J. Agric. Sci. Mansoura Univ., 32 (10): 8831 - 8838, 2007

EFFECTIVENESS OF OPEN DRAINS IN RECLAIMING SALTY CLAY LOW PERMEABLE SOIL

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ABSTRACT

A field study was carried out at Khalid Ibn Al Walid village, Hessanya, Sharkia Governorate during the winter season of 2006/07 where barely crop was grown to investigate the possibility of restoring the deteriorated soil through open field drains. The field served by open drains at a depth of 90 cm with length of 100 m. and the drain spacing treatments were at 10 and 20 m.

The results indicated that drain spacing treatments reduced the watertable level. The recession percentages of watertable level were 60, 47, 29 and 28 % after 5, 10, 15 and 20 days, respectively in the treatment of 10 m drain spacing compared to the one of 20 m. Generally, close drain spacing relatively was more effective on lowering watertable level than the wider spacing. Watertable salinity during the recession of watertable increased with depth to reach the maximum value at deeper layers. Closer drain spacing caused a considerable reduction in soil moisture content with days after irrigation more than the obtained reduction under wider drain spacing. The reduction in the moisture content of soil profile was 11.69, 13.08, 25.88 and 24.74 % after 5, 10, 15 and 20 days from irrigation, respectively in 10 m drain spacing treatment compared to that of 20 m. The reduction in soil salinity for the treatment of narrow drain spacing was more obvious than that in wider one especially in the surface layer and short time after irrigation (5 days). The reduction in the salinity of soil profile was 14.71, 8.00, 9.52 and 7.14% after 5, 10, 15 and 20 days from irrigation, respectively in 10 m drain spacing treatment compared to that of 20 m.

It might be concluded that drainage alone is not enough for control of the twin menace of waterlogging and salinity. Therefore, supplementary practices to improve drainage efficiency such as subsoiling can be used periodically. Subsoiling will enhance downward movement of irrigation water carrying off excess salts from surface layers. After wards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when it comes close to soil surface. The percolating water will constitute a temporary front preventing the saline groundwater in subsurface layers from linking with the upper ones.
Keywords: salt clay soil, surface drainage, highly saline watertable

INTRODUCTION

In the arid and semi arid regions, soil salinity still limits crop production significantly. Hence, it has a negative effect on food security. This is especially true in irrigated agriculture because of the salts added with the irrigation water and the buildup of saline groundwater where natural drainage is insufficient. Although only approximate figures are available, FAO estimated in 2002 that salinity had damaged about 20-30 million ha of irrigated land worldwide, and that 0.25- 0.50 million ha were being lost from production every year as a result of soil salinization (FAO, 2007).

The main goal of surface drainage is to improve crop growth conditions by providing timely removal of excess water remaining at or near the ground surface before the crops is damaged. Surface drainage is also needed to guarantee soil workability and trafficability, so preventing delays in soil preparation operations and harvesting, respectively. Shallow surface drains can also serve to leach out salts by surface as well as subsurface flow. For instance, with ditches of only 0.4 m depth the farmers in Egypt succeed in leaching their new salty land (Ochs and Bishay, 1992). Chang et al. (2001) revealed that drainage alone is not enough for control of the twin menace of waterlogging and salinity. Aslam (2002) stated that irrigated agriculture has contributed to the development of many countries, especially in semi arid and arid regions, and to the food security around the world. One of the negative impacts of irrigated agriculture is salinization due to concentration of salts following evaporation of irrigation water, and water logging due to inappropriate irrigation methods. Drainage of irrigated lands mitigates these two concerns. Bilal and Sarwar (2005) found that waterlogging is the major problem of the Kafur Dheri Unit, Peshawar, Pakistan area and it increases day-by-day due to non collaboration of farmers on maintenance of the drains, which causes reduction in crop yield, hence, rehabilitation of existing drainage system is necessary. Agsource (2006) stated that upon deciding whether corrective action for saline and sodic soils will be effective, it is of primary importance to consider the drainage conditions. The ability to leach water is dependent upon drainage, and the overall effectiveness of your reclamation system is dependent upon leaching. Drainage carries the salts down through the soil profile and out of the rooting zone. Without drainage, salts will accumulate regardless of any applied soil amendments. Drainage is an expensive operation requiring technical knowledge and should be performed only after consultation with agricultural irrigation drainage experts.

Riasat (2007) stated that deep open drains have been promoted over the past few decades. Despite problems such as variability in drainage response and the relatively flat landscapes in the wheat belt, deep drains are increasingly seen as a viable option in this region.

Most of the reclamation areas use surface drainage in the first stage of renovation for control watertable and leaching process. Nowadays, the farmers are in hastening to cultivate their lands without waiting or waste time for long leaching. They believed that soil reclamation might be achieved by cultivated a proper crop even though its productivity is less. Consequently, they started directly to install surface drainage to accelerate the process of soil improving. The present study has been setup to investigate the possibility of restoring the deteriorated soil through open field drains.

MATERIALS AND METHODS

The current study was carried out at Khalid Ibn Al Walid village, at South Hessanya Plain in the East Delta region, Sharkia Governorate during the winter season of 2006/07 where barely crop was grown. The selected field served by open drains at a depth of 90 cm and the drain spacing treatments were at 10 and 20 m; the length of the field drain for both spacing was 100 m. Disturbed soil samples at regular depths of 30 cm down to open drain depth

(90 cm) were collected from each treatment, then air dried, ground to pass a 2mm sieve and they were subjected for chemical analysis according to Page et al. (1982). Some soil properties of the studied area are shown in Table 1.

Table 1. Some soil properties of the investigated soil

Soil depth (cm)	Sand %	Silt %	Clay %	Texture class	O.M. %	$CaCO_3$ %	EC_e (dS/m)
0-30	14.33	26.15	59.52	Clay	1.39	3.17	9.12
30-60	13.74	27.43	58.83	Clay	0.75	5.53	12.23
60-90	13.46	26.56	59.98	Clay	0.84	3.22	15.49
mean	13.84	26.71	59.450	Clay	0.99	3.97	12.28

O.M.= organic matter **EC_e= electrical conductivity in soil paste**

Watertable depths at midway between open drains during an irrigation interval (21 day) were recorded through observation wells (19 mm. Diameter and 1.5 m. length) according to Ritzema (1994). Watertable depth was measured by using a sounder consisting of a 1.25 cm diameter copper tube and 5.0 cm in length connected with a calibrated steel tape. Samples of watertables each 5 days from both treatments were collected from observation wells to measure their salinity using electric conductivity meter. A soil profile from each treatment was chosen adjacent to the observation wells to collect soil samples from consecutive depths of 30 cm down to 90 cm after 5, 10, 15 and 20 days from irrigation. The soil samples were subjected to determine soil moisture content by gravimetric method and salinity in soil paste using electrical conductivity meter (Page et al., 1982).

RESULTS AND DISCUSSIONS

For drainage condition inspection, two important factors should be checked; first watertable situation and soil moisture condition; second soil salinity. Regarding to watertable circumstances, generally, results indicated that drain spacing treatments reduced the watertable level. The data presented in figure (1) showed that after 5 days watertable depth reached to 24 and 15 cm for 10 and 20 m drain spacing treatments, respectively. Before the next irrigation (after 20 days), the watertable level went deeper to reach a depth of 78 and 61 cm for the corresponding treatments. The recession percentages of watertable level were 60, 47, 29 and 28% after 5, 10, 15 and 20 days, respectively in the treatment of 10 m drain spacing compared to the one of 20 m. Generally, close drain spacing relatively was more effective on lowering watertable level than the wider spacing. In a heavy clay soil, Moukhtar et al. (2004) found that the watertable level went deeper under 20 m open drain spacing than that of 40 m. The results assure that although the soil is salt affected to some extend but drainage treatments reduced the watertable level to a consider depth.

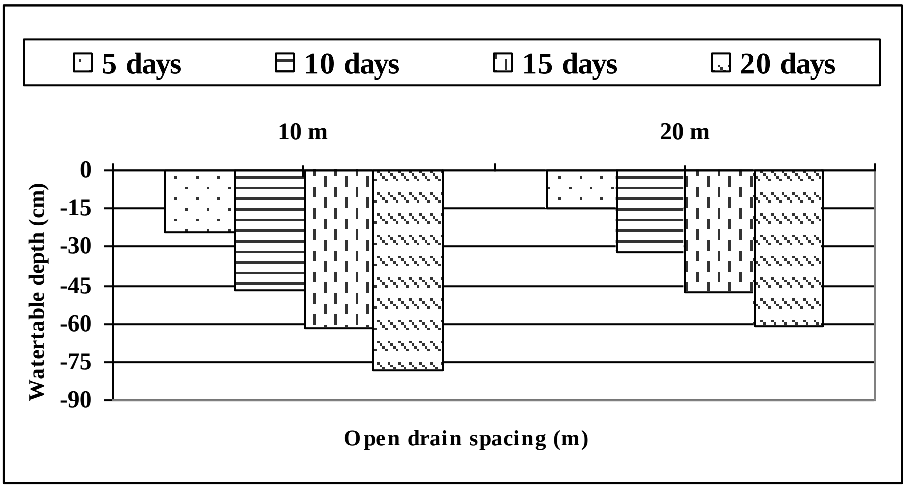

Fig. (1):Watertable depth in relation to time and drain spacing treatments.

Concerning the recession of watertable depth with days after irrigation and their corresponding salinity, the data are shown in figure (2). Results revealed that the rate of watertable drawdown changed with drainage treatments. The data indicated that the watertable recession was faster in treatment of 10 m drain spacing than that of 20 m drain spacing. On the other hand, the corresponding watertable salinity during the recession of watertable increased with depth to reach the maximum value at deeper layers. It was noticed that during the first five days, salinity of watertable was mixed by the irrigation water which causing a dilute effect of watertable salinity especially in the upper layer (30 cm). Furthermore, wtertable salinity increased gradually with depth to reach the maximum value before the next irrigation. It may worth to mention that the dilute effect of watertable by irrigation water in the environment of active root zone was very important factor for effective plant growth. The result agreed with those obtained by Moukhtar et al. (2003) who found highly significant correlation between both the groundwater salinity and the rate of drawdown and soil salinity.

The other vital issue is to have an idea about both wet and dry soil condition through soil moisture content which has a great influence on restructure and soil productivity. Data of soil moisture content are presented in figure (3). In general, soil moisture content was relatively increased with soil depth. Data indicated that soil moisture content during irrigation interval was affected by drainage treatments. In general, closer drain spacing caused a considerable reduction in soil moisture content with days after irrigation more than the obtained reduction under wider drain spacing. In treatment of 10 m drain spacing, the average moisture content of soil profile was 46.1 and 28.9% after 5 and 20 days from irrigation, respectively. The reduction percent in the moisture content of soil profile was 37.31% after 20 days compared to

5 days after irrigation. In treatment of 20 m drain spacing, the average moisture content of soil profile was 52.2 and 38.4% after 5 and 20 days from irrigation, respectively. The reduction percent in the moisture content of soil profile was 26.44% after 20 days compared to 5 days after irrigation. Regarding the effect of drain spacing, the reduction in the moisture content of soil profile was 11.69, 13.08, 25.88 and 24.74% after 5, 10, 15 and 20 days from irrigation, respectively in 10 m drain spacing treatment compared to that of 20 m. Abdel-Mawgoud et al. (2007) found that the soil moisture content increased as tile drain spacing increased. For such circumstance, data appears that drainage was affective on soil moisture content and consequently on shrinkage and swelling which takes part on soil structure in the root zone layer.

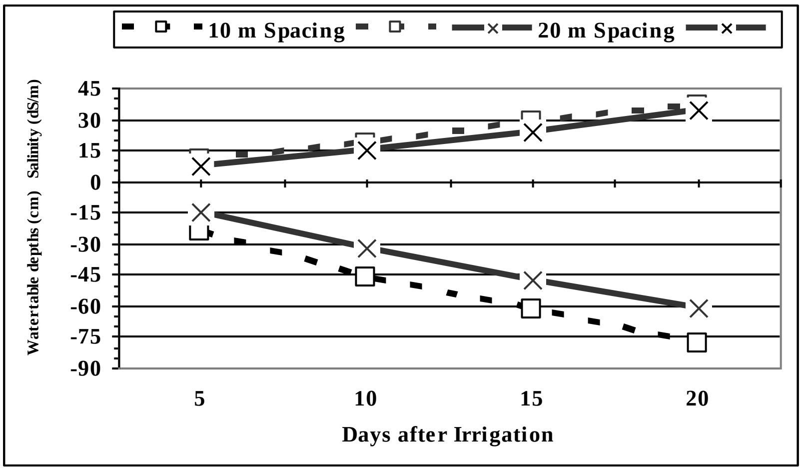

Fig. (2). Watertable depth and its salinity in relation to time and drain spacing treatments.

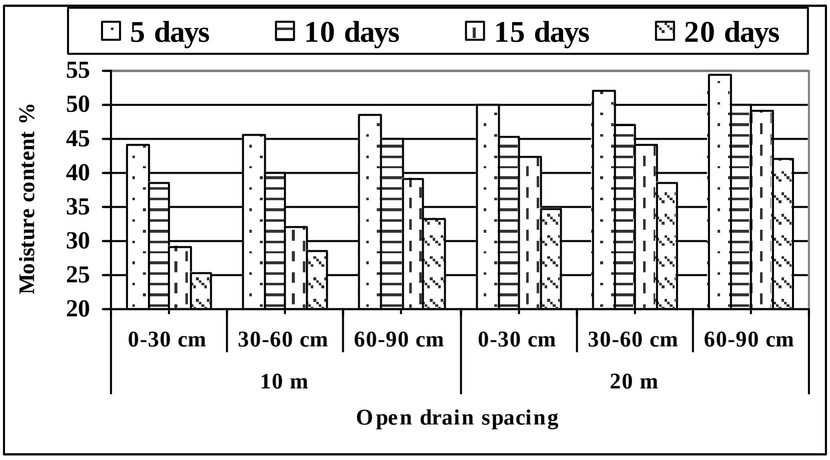

Fig. (3). Moisture content with soil depths in relation to time and drain spacing treatments.

To get a complete picture, soil salinity was measured at different soil depths with time in both drain spacing treatments (Fig. 4). In general, results indicated that soil salinity increased with soil depth and as the time proceeded. The data showed that soil salinity was highly affected by drainage treatments. The reduction in soil salinity for the treatment of narrow drain spacing was more obvious than that in wider one especially in the surface layer and short time after irrigation (5 days). In treatment of 10 m drain spacing, the average salinity of soil profile was 5.8 and 9.1 dS/m after 5 and 20 days from irrigation, respectively. The average salinity of soil profile increased by 36.26% after 20 days compared to 5 days after irrigation. In treatment of 20 m drain spacing, the average salinity of soil profile was 6.8 and 9.8 dS/m after 5 and 20 days from irrigation, respectively. The average salinity of soil profile increased by 30.61% after 20 days compared to 5 days after irrigation. Regarding the effect of drain spacing, the reduction in the salinity of soil profile was 14.71, 8.00, 9.52 and 7.14% after 5, 10, 15 and 20 days from irrigation, respectively in 10 m drain spacing treatment compared to that of 20 m. It is known that soil salinity is greatly affected plant growth which depending on plant species. For local soil situation, surface drainage is suitable to lowering soil salinity in the root zone environment.

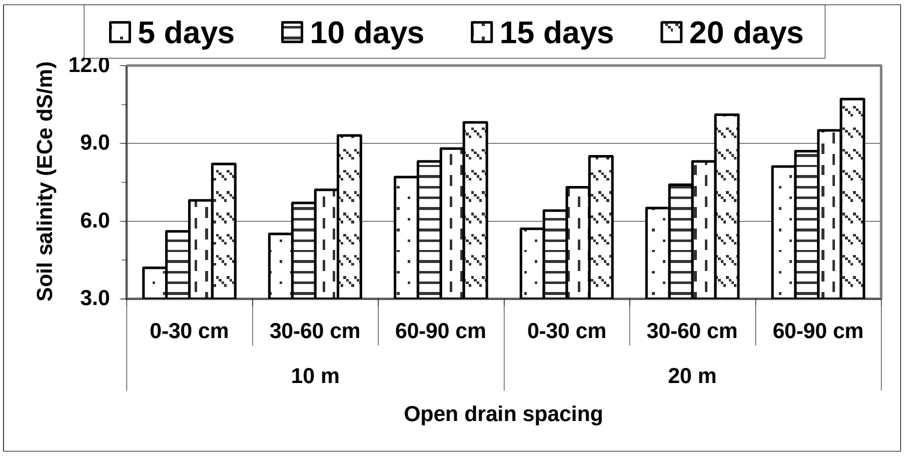

Fig. (4). Soil salinity with depth in relation to time and open drain spacing treatments.

It can be concluded that drainage alone is not enough for control of the twin menace of waterlogging and salinity. Therefore, supplementary practices to improve drainage efficiency such as subsoiling can be used periodically. Subsoiling and/or moling will enhance downward movement of irrigation water carrying off excess salts from surface layers. After wards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when it comes close to soil surface. The percolating water will constitute a temporary front preventing the saline groundwater in subsurface layers from linking with the upper ones.

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كفاءة المصارف المكشوفة فى استصلاح الأراضى الملحية الطينية بطيئة النفاذية

على سيد على عبدالموجود
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إقيمت تجربة حقلية بقرية خالد بن الوليد بالحسنية، محافظة الشرقية خلال الموسم الشتوى لعام 2007/2006 حيث كان الشعير المحصول المنزرع لدراسة امكانية استرجاع الأراضى المتدهورة باستخدام المصارف الحقلية المكشوفة. والحقل التجريبى به شبكة صرف مكشوف على عمق 90سم وبطول 100متر وكانت معاملات مسافات الصرف المكشوف على أبعاد 10، 20 متر.

وقد أظهرت النتائج أن معاملات أبعاد الصرف أدت الى انخفاض مستوى الماء الأرضى، وكانت نسب معدل هبوط مستوى الماء الأرضى 60، 47، 29، 28% بعد 5، 10، 15، 20 يوم من الرى على الترتيب فى معاملة أبعاد المصارف 10 متر بالمقارنة بالمعاملة ذات الأبعاد 20 متر. وبصفة عامة كانت أبعاد المصارف الضيقة أكثر كفاءة فى خفض مستوى الماء الأرضى من مثيلتها الأوسع مسافات. وملوحة مستوى الماء الأرضى خلال الهبوط تزيد مع العمق لتصل الى أعلى قيمة فى الطبقات العميقة. ومسافات المصارف الأضيق أدت الى نقص مقبول فى المحتوى الرطوبى للتربة مع توالى الأيام بعد الرى أكبر من مثيلتها الأوسع مسافات. وكان النقص فى المحتوى الرطوبى لقطاع التربة 11.69، 13.08، 25.88، 24.74% بعد 5، 10، 15، 20 يوم من الرى على الترتيب فى معاملة أبعاد المصارف 10 متر بالمقارنة بالمعاملة ذات الأبعاد 20 متر. وكان النقص فى ملوحة التربة للمعاملات ذات الأبعاد الأضيق أكثر وضوحاً من مثيلتها فى المعاملات ذات الأبعاد الأوسع خاصة فى الطبقة السطحية وبعد فترة قصيرة من الرى (5 أيام). وكان النقص فى ملوحة القطاع الأرضى14.71، 8.00، 9.52، 7.14% بعد 5، 10، 15، 20 يوم من الرى على الترتيب فى معاملة أبعاد المصارف 10 متر بالمقارنة بالمعاملة ذات الأبعاد 20 متر.

والخلاصة يمكن القول أن الصرف بمفرده غيركافى للتحكم فى غداقة التربة والملوحة. ولهذا يمكن استخدام تطبيقات تكميلية لتحسين كفاءة الصرف مثل الحرث تحت التربة بصفة دورية. الحرث تحت التربة سوف يحسن حركة ماء الرى الى أسفل حاملة معها الأملاح من الطبقة السطحية. وبعد فترة من تتابع الرى سوف يؤدى تدريجياً الى نقص المحتوى الملحى للماء الأرضى على الأقل فى حالة قربه من سطح التربة. حيث أن الماء المار الى أسفل سوف يكون جبهة مائية مؤقتة تحجب ملوحة الماء الأرضى فى الطبقات التحت سطحية من الاتصال بالطبقات العليا.