OPEN DRAINAGE AND MOILING FOR DESALINIZATION OF SALTY CLAY SOILS OF NORTHEASTERN EGYPT[1]

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ABSTRACT

This work is a part of composite studies dealing with problem marine clay salty lands of low level (0 m MSL), underlain by a permanent saline groundwater, and which had not yet been provided with subsurface drainage system. The study was conducted in the experimental drainage field at El-Serw Research Station, Northeastern Delta, near Lake Manzala with open field drains involving 2 spacing treatments 20 and 40. Later, moiling was executed perpendicular to the field drains. The objective of this article is to follow the extent of soil desalinization obtained with the above drainage practices, along 5 cropping seasons.

A slow, gradual, non-uniform decrease is observed in the salinity of the profiles of the test plots up to 120 cm. The decrease depends on the initial salinity of the profile layers. The degree of reduction is higher in 20m treatment. Compared to the initial state, highly significant reduction in the mean salinity of the profiles occurred in both spacing treatments at the last cropping season after moiling. Subsurface layers remained slightly saline. The reduction is realized in spite of the persisting high salinity of the groundwater. Moiling could be considered in conjunction with open drainage when dealing with similar soil conditions, which need special water management to raise productivity.

Key Words: Mole drainage, Open drains, Clay soil, saline groundwater table

1 INTRODUCTION

In Egypt, northern part of the Nile Delta represents large area of heavy clay soils with low permeability that might have a potential production. These soils are always threatened by a sallow saline groundwater. In the irrigated area, saline groundwater is a permanent source of soil salinization that causes poor productivity. The groundwater contribution in soil salinization is governed, to a large extent, by its fluctuation and solute movement through soil profile, whether in saturated or unsaturated state. This behavior is a function of different complicated factors of climatic and soils environmental conditions interacting together. Many investigators such as Simedema and Rycroft (1983), Ritzema (1994), Moukhtar et al, 1995 and 1998) mentioned that heavy soils of low hydraulic conductivity often require very closely spaced drainage systems for satisfactory water control. With conventional pipes, the cost of such systems is usually uneconomic and hence alternative techniques are required. Surface drainage is one possibility; the other is mole drainage.

The limited flow of water in salty clay soils restricts salt removal. This situation is aggravated if the shallow groundwater is highly saline; only shallow rooted crop can be grown. On the other hand, Moukhtar et al, (1995) decide that field drainage with open ditches alone is not quite satisfactory for a good crop production. Mole drainage, in combination with open drain ditches overcomes the slow water movement. A fast recession of water table upon irrigation is realized through fissure and cracks above the mole line. This is reflected satisfactory on soil salinity in the rootzone and leads to good and uniform vegetation. Moukhtar et al, (1995), (2002) and (2003) concluded that moling combined with field drains could be highly recommended as an auxiliary drainage treatment in clay salty soils of low level with a saline water table to raise the soil productivity. It is a low cost measure needing no advanced machinery and small farmers instead of using narrow drain spacing, which wastes the area of agricultural land, can adopt it. In addition, this type of soil should not be left fallow even for a short period otherwise salinization quickly arises. Also, shallow root crops are preferred. Water submerged crops i.e. rice, amshout should be included in agricultural rotation.

The management of such soils depends essentially on providing efficient drainage conditions beside regular irrigation to preserve the rootzone from salinity in the cropping season and to restrict capillary rise from the saline groundwater between cropping seasons. The objective of this article is to follow the extent of soil desalinization obtained with the above drainage practices, along 5 cropping seasons.

2 MATERIALS AND METHODS

The site of the field under study (0 m MSL) is representative of northern low lands, fluviomarine clay salt affected soils of low productivity (mean clay content: 63.5% up to 90 cm soil depth with hydraulic conductivity: 0.0669 m/day). Moreover, they are assumed to lie in the zone of hydrostatic pressure. A main controversial factor is the extreme salinity of the groundwater table, which renders the desalinization process of the soil profile rather difficult. The mean EC: of soil profile is 25 dS/m, dominant salt: sodium chloride and magnesium exceeds calcium. (Moukhtar et al 1990). Crop rotation comprises in winter wheat, barley, clover, and sorghum, in summer corn, rise and sometimes cotton. Also in highly saline parts, submerged permanent forage crops (amshout) are grown and last several years in the land.

Drainage testing was monitored in replicate plots in an experimental field with open drain ditches involving 2 spacing treatments 20 and 40 m. Later and recently in 2000, moling was executed perpendicular to field drains, two meter apart and 50 cm depth. Water table depth was measured in observation well in the test plots; Calculated mean water table depth during 7 and then 13 days period of the irrigation intervals (about 2 weeks) was studied. Soil salinity was determined as EC in soil saturation extract. Soil desalinization obtained with the above drainage practices was recorded through 5 cropping seasons, three before moling and two after installation.

3 RESULTS

Monitoring water table fluctuation and drawdown rates were observed. In general, water table fluctuation differs among the test plots due to soil variability. The data shows that the mole drains were effective at the beginning of the irrigation interval. Five days after irrigation, the water table depth recedes deeper in the second and third season of years 2001 and 2002 (after moling was executed) than in the first season with open drains alone. The recession of water table after moling was faster in 20m spacing treatment. The effect of moling was not visible beyond 60 cm soil depth. Statistical analysis shows a highly significant difference between water table depth before and after moling in the fifth day after irrigation. In each period, the watertable depths in all the irrigation’s are deeper under 20m than under 40m spacing treatment. On the other hand, the difference between values 20 m spacing treatment before and after moling is highly significant and significant in the first and second periods, respectively; whereas, in 40 m treatment, it was significant in the first period only. Concerning rate of water table drawdown, with drain alone, it was very low at the fifth day and then increased slightly (6.5cm/day) by one week. This increase might be due to existing bio-pores channels. Moiling in conjunction with open drains realized a high rate of water table drawdown in almost all the irrigation’s. Five days after irrigation, the rate of water table drawdown was deeper in 20m spacing treatment 12cm/day than in 40m treatment about 8 cm/day. This tendency demonstrates the beneficial effect of moling combined with open drains to prevent water logging in the rootzone.

In General, Results showed a gradual, non-uniform decrease in soil salinity of the different profile layers through the studied seasons. In the topsoil up to 60 cm, the decrease was quite obvious after moling where the EC of the soil saturation extract dropped to the convenient values around 4 dS/m or less. However, of the subsurface layers, still remained saline, although conceivable reduction is realized (Figure 1,2). Regarding monitoring soil desalinization and desodification, in general, the desalinization of the profiles occurred as a result of the decrease in salinity of the different soil layers. Another important beneficial effect of the standing fresh water that keep the saline groundwater faraway enough from the rootzone and dilutes the upper part of it (El Hakim et al, 1990). Compared to the electric conductivity values, a decrease is realized in the topsoil up to 60 cm, especially in the surface layer (0-30 cm), the electric conductivity values decreased below 4 dS/m in both spacing treatments. There is invisible decrease in electrical conductivity values in subsurface layers (60-120 cm). These results might be explained by the effect of moling on water table recession, which occurred only around mole depth and thus contributing to an active salt transfer during the falling water table. It could be concluded that in heavy textured soils, the ponding conditions under rice culture, realizes desalinization of the surface soil layers and partly of the subsurface layers. Whereas, moling is effective in removing salts from the upper layers only. Salt transfer from deeper layers depends on the drainage efficiency.

Regarding average profile salinity in each treatment, statistical analysis showed significant and highly significant reduction after rice cultivation and after moling, respectively, compared to the initial salinity. The average salinity of the profiles in 20m spacing treatment dropped from an initial value of 8.7 dS/m to 5.3 dS/m after rice and to 4.8 dS/m after moling, whereas in the 40m spacing treatment, it dropped from 7.1 dS/m to 4.8 dS/m after rice and to 4.4 dS/m after moling.

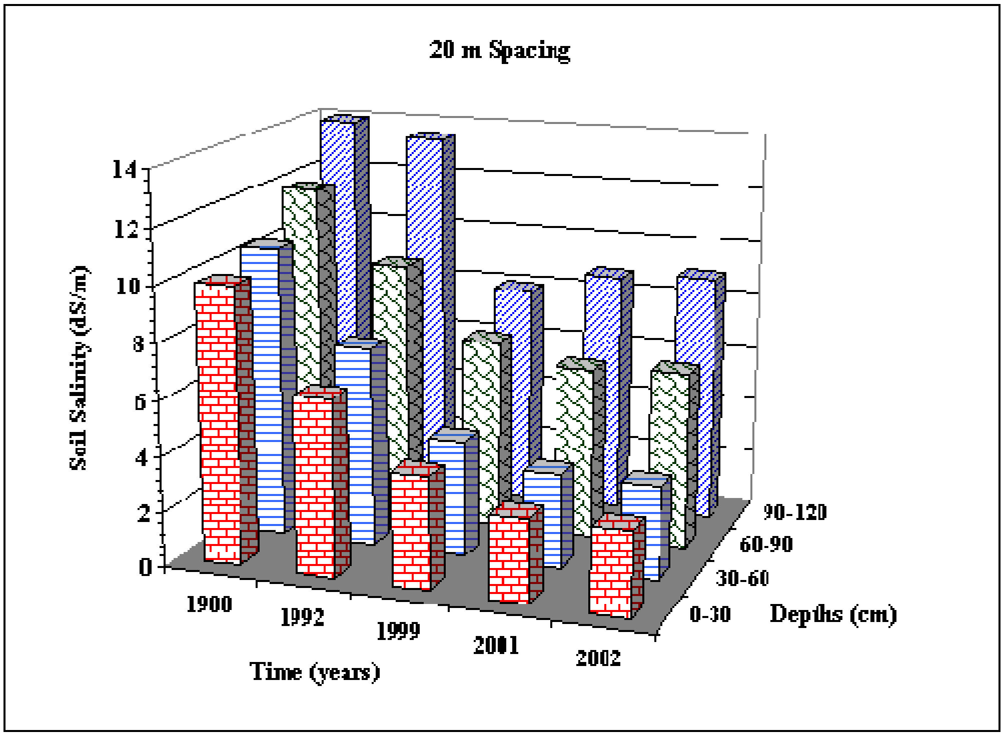

Figure 1   Mean salinity in the profile layers in successive years for 20 m spacing treatment.

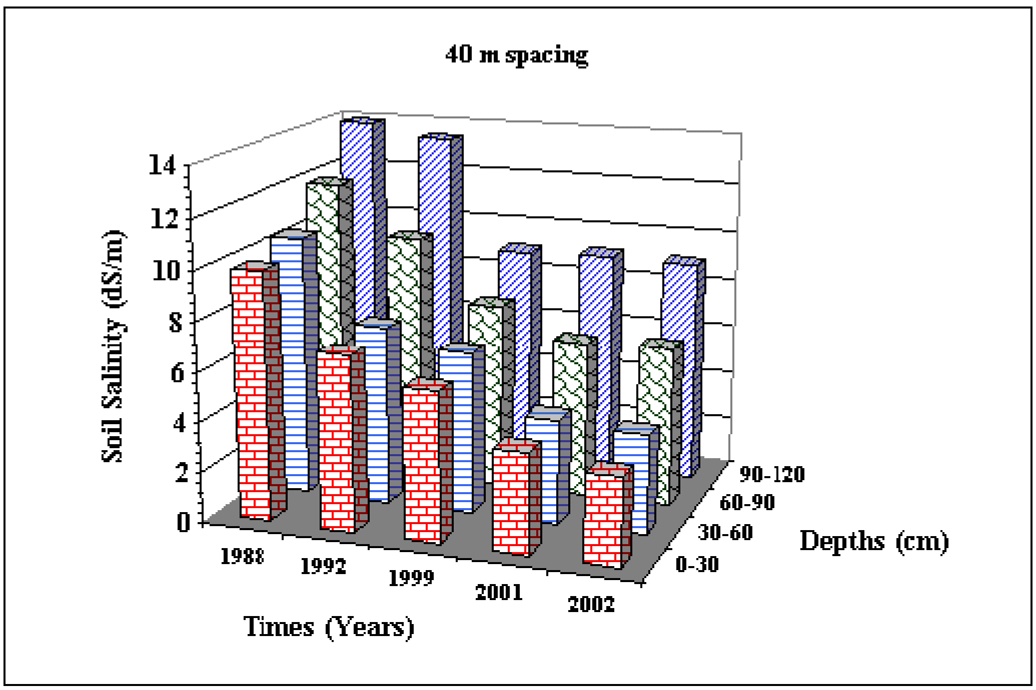

Figure 2   Mean salinity in the profile layers in successive years for 40 m spacing treatment

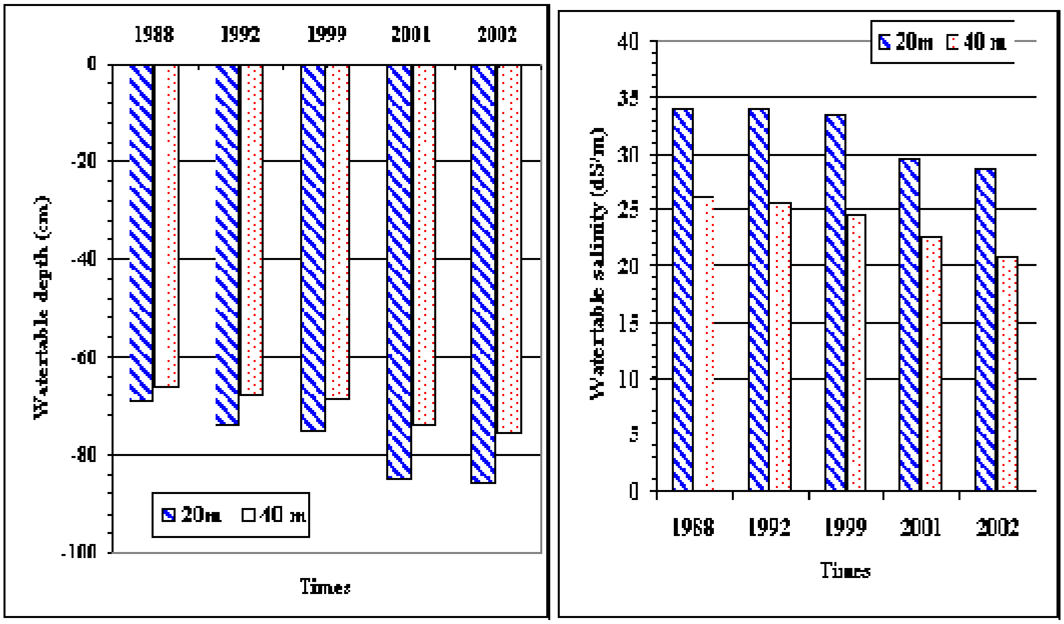

Figure 3 Mean groundwater depth (cm) and salinity in the successive years for both drainage treatments.

Regarding soil desodification after rice and gypsum addition, the decrease in exchangeable sodium percentage ESP was confined only in the upper 30 cm soil depth, where the ESP decreased from values of 20 and 25 to around 10 and 15 in 20 m and 40 m spacing treatment, respectively.

The reduction occurred in spite of the persisting salinity of the groundwater table till the last season. Initial average groundwater EC of the profile plots in each treatment at the first season was 34.0 dS/m at 69 cm depth and 26.0 dS/m at 66 cm depth in 20 and 40 m spacing treatment, respectively (Figure 3). At the last season (year of 2002) after moling, the average EC was still high but at a deeper depth; EC being 28.6 dS/m and20.9 dS/m at 85.3 cm and 75.5 cm depth in 20 and 40 m spacing treatments, respectively.

With respect to crop growth conditions, during the first summer season (1989), sorghum growth was not uniform; many barren patches were found in the field. Whereas in the season where moling was executed, and in the following season, sorghum growth became normal and the barren patches totally disappeared. This is due to the improvement that occurred in the rootzone conditions, as a direct effect of soil desalinization and to the faster water table recession upon irrigation as a result of moling.

It may be concluded that, moling combined with field drains is an adequate auxiliary drainage treatment in clay salty soils of low level with a saline water table top reserve the rootzone from water logging and salinity.

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