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EFFECT OF DRAIN SPACING ON SOME SOIL CHARACTERISTICS AND COTTON YIELD IN EASTERN NORTH DELTA, EGYPT.

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ABSTRACT

Clay soil in the north Delta represents area that need very narrow drains which is costly from economic point of view. To drain such soils an auxiliary drainage treatment is required to increase the efficiency of subsurface drainage. Cotton yield was cultivated in the growing season of 2004 in a previously established experimental drainage field at El-Serw Agricultural Research Station Farm, northeastern delta of Egypt near El-Manzala Lake. The experiment was conducted on plots included two main drain treatments (15 and 30 m drain spacing) that combined with or without sub-soiling spaced at 1.5m. The aim is to assess and evaluate the effects of drainage treatments and sub-soiling on soil conditions and cotton yield.

The results indicated that water table depth went deeper with the closer spacing treatments and in the sub-soiling treatments. It was 78 and 60 cm at the midway between drains for 15 and 30 m drain spacing without sub-soiling, respectively; and was 85 and 72 cm for 15 and 30 m drain spacing with sub-soiling. The water table depth went deeper whenever it came closer to drains; it was 110 and 77 cm for 15 and 30 m drain spacing without sub-soiling, respectively at 1/8 L. While in sub-soiling treatments, it was 116 and 96 cm for respective treatments. Soil moisture content was relatively decreased at closer drain spacing compared to the wider one. The reduction in soil moisture content was more pronounced in the drain spacing combined with sub-soiling and the soil layers got dryer as the time proceed. Bulk density was relatively decreased by narrow spacing combined with sub-soiling. Soil salinity and sodicity decreased as the drain spacing get closer and with sub-soiling treatments. Cotton yield increased with narrow drains spacing treatments combined with sub-soiling treatments

Keywords: drainage, water table depth, sub-soiling, soil moisture content, bulk density, salinity, cotton Yield.

INTRODUCTION

Drainage plays a vital role in low permeable clay soils in order to prevent soil degradation. 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 shallow saline groundwater, which is a permanent source of soil salinization that causes poor productivity. Soil physicochemical properties such as salinity, soil texture and structure, plant-available water, trace elements and ion toxicity are the primary soil factors influencing crop yield (Tanji, 1996). These properties tend to be highly spatially variable. Numerous studies have indicated that watertable depth and soil physicochemical properties are usually the most influential factors for cotton yield and fiber quality (Cassman *et al.*, 1990; Morrow and Krieg, 1990; Johnson *et al.*, 1998; Ping and Green, 1999; Bradow and Davidonis, 2000; Elms *et al.*, 2001; Li *et al.*, 2001).

Sharma *et al.* (2000) stated that the drains facilitated reclamation of the waterlogged saline land which had variations in salt removal with space and time. The removal of salts from the root zone varied initially with distance from the drain and with depth. However, after a few years, the variations were reduced and the land was reclaimed sufficiently to grow most of the crops of the region. Plots provided with a drain spacing of 75 m required more time for complete reclamation compared to plots provided with 25 m drain spacing. Leaching through subsurface drainage increased soil porosity, modulus of rupture, infiltration rate, organic carbon, available nitrogen, phosphorus, potassium, and available water, and decreased bulk density differently in the three drain spacing (25, 50 and 75 m). In the 75 m drain spacing plots, soil salinity (EC_e) and water content remained higher than in the 25 and 50 m drain spacing plots. Soil EC_e and water content were less near the drains, were highest in areas midway between the drains. Wasef (2004) found that enhanced soil hydraulic properties by lowering water table level was more effective under closed drain spacing than that of wide one. Mohamedin and El-Sawaf (2005) found that the total soil porosity increased by 2.81, 4.09 and 5.10 % for tile drain spacing of 40, 30 and 20 m., respectively. Sharma and Gupta (2005) found that subsurface drainage facilitated the reclamation of waterlogged saline lands and a decrease in the soil salinity (EC_e, dS m^{-1}) that ranged from 16.0 to 66.3 per cent in different blocks. On average, 35.7 per cent decrease in salt content was observed when compared with the initial value. Provision of subsurface drainage controlled the water-table below the root zone during the monsoon season and helped in bringing the soil to optimum moisture content for the sowing of winter crops. In the drained area, the increase in yields of different crops ranged from 18.8 to 27.6 per cent. However, in the undrained area the yield of different crops decreased due to the increased water logging and soil salinity problems. Overall the results indicated that investment in subsurface drainage is a viable option for reversing the land degradation of waterlogged saline lands in a monsoon climate. Abdel-Mawgoud *et al.* (2007) concluded that tile drain spacing treatments realized an enhancing effect by lowering the water table and accelerated its recession, particularly under narrow spacing treatment. They also, noticed that an improvement in drainage conditions was realized progressively as time proceeds, especially in the treatment of 15 m tile drain spacing.

The present study aims to assess the effect of different tile drain spacing on some physicochemical properties and cotton yield grown in heavy clay soil.

MATERIALS AND METHODS

The current study was carried out at El-Serw Agricultural Research Station Farm, northeastern delta of Egypt near El-Manzala Lake. The area is lowland (0 m MSL), heavy clay (60%) with some irregular lenses of lighter texture. The soil is salty (EC= 12 dS/m) and underlain by a saline groundwater (EC= 25 dS/m). The average saturated hydraulic conductivity (k_s) is about 0.079 m/day which considered low according to Rickard and Cossens (1965).

Cotton crop was planted on the 3rd of March, 2004 in a field provided by tile drainage system with different spacing between drains (15 and 30 m) with and without sub-soiling. The agricultural tillage for cotton plants were practiced as that in neighborhood fields. Water table depth during an irrigation interval was measured through observation wells (19 mm. Diameter and 2 m. length) placed at L/2, L/4 and L/8 (where L= spacing between drains) according to Ritzema (1994). Disturbed soil samples from consecutive depths of 30 cm down to 90 cm were collected from each treatment, then air-dried, ground to pass a 2 mm sieve and subjected for chemical analysis according to Page *et al.* (1982). Also, undisturbed soil samples were taken from the same soil depth using cores with 4.3 cm diameter and 3.0 cm height to determine soil moisture content, bulk density and total porosity according to the procedure outlined by Klute (1986). The soil moisture content was determined at the midway between the tile drains one week after irrigation. At the end of the season, cotton yield was determined for each treatment.

RESULTS AND DISCUSSIONS

Water Table Depth:

The water table depth was highly affected by drainage treatments. Data of water table depth through irrigation interval is shown in figure (1). Results indicated that at midway between drains, water table depth went deeper with the closer spacing treatments and in the sub-soiling treatments. The water table depth was 78 and 60 cm at the midway between drains for 15 and 30 m drain spacing without sub-soiling, respectively; the water table depth went deeper to reach a depth of 85 and 72 cm for 15 and 30 m drain spacing with sub-soiling. Also, it was noticed that the water table depth went deeper whenever it came closer to drains. Very close to the drain (L/8), the water table depth was 110 and 77 cm for 15 and 30 m drain spacing without sub-soiling, respectively. While in sub-soiling treatments, the water table depth went deeper to reach a depth of 116 and 96 cm for 15 and 30 m drain spacing, respectively.

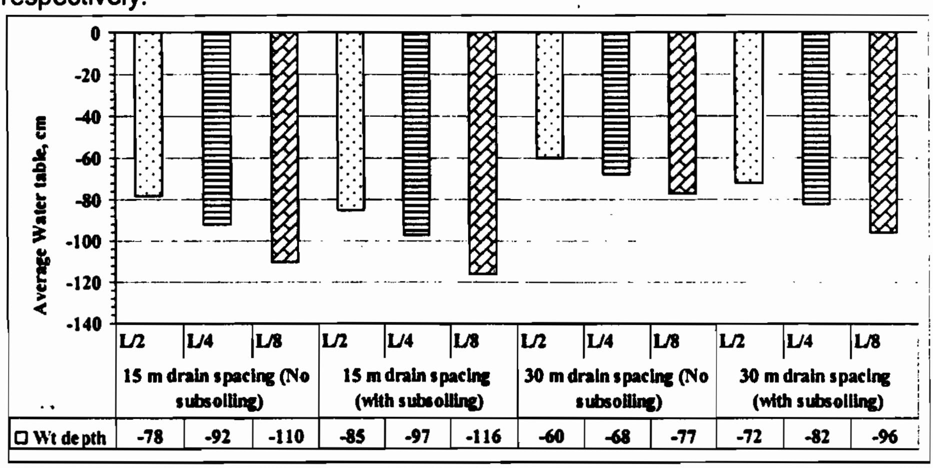


Figure (1). The water table depths through irrigation interval under different drainage and sub-soiling treatments.

Soil Moisture Content:

Drainage and sub-soiling treatments were highly affected the water table depths and consequently the retained soil moisture. Data of soil moisture content as influenced by drainage and sub-soiling treatments is shown in figure (2). In general, the results indicated that the top soil (0-60 cm) was more affected by drainage treatments compared to subsoil layer (60-90 cm). Soil moisture content was relatively decreased at closer drain spacing compared to the wider one. Also, data indicated that the reduction in soil moisture content was more pronounced in the drain spacing combined with sub-soiling. Also, data indicated that the soil layers got dryer as the time proceed (Figure 2).

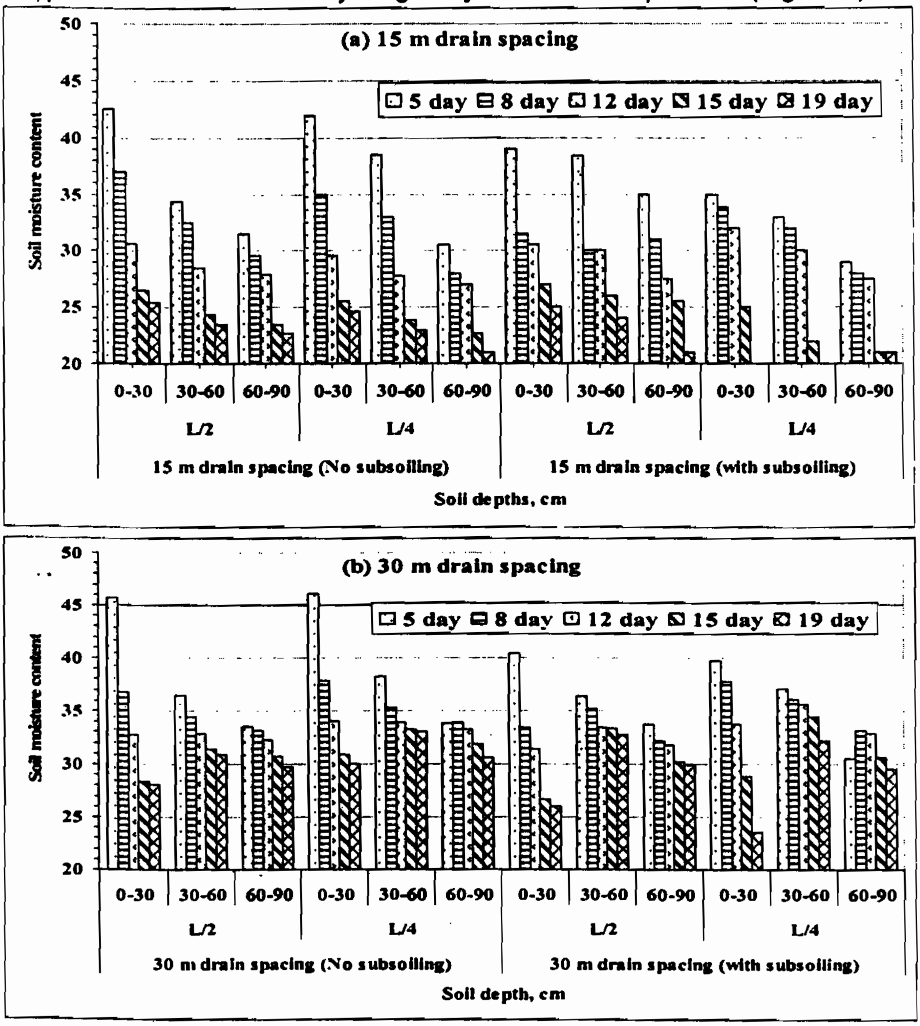


Figure (2). Soil moisture content as affected by drainage and sub-soiling treatments as the time proceeds through an irrigation interval: a) 15 m and b) 30 m drain spacing.

Bulk density

Bulk density in relation to drainage and sub-soiling treatments of different soil layers is shown in figure (3). Generally, the results showed that bulk density was decreased relatively by drainage treatments in the surface layers. Also, bulk density was slightly decreased with the narrow spacing combined with sub-soiling treatments.

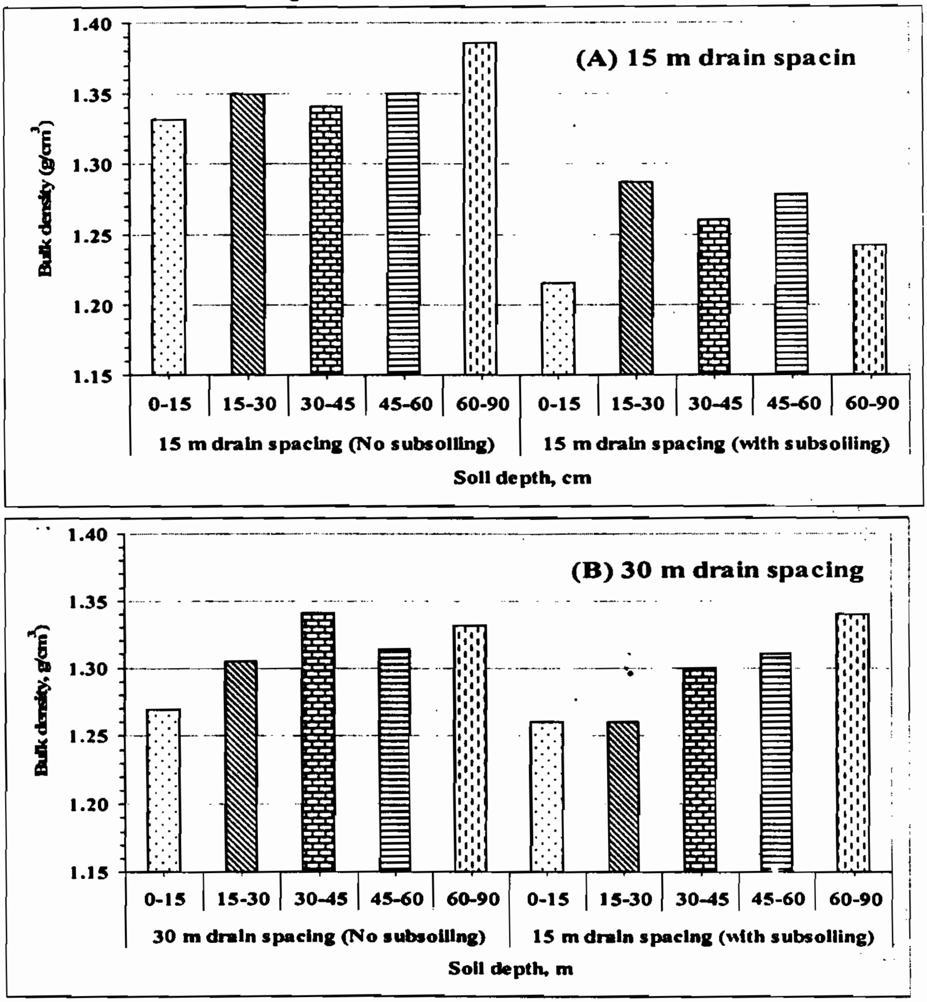
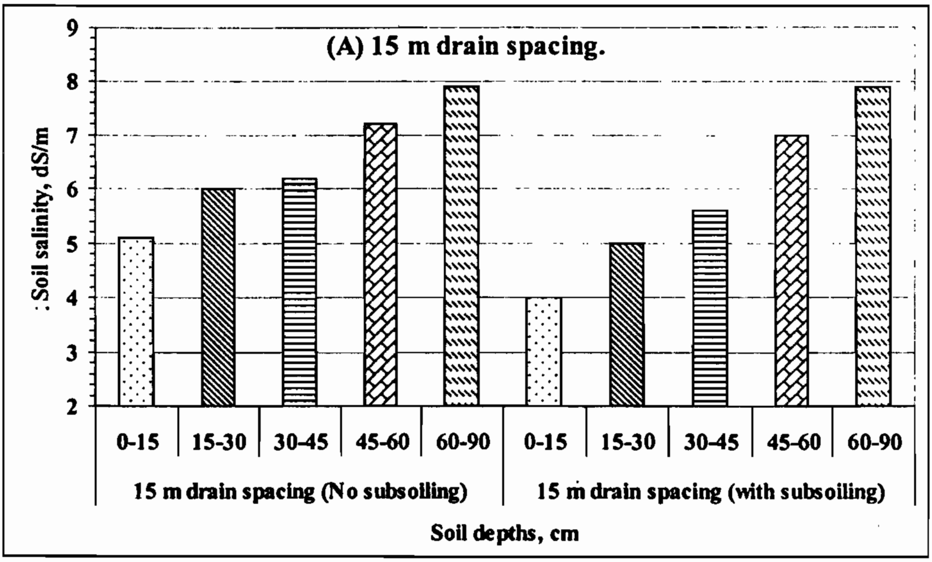


Figure (3). Bulk density as affected by drain spacing and sub-soiling: (A, 15 m and B, 30 m drain spacing with and without sub-soiling)

Soil salinity

Regarding to soil salinity, data in figure (4) shows the effect of both drainage and sub-soiling treatments on soil salinity at different layers. Generally, soil salinity (EC_e) values were relatively affected by drain spacing treatments especially in upper layers compared to lower ones. Data indicate that soil salinity decreased as the drain spacing get closer and with sub-soiling treatments.



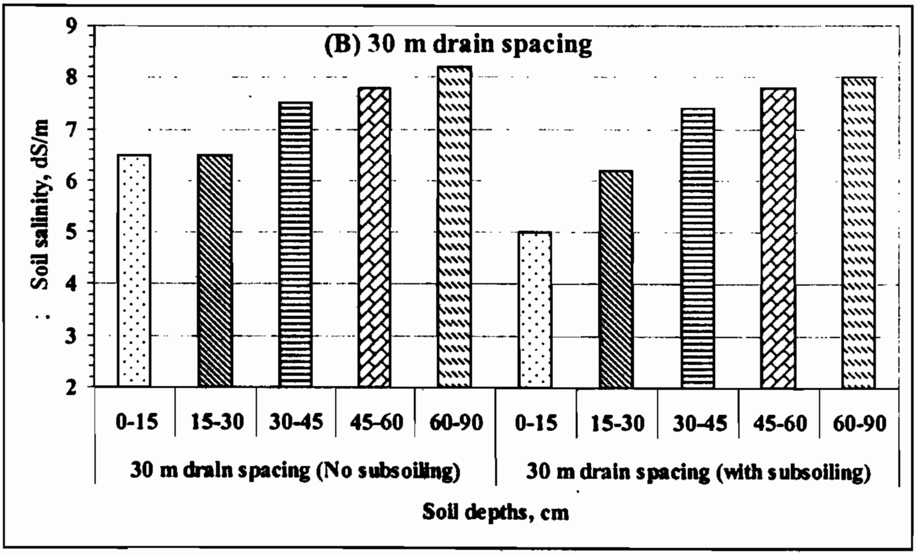


Figure (4). Soil salinity at different layers as affected by drainage and sub-soiling treatments.

Soil sodicity

The exchangeable sodium and magnesium are the most important cations that threaten the clay soil. In general, data indicated that both exchangeable sodium and magnesium percentage were slightly affected with drainage treatments especially in the surface layer (figure 5). The values of ESP and EMgP were still higher in the deeper layers.

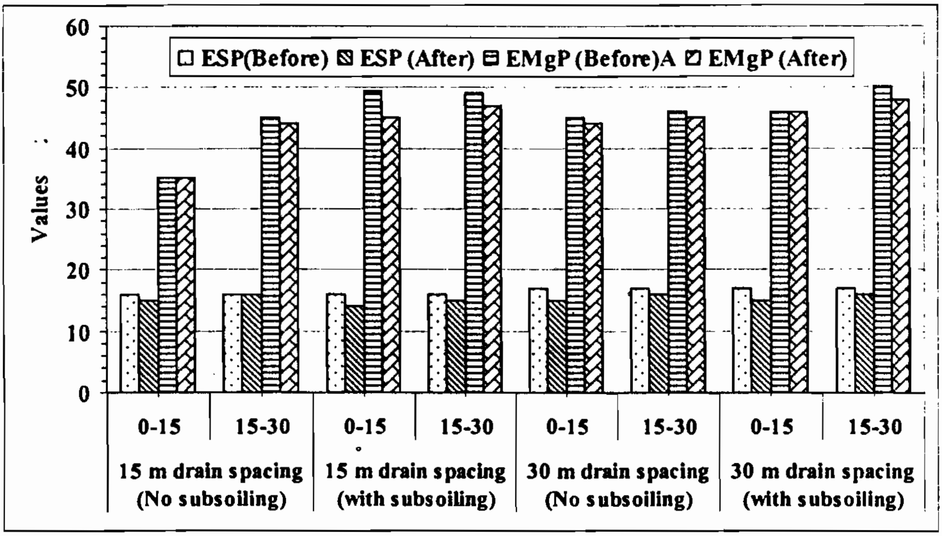
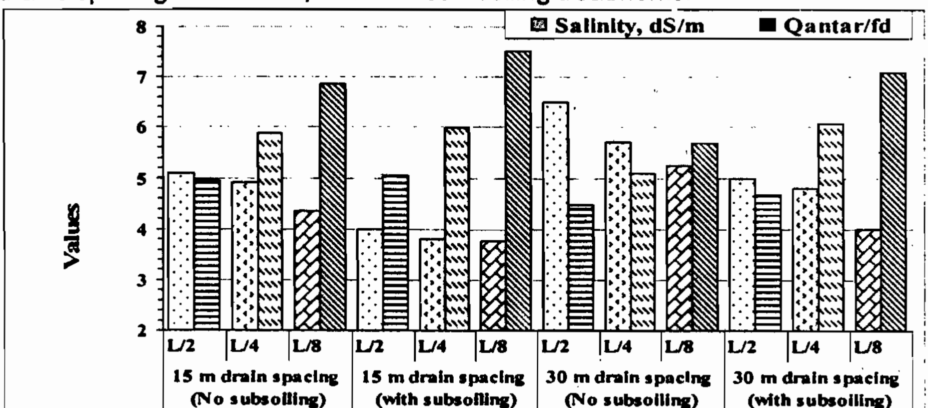


Figure (5) Exchangeable sodium and magnesium percentage as affected by drain spacing and sub-soiling treatments.

Cotton Yield

The results indicated that drainage and sub-soiling treatments affected clearly cotton yield production. Data in figure (6) shows the average cotton yields in relation to soil salinity as affected by different drainage treatments. Results showed that there was an increment in cotton production with narrow drains spacing treatments, and with sub-soiling treatments.



	L/2	L/4	L/8	L/2	L/4	L/8	L/2	L/4	L/8	L/2	L/4	L/8
Salinity, dS/m	5.10	4.90	4.35	4.00	3.80	3.75	6.50	5.70	5.25	5.00	4.80	4.00
Qantar/fd	4.948	5.872	6.849	5.054	5.988	7.517	4.477	5.092	5.693	4.662	6.078	7.085

Distance from Drains, m

Figure (6). Cotton yield in relation to soil salinity at various distance from drains and different drain spacing treatments (L= drain Spacing).

It can be concluded that drainage and drains combines with sub-soiling lead to improve root zone conditions, as a direct effect of soil desalinization and to the faster water table recession upon irrigation. Cotton yield was clearly increased by improving the soil conditions. Also, drainage treatments improved soil permeability, and enhanced the water movement which was the important factor for salt leaching and preventing water logging in the root zone. Also, drainage combined with sub-soiling could be the best integrated approach to soil and water management in clay soil. It can be recommended that drainage conditions are satisfactory additional measures could be taken for better soil water management.

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أثر مسافات الصرف والحرث تحت التربة على بعض خواص التربة وإنتاجيـــة محـــصول القطن فى شمال شرق الدلتا، مصر

صلاح سلامه بحيرى
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تمثل الأراضى الطينية فى شمال الدلتا مساحات تحتاج الى مصارف متقاربة والتى تعتبر مكلفة من وجهة النظر الإقتصادية. ولصرف هذه الأراضى فإنها تحتاج معاملات صرف مساعد لزيادة كفاءة الصرف. وقد تم زراعة محصول القطن فى موسم 2004 فى حقل الصرف التجريبى بمزرعة محطة البحوث الزراعية بالسرو، شمال شرق الدلتا بالقرب من بحيرة المنزلة. وقد تم تنفيذ التجربة فى قطع تجريبية ذات مصارف حقلية على أبعاد 15 و30 متر مع الحرث تحت تربة على مسافات 1.5م وبدون حرث وذلك بهدف معرفة وتقييم تأثيرات معاملات الصرف والحرث تحت التربة على حالة التربة وإنتاجية محصول القطن.

وقد أظهرت النتائج أن مستوى الماء الأرضى كان أعمق مع مسافات الصرف الأقرب فى وجود الحرث تحت التربة، حيث كان 78، 60 سم فى منتصف المسافة بين مصارف على أبعاد 15، 30م على التوالى وبدون حرث تحت التربة بينما وصل الى 85، 72سم لنفس مسافات الصرف فى وجود الحرث تحت التربة. وقد زاد تعمق مستوى الماء الأرضى كلما اقتربنا من المصرف حيث وصل الى 110، 77سم. عندما كان البعد عن المصرف 8/1 من مسافة الصرف 15، 30م على الترتيب بدون حرث تحت التربة بينما وصل الى 116، 96سم فى وجود الحرث تحت التربة لنفس البعد والمسافة. وقد نقص المحتوى الرطوبى للتربة فى مسافات الصرف الأقرب مع وجود الحرث تحت التربة وكان هذا النقص أكثر وضوحاً فى الطبقات السطحية ومع مرور الزمن. وقد انخفضت نسبياً كل من الكثافة الظاهرية، وملوحة وقلوية التربة خاصة فى الطبقات السطحية فى مسافات الصرف الأقرب مع وجود الحرث تحت التربة. وقد زاد محصول القطن زيادة ملحوظة مع تحسن ظروف التربة والتى كانت أكثر وضوحاً فى مسافات الصرف الأقرب مع وجود الحرث تحت التربة.