at the two sites, respectively. Sodium adsorption ratio (SAR) has also ben reduced by (60%, 26.7%) at the 2nd season (75.90%, 80.28%) at the 3rd season for irrigation water at the two sites, respectively. For drainage water, the corresponded changes were (48.7%, 10.5%) at the 2nd season and (74.79%, 65.18%) at the 3rd season, respectively. Acidity (pH) remained almost unchanged.

III- Chemical composition of soil solution

Table 3 illustrates the changes in the composition of the soil solution of the

Table 2. chemical composition of leaching and drainage waters of the two experimental sites through the three growth seasons.

Growth season	Ec_{-1} dS.m	Soluble ions (meg/L.)								SAR	pH
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	SO_4^{--}	Cl^{-}		
1989/1990											
Site A irrig. Water	4.0	6.8	7.0	24.0	3.0	0.5	1.5	8.0	29.0	9.1	7.8
Site A drain. Water	29.8	27.0	30.0	218.2	2.3	0.0	7.8	39.9	259.8	40.8	7.7
Site B irrig. Water	10.0	10.0	15.0	70.0	1.9	1.1	3.5	20.0	75.0	20.0	7.6
Site B drain. Water	43.2	48.0	62.0	308.0	2.5	3.7	10.5	75.0	315.0	41.5	7.5
1990/1991											
Site A irrig. Water	1.1	2.0	2.0	5.1	2.0	0.1	0.4	2.4	8.7	3.6	7.8
Site A drain. Water	16.3	25.8	21.7	114.1	2.1	0.0	5.0	24.6	134.0	23.4	7.6
Site B irrig. Water	3.1	4.3	5.9	21.0	2.0	0.0	1.0	6.0	22.1	9.3	7.5
Site B drain. Water	26.7	31.9	29.4	205.8	2.7	0.0	6.1	30.4	230.3	37.2	7.6
1991/1992											
SiteA irrig. Water	1.0	1.0	2.1	6.0	0.6	0.0	2.7	3.2	5.9	4.8	7.5
SiteA drain. Water	4.0	4.9	7.6	25.8	0.9	0.0	5.5	10.2	23.8	10.3	7.9
Site B irrig. Water	1.3	2.5	3.1	6.6	1.7	0.0	2.7	3.4	7.7	3.9	7.3
Site B drain. Water	4.9	6.3	6.0	35.9	1.3	0.0	6.4	16.4	25.5	14.5	7.4

Note : The values of irrigation and drainage water analyses are the average pf composite samples for winter and summer seasons.

Table 3. Chemical composition of the soil paste extract of the two experimental sites through the three seasons.

Growth season	EC-1 dS.m	Soluble ions (meg/L)								SAR	ESP	pH
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO3^{=}$	$HCO3^{=}$	$SO4^{=}$	Cl^{-}			
1989/1990												
Site A	11.1	13.4	15.8	075.0	0.7	0.0	10.2	22.9	77.4	19.6	15.3	8.3
Site B	21.2	26.6	31.8	149.0	0.8	0.1	01.8	28.3	177.0	27.6	18.6	8.7
Mean	16.2	20.0	23.3	112.0	0.7	0.0	06.0	25.6	127.2	23.6	17.0	8.5
1990/1991												
Site A	6.2	11.4	10.3	36.0	0.5	0.0	6.7	18.5	38.9	10.9	9.0	8.2
Site B	13.4	19.9	22.8	88.5	0.7	0.1	4.5	28.5	95.3	19.2	15.4	8.6
Mean	9.8	15.7	16.6	62.3	0.6	0.0	5.6	23.5	67.1	15.1	12.2	8.5
1991/1992												
Site A	3.3	4.8	5.5	22.8	0.6	0.4	2.82	8.6	22.5	10.0	8.6	8.4
Site B	6.5	3.0	10.6	39.6	1.0	0.0	3.75	10.3	53.7	11.2	9.1	8.5
Mean	4.9	8.9	8.1	31.2	0.8	0.2	3.2	9.5	38.1	10.6	8.9	8.5

Note: the values of soil paste analyses represent the average of composite samples for winter and summer seasons.

Table 4. Effects of water regime, organic manure, experimental site and seasonal variation on barley and rice production (ton/ f e d)

Field crop		Barley								Rice							
Growth season		89/90		90/91		91/92		Mean	Mean	89/90		90/91		91/92		Mean	Mean
Exp. Site		A	B	A	B	A	B	WR	OM	A	B	A	B	A	B	WR	OM
Water regime	Organic manure m3/fed.																
Cont. sub-mergence	0	0.20	0.09	0.58	0.48	0.63	0.49	Cont.sub.	OMo=0.42	0.53	0.50	0.70	0.64	1.32	1.00	Con.sub	OMo=0.76
	20	0.22	0.14	0.73	0.54	1.19	0.79	0.62	OM1=0.66	0.55	0.64	0.80	0.96	1.39	1.28	0.93	OM1=1.05
	40	0.30	0.20	0.79	0.51	1.77	1.45		OM2=0.78	0.87	0.55	1.30	0.79	1.58	1.37		OM2=1.10
Int. sub-mergence	0	0.24	0.15	0.50	0.36	0.70	0.62	Int. sub.		0.55	0.47	0.68	0.68	1.09	0.94	Int.sub.	
	20	0.34	0.32	0.64	0.43	1.16	1.48	0.63		0.81	0.91	1.20	1.21	1.40	1.48	1.01	
	40	0.41	0.31	0.68	0.53	1.34	1.05			0.73	0.83	0.86	1.21	1.82	1.37		
Mean site		Site A = 0.69 ; Site B = 0.55								Site A = 1.01 ; Site B = 0.93							
Mean season		0.24 ; 0.56 ;0.55								0.66 ; 0.92 ; 1.33							
LSD. 5%		WR= n.s. ; OM = 0.23 ; Site= 0.10 ; Season= 0.23								WR= 0.07 ; OM= 0.18 ; Site = 0.07 ; Season = 0.19							

two experimental sites through out the three seasons as follows :
a) Salinity index (EC_o) : soil salinity at site A is almost half of that of site B through seasonal changes of the three seasons by leaching processes. On average site, the soil salinity decreased from 16.18 (after main leaching) at the 1st season to 9.81 (2nd season) to 4.926 $dS.m^{-1}$ (3rd season). The parallel decrements were 39.37% and 69.62%, respectively. b) Sodium adsorption ratio (SAR) : it has been lowered as a result of leaching processes from 23.60 (1st season) to 15.08 (2nd season) to 10.63 (3rd season) with decrements of 36% and 54.90% relative to the 1st season, respectively. c) Exchangeable sodium percentage as a result of soil leaching was lowered from 16.955 (1st season) to 12.17 , (2nd season) to 8.877 (3rd season). The corresponding percentage decrease was 8.22%, 47.68%, respectively.

IV-Barley & Rice production

As presented in Table 4, production of barley and rice are affected by the studied variable, i.e. water leaching, organic manure, experimental sites and seasonal variation. For barley, there was no significant difference due to water leaching, but organic manure gave higher grain yields over the check treatment (M_o) by about 57.14% and 85.71% by applying OM_1 and OM_2, respectively. Site A gave an increment of 25% over Site B. The increments obtained in 2nd and 3rd seasons amounted to 133% and 128% over the 1st season, respectively.

For rice, intermittent submergence gave higher yield by about 9% over continuous submergence. Organic manure gave higher yields by 39.15% and 45.63% over OM by adding 20 and 40 m^3/fed. respectively. The grain yield due to Site A increased by 7% over that of Site B. The seasonal variation indicated that rice grain increased in 2nd and 3rd seasons by 39% and 118% over the 1st season, respectively. Balba (1980), Genaidy *et al.* (1989) and Genaidy & Hegazy (1991) reported similar findings in such soils.

Conclusion

The above results led to conclude that leaching water (comprising its regime and its quality) is the only and principal limiting factor for reclaiming and cultivating processes for saline-sodic soils, by removing the harmful soluble salts. Reclamation processes took about 4 years to remove 87% and 52% of soil salinity and sodicity in plow layer. Organic manure is an important factor to facilitate chemical reclamation processes by improving the nutrients status of the soils, which reflected on barley and rice yields.

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أهمية ماء الغسيل والتسميد العضوى لإستصلاح وإستزراع الأراضى الملحية-الصودية

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مركز البحوث الزراعية - معهد بحوث الأراضى والمياة (الجيزة) ، محطة البحوث الزراعية بسخا

فى محاولة لإستصلاح وإستزراع مساحة ثلاثين فداناً (مملوكة لمجموعة من المزارعين الجدد) وممثلة لمشروع سبعة آلاف فدان مجففة من بحيرة البرلس. تم وضع البنية الأساسية لها من أعمال التسوية وشبكات الرى والصرف . تتلخص أهم خصائص هذة الأراضى فى الآتى : ذات قوام طينى - ملحية صودية (متوسط الملوحة ٣٨,٥ مليموز/سم ومتوسط الصودية ١٨,٥٪) ، سعة تبادلية عالية ٣٨ مليمكافئ/ ١٠٠ جم ، إنخفاض واضح فى نسبة المادة العضوية ومستوى الصور الصالحة من العناصر المغذية.

تم عمل برنامج إستصلاح وإستزراع لهذة المساحة لمدة أربع سنوات (من ١٩٨٩-١٩٩٢) يتلخص فى إستخدام ماء الغسيل الذى إستمر لمدة ستة شهور فى الفترة الأولى ثم أتبع ذلك بزراعة الشعير والأرز لمدة ثلاث مواسم متتالية إستخدم فيها السماد العضوى بمعدلات مختلفة ، وإستخدم ماء الغسيل (بغمر مستمر ، وغمر متقطع) فى فترة الستة شهور الأولى وكذلك مع زراعة الأرز - ويمكن تلخيص أهم النتائج فى الآتى :

١) ماء الغسيل (نظامة ونوعيتة) يعتبر العامل المحدد لعمليات إستصلاح وإستزراع تلك الآراضى .

٢) بعد حوالى ٤ سنوات من إجراء عمليات الإستصلاح والإستزراع إنخفض مستوى الأملاح من ٣٨,٥ مليموز/سم الى ٤,٩٢ مليموز/سم ومستوى الصودية من ١٨,٥٪ الى ٨,٨٧ ٪.

٣)إضافة السماد العضوى يعتبر عاملاً حيوياً فى تسهيل عمليات الإستصلاح الكيمائى والطبيعى للتربة ، وبالتالى تحسين خصوبتها مما إنعكس على نجاح محاصيل الشعير والأرز بها.

٤) إزداد المحصول من الشعير والأرز من هدة المساحة سنوياً مما يعكس الطريق الصحيح لإجراء عمليات الإستصلاح والإستزراع بها .

٥) هذا العمل المثمر يعتبر دليلاً ومؤشراً جيداً للمزارعين الجدد الذين يقبلون على هذة المهمة السامية فى أراضى هذة المنطقة.