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# EFFECT OF TILE DRAINAGE AND LASER LAND LEVELING ON SOME SOIL PROPERTIES AND PRODUCTION OF SUGAR BEET AND WHEAT CROPS.

**Antar, A. S. ; H. A. Khafagi ; I. E. Nasr El-Din and I. A. El-Saiad**
**Soils, Water and Environment Res. Inst., Agric. Res. Center, Egypt.**

## ABSTRACT

A field experiment was conducted at North Nile Delta, Kafr El-Shiek Governorate, Egypt, to evaluate the effect of distance from drain line and land leveling on some soil physio-chemical properties, yields and N-uptake for sugar beet and wheat crops. Results indicated that the drop of water table level was faster above the drain than between the drains. Mean values of water table depth were 88, 65 and 52cm for above drain, 1/4 and 1/2 distance from drain line, respectively, under sugar beet plant. The corresponding values under wheat plant were 90, 66 and 55cm. The effect of distance from drain on soil salinity and sodcity are more pronounced in above drain. The reduction of soil salinity above drain were 0.89 and 1.60 dS/m under beet, and were 0.91 and 1.32 dS/m under wheat than 1/4 and 1/2 distance from drain, respectively. The corresponding values of ESP were 1.9 and 2.88 with beet and 2.41 and 3.31 with wheat, respectively. Laser land leveling not realized different for soil salinity and sodcity.

Soil bulk density above the drains was lower than that between drains. Mean values of bulk density under sugar beet were 1.18, 1.25 and 1.29 gcm$^{-3}$ for above drain, 1/4 and 1/2 distance from drain, respectively. The corresponding values were 1.20, 1.28 and 1.31 gcm$^{-3}$ under wheat plant. Laser land leveling caused increase of soil bulk density than traditional leveling by 6.06 and 5.79% for beet and wheat, respectively. Infiltration rate and Hydraulic conductivity (K) above the drain line were higher than between drains. Basic IR values were 1.08, 0.91 and 0.77 cm h$^{-1}$ under beet and 1.18, 0.89 and 0.75 cm h$^{-1}$ under wheat for above drain, 1/4 and 1/2 distances from drain line, respectively. Laser land leveling led to reduce IR and K. Basic IR values were 0.55 and 0.78 cm h$^{-1}$ with beet and 0.51 and 0.76 cm h$^{-1}$ with wheat, for laser and traditional leveling, respectively. Laser land leveling led to decrease K by 1.6 and 1.9 cmday$^{-1}$ for beet and wheat, respectively.

QDP and SDP were higher above the drain and gradually decreased towards the midway between drains while, FCP were lower near the drains and increased far from the drains. Mean values of QDP, SDP and FCP were 13.16, 14.85 and 19.59%, respectively with above drains. The corresponding values, respectively were 9.93, 11.44 and 27.69% with 1/2 distances from drains. Laser leveling realized decrease for QDP, SDP and WHP and increase in FCP. The mean values of QDP, SDP and WHP were 8.80, 10.20 and 20.00% with laser land leveling and were 10.00, 11.70 and 22.31%, respectively with traditional leveling. FCP under laser leveling were higher than traditional leveling by 11.69%.

Sugar beet and wheat yields were reduced far from drain line than above drain line. The average root yield of beet being 34.01, 32.02 and 31.24 tonfed$^{-1}$ for above drain line, 1/4 and 1/2 distance from drain line, respectively. The corresponding values of wheat grain yield were 3.00, 2.76 and 2.52 ton fed$^{-1}$, respectively. Laser land leveling were reduced root of sugar beet yield by 2.51 tonfed$^{-1}$ compared to traditional leveling. While, laser land leveling were increased wheat grain yield by 16.95 % than traditional leveling. Gross sugar yield were higher above drain line by 0.36 and 0.53 tonfed$^{-1}$ than 1/4 and 1/2 distances from drain line, respectively. Gross sugar yield was lower with laser land leveling than traditional land leveling by 0.49 ton fed$^{-1}$. N-uptake by root of beet were higher above drain line by 3.11 and 4.7kgfed$^{-1}$ than 1/4 and 1/2 distance from drain line, respectively. The corresponding values by grain wheat were 3.79 and 7.51 kgfed$^{-1}$. N-uptake with laser and traditional land leveling, respectively were 54.35 and 56.64 kg fed$^{-1}$ in root of beet and 42.99 and 36.83 kg fed$^{-1}$ in grains of wheat.

**Keywords:** Drainage, laser land leveling, clay soil, yield, N-uptake, sugar beet, wheat.

## 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. The present study is conducted in a drainage experimental field, northeastern Nile Delta, where previous studies were fulfilled to improve crop production under saline groundwater (Moukhtar *et al*., 2010). Soil structure, i.e. porosity and aggregation, markedly affects the cultivability, workability and hydrological properties of clay soils. Subsurface drainage has been reported to improve the aggregation and aggregate stability of clay soil (Baker *et al*. 2004) and to increase the volume of air-filled pores (Hundal *et al*., 1976) and saturated hydraulic conductivity (Bouma *et al*., 1979) of clay soils. According to Yli-Halla *et al*. (2009), the lowering of the groundwater table by subsurface drainage has markedly affected the structure development of Finnish clay soils.

Land leveling resulted in significant changes to near-surface soil properties. Numerous soil property magnitudes increased or decreased significantly as a result of land leveling. Few near-surface soil properties remained unaffected by land leveling. Similar to soil property magnitudes, the variability associated with many soil properties increased significantly due to land leveling resulting in a soil surface across the entire field that was less-uniform after land leveling than before land leveling occurred (Brye, 2007). Said (2002) revealed that soil compaction influenced soil strength, bulk density, distribution and continuity of pores with consequent an adverse effect on drainage, root penetration, aeration, biological processes and nutrient uptake; all of which could have a direct bearing on crop production.

Although sugar beet is considered a salt tolerant crop, it is important to evaluate its behavior under more favorable soil conditions. Sugar beet is an important crop for manufacturing sugar for complementary national provisions of sugar in Egyptian market. Sugar beet provides about 40% of the world's sugar production (Abd-el-Hadi *et al*., 2002). Sugar beet in Egypt has a considerably higher sugar content and short growth period compared with sugar cane. Furthermore, consumed water by sugar beet to produce one ton of sucrose is about 1300 m$^3$, whereas sugar cane needs about 4000 m$^3$ of water to produce the same quantity of sucrose. Sugar beet is widely grown in areas with salinity problems (Moukhtar *et al*., 2010).

Wheat (Triticum aestivum) is the principal winter crop in Egypt, it is the most important grain crop in the world. The world production exceeds that of any other grain crop, and in many respects it is superior to any other human food. Wheat is the major breadmaking cereal, and Egypt has to supplement production by importing just over half of its needs to supply the annual demand.

The current study aims to evaluate the effect of distance from drain line and laser land leveling on some soil physio-chemical properties, yields and N-uptake of sugar beet and wheat crops.

## MATERIALS AND METHODS

A field experiment was conducted at North Nile Delta (Islah-Perempal Region, Motobus District, Kafr El-Shiek Governorate, Egypt), to evaluate the effect of distance from drain line and land leveling on some soil physio-chemical properties, yields and N-uptake for sugar beet and wheat crops. The field is provided by tile drains network spaced at 60 m with 1.4 m depth. The soil of the experimental field was clayey in texture (Table 1)**.** The location is situated at 31°22′ 93″ N latitude and 30°31′ 15″ E longitude. The initial of some soil properties for the experimental field are presented in Table (1). The field was plowing two times with chisel plow to a depth of 20cm. and making traditional land leveling. The experiments were conducted in a completely randomized black design.

The treatments were as follows:

- $T_1$- above drain line.
- $T_2$- 1/4 distances from drain line.
- $T_3$- 1/2 distances from drain line.
- $T_4$- Traditional land leveling.
- $T_5$- Laser land leveling

Like most of the northern lands, the field lies on the tail of the main canal, irrigation water is frequently insufficient. The main source of irrigation water is mixed water. The salinity of irrigation water ranges between 1.11 - 1.23 dS/m with an average of 1.17 dS/m.

In the winter season (2010/2011) Seeds of sugar beet (*pleno variety*) were sown on 5th of Sept. in 2010. The hills were thinned to one plant before the first irrigation. All plots received 100 Kg Ca-superphosphate/fed, and 50 Kg K-sulfate/fed, during tillage operation. Nitrogen fertilizer in the form of urea was side dressed at a rate of 80 Kg N/fed, in three doses before the first, the second and the third irrigations.. Also, wheat (Triticum aestivum) Giza 168 variety was planted on November 19, 2010. All plots received a total of 75 Kg Ca-superphosphate/fed., during tillage operation. Nitrogen fertilizer in the form of urea was side dressed at a rate of 75 Kg N/fed, in two doses after 40 and 60 days from the planting. The different agricultural practices were done as recommended for two crops under study. through the stages of sugar beet maturity and wheat booting, soil samples (0-15, 15-30, 30-60 and 60-90cm depth) were collected and determined for some physical and chemical analysis. Salinity was determined in the saturated soil paste extract according to Page *et al*. (1982). Exchangeable sodium was determined using ammonium chloride and measured by using flame photometer according to Page *et al*. (1982). A set of

observation wells were installed in the plots to measure the water table depth in all treatments and, convert the water table depths into hydraulic head values (Hydraulic head = Drain depth - Water table depth). Infiltration rate was determined using double cylinder infiltrometer as described by Garcia (1978). Soil hydraulic conductivity (K) was measured in the field by using the auger-hole method according to Van Beers (1970). Soil bulk density and total porosity of the different layers of soil profile were measured for all treatments using the core sampling technique as described by Campbell (1994). Pore size distribution was calculated from soil moisture retention curves according to DeLeenher and De Boodt (1965). Soil pores are classified according to their size and ability to retain water at different head pressures, to quickly drainable pores (QDP) that can hold water between 0.00 and 100cm head, slowly drainable pores (SDP) difference between 100 and 330cm head. Water holding pores (WHP) or medium pores which retain soil moisture between field capacity (330cm head) and wilting point (15000cm head) and fine capillary pores (FCP) which retained soil moisture at suction head of 15.0 atm. Productivities for two crops with different treatments were determined and determined sucrose % in beet root. Gross sugar yield (ton/fed) was calculated by multiplying root yield (ton/fed) by sucrose %. Root and shoot samples for beet and green and straw samples for wheat were taken and dried at 70$^{o}$C, grounded with a mill and its total N content was determined using Kjeldahl digestion (Cottenie *et al*., 1982). N-uptake (kg/fed) was calculated by multiplying dry yield (kg/fed) by N % (N content in percentage either for root and shoot).
Statistical analysis: Data obtained are subjected to statistical analysis according to Snedecor and Cochran (1980).

**Table (1): The initial of some soil properties for the experimental field**

| Soil depth (cm) | Particle size distribution | | | Texture grade | EC (dS/m) | ESP % | Bulk density g/cm$^3$ | IR (cm/h) |
|---|---|---|---|---|---|---|---|---|
| | Sand% | Silt% | Clay% | | | | | |
| 0-15 | 12.22 | 33.41 | 54.37 | Clayey | 3.68 | 11.36 | 1.18 | 0.87 |
| 15-30 | 13.16 | 32.99 | 53.85 | Clayey | 4.52 | 14.01 | 1.26 | |
| 30-60 | 14.33 | 33.64 | 52.03 | Clayey | 5.41 | 16.17 | 1.37 | |
| 60-90 | 13.82 | 34.05 | 52.13 | Clayey | 7.24 | 18.88 | 1.42 | |
| Mean | 13.38 | 33.52 | 53.10 | Clayey | 5.21 | 15.11 | 1.31 | |

## RESULTS AND DISCUSSION

**Water table depths**:

The results in Table, 2 indicated that the water table level increased rapidly with elapsing of the time after irrigation until it reached the highest values. The average values of water table depth after 12 days from irrigation were 123, 91 and 77 cm for above drain line, 1/4 and 1/2 distance between the drain line, respectively, under sugar beet plant. The corresponding values under wheat plant were 123, 91 and 79 cm.. The drop of water table level was faster above the drain line than midway between the drain lines. The average values of water table depth were 88, 65 and 52 cm for above drain line, 1/4 and 1/2 distance from drain line, respectively, under sugar beet plant. The corresponding values under wheat plant were 90, 66 and 55cm.

This may be due to more effectiveness of drainage system near the drain line than far from the drain line. Results of water table measurements (Table 2) indicate that the treatments of laser land leveling (T5) and traditional land leveling (T4) were nearly the same values, and there is no different with both plants. Similar results were obtained by Gendy, *et al*, (2009) and Paulo Castanheira (2010).

The obtained data of water table levels (Table 2) for the investigated treatments were reflected on hydraulic head (Figs. 1 and 2). Where an almost opposite trend to that encountered with water table depth was recorded. The results indicated a relatively higher value of water table and lower values of hydraulic head for all treatments.

**Table (2): Average water table depths (cm) after irrigation under sugar beet and wheat crops for all treatments.**

| Time (day) | Water table depths (cm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sugar beet | | | | | Wheat | | | | |
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| 1 | 26 | 15 | 11 | 15 | 13 | 24 | 14 | 14 | 13 | 12 |
| 2 | 48 | 35 | 20 | 24 | 24 | 50 | 40 | 27 | 25 | 30 |
| 3 | 65 | 45 | 30 | 31 | 34 | 75 | 46 | 36 | 34 | 35 |
| 4 | 75 | 60 | 38 | 40 | 40 | 80 | 58 | 42 | 42 | 43 |
| 5 | 80 | 65 | 46 | 50 | 50 | 90 | 63 | 48 | 49 | 45 |
| 6 | 89 | 69 | 54 | 59 | 57 | 93 | 69 | 58 | 50 | 53 |
| 7 | 97 | 73 | 60 | 63 | 65 | 97 | 75 | 63 | 63 | 63 |
| 8 | 104 | 78 | 68 | 70 | 70 | 104 | 78 | 69 | 70 | 68 |
| 9 | 111 | 81 | 72 | 74 | 73 | 110 | 83 | 72 | 72 | 71 |
| 10 | 116 | 84 | 74 | 76 | 75 | 116 | 86 | 76 | 74 | 72 |
| 11 | 119 | 88 | 76 | 77 | 77 | 121 | 88 | 77 | 77 | 77 |
| 12 | 123 | 91 | 77 | 79 | 78 | 123 | 91 | 79 | 80 | 78 |
| Mean | 88 | 65 | 52 | 55 | 55 | 90 | 66 | 55 | 54 | 54 |

**$T_1$- above drain line.** **$T_2$- 1/4 distances from drain line.**
**$T_3$- 1/2 distances from drain line.** **$T_4$- Traditional land leveling.**
**$T_5$- Laser land leveling**

## Soil salinity and sodcity:

Data in Table (3) show that salinity and sodcity of the soil increased markedly with the increasing of soil depth. Soil salinity and sodcity in the topsoil up to 30cm, varied from 3.45 to 5.1 dS/m and 9.13 to 13.94%, respectively, under both crops. The corresponding values in the deeper layers (30-90cm) were 4.52 to 7.75 dS/m and 10.42 to 15.56 %, respectively. This may be due to high rate of leaching by irrigation water in the surface layer, which is characterized with high porosity. The effect of distance from drain line on soil salinity and sodcity are more pronounced in above drain line compared to distances in between drain line. This may be due to the leaching of salts in the area adjacent to the drain lines. The reduction of soil salinity ($EC_e$) above drain line were 0.89 and 1.60 dS/m under beet, and were 0.91 and 1.32 dS/m under wheat than 1/4 and 1/2 distance from drain line, respectively. The corresponding values of ESP are 1.9 and 2.88 under beet and 2.41 and 3.31 under wheat, respectively. It should be mentioned that the leached salts especially sodium salts above laterals were more than that in the midway between laterals. These results are in agreement with those obtained by Ibrahim (1999) and Antar (2005).

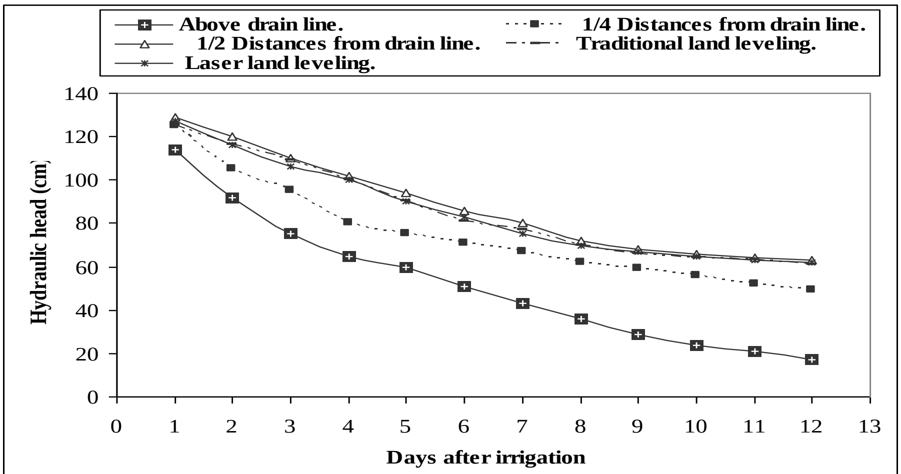


Fig (1): hydraulic head (cm) with days after irrigation for different treatments under sugar beet crop.

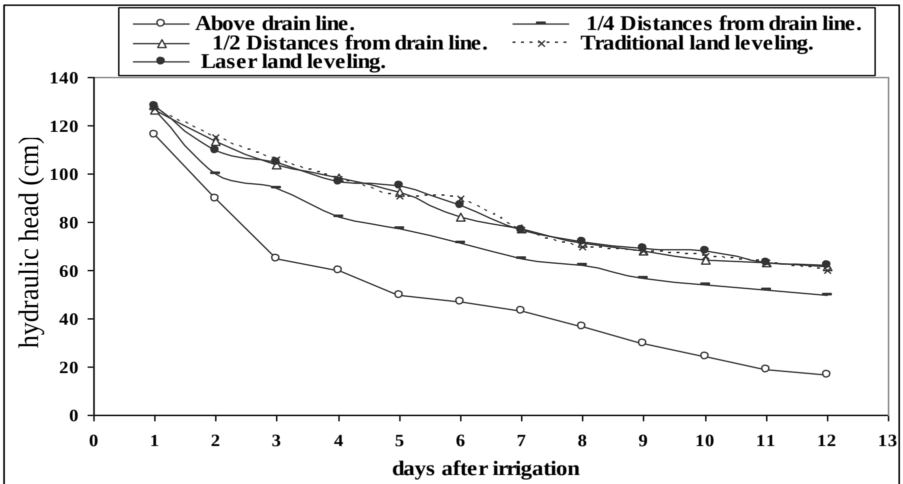


Fig (2): Hydraulic head (cm) with days after irrigation for different treatments under wheat crop.

Regarding to land leveling, data illustrated in Table, 3 showed that, laser land leveling not realized different for soil salinity and sodcity compared to traditional land leveling. The salinity and sodcity values under sugar beet plant were 5.81dS/m and 14.30% with laser land leveling and were 5.57 dS/m and 14.15%, respectively with traditional land leveling. The corresponding values under wheat plant were 5.99 dS/m and 13.75% and were 5.83dS/m and 14.41%, respectively.

**Table (3): Average of soil salinity (EC, dS/m) and sodcity (ESP) under sugar beet and wheat crops for all treatments.**

| Treatments | Soil depth (cm) | Sager beet | | Wheat | |
|---|---|---|---|---|---|
| | | EC (dS/m) | ESP % | EC (dS/m) | ESP % |
| Above drain line. | 0-15 | 3.45 | 9.13 | 3.69 | 9.52 |
| | 15-30 | 3.75 | 10.41 | 3.98 | 10.35 |
| | 30-60 | 4.78 | 12.79 | 4.52 | 10.42 |
| | 60-90 | 4.78 | 12.84 | 5.37 | 12.84 |
| | Mean | 4.19 | 11.29 | 4.39 | 10.78 |
| 1/4 Distances from drain line. | 0-15 | 3.79 | 11.56 | 3.96 | 11.84 |
| | 15-30 | 4.32 | 12.39 | 4.83 | 12.61 |
| | 30-60 | 5.64 | 13.96 | 5.55 | 13.58 |
| | 60-90 | 6.55 | 14.88 | 6.87 | 14.75 |
| | Mean | 5.08 | 13.20 | 5.30 | 13.20 |
| 1/2 Distances from drain line. | 0-15 | 4.21 | 12.54 | 4.12 | 12.46 |
| | 15-30 | 4.85 | 13.58 | 4.86 | 13.61 |
| | 30-60 | 6.33 | 15.11 | 6.23 | 14.78 |
| | 60-90 | 7.75 | 15.44 | 7.62 | 15.52 |
| | Mean | 5.79 | 14.17 | 5.71 | 14.09 |
| Traditional leveling | 0-15 | 4.41 | 12.66 | 4.37 | 13.06 |
| | 15-30 | 4.65 | 13.87 | 5.01 | 13.94 |
| | 30-60 | 5.98 | 14.65 | 6.24 | 15.21 |
| | 60-90 | 7.24 | 15.42 | 7.71 | 15.42 |
| | Mean | 5.57 | 14.15 | 5.83 | 14.41 |
| Laser land leveling | 0-15 | 4.77 | 12.44 | 4.87 | 12.18 |
| | 15-30 | 4.66 | 13.93 | 4.86 | 13.88 |
| | 30-60 | 6.44 | 15.25 | 6.84 | 13.66 |
| | 60-90 | 7.38 | 15.56 | 7.38 | 15.27 |
| | Mean | 5.81 | 14.30 | 5.99 | 13.75 |

**Soil bulk density and Soil porosity**

Soil bulk density is considered as one of the parameters which indicate the status of soil structure and consequently, soil water, air and heat regimes (Richards, 1954). Results in Table (4) show that soil bulk density increased with increasing soil depth for all tested profiles. This increase may be resulted from increasing soil compaction due to layers weight. Results in Table (4) show that, soil bulk density above the drains were lower than that between drains. The average values of soil bulk density under sugar beet plant were 1.18, 1.25 and 1.29 g $cm^{-3}$ for above drain line, 1/4 and 1/2 distance between the drain line, respectively. The corresponding values were 1.20, 1.28 and 1.31 $cm^{-3}$ under wheat plant.

Concerning to land leveling, results (Table,4) showed that, laser land leveling caused increase of soil bulk density compared to traditional land leveling. Bulk density values were higher with laser land leveling treatment than traditional leveling by 6.06 and 5.79% for sugar beet and wheat plants, respectively. This may be due to the compaction resulted from laser land leveling operation. Similar results were obtained by Brye, (2007).

Soil porosity values (Table, 4) had taken almost the opposite trend to that encountered with bulk density. The results indicate that the values of bulk density were increased and values of total porosity were decreased with the depth for all treatments (Table, 4).

**Table (4): Soil bulk density ($gcm^{-3}$) and total porosity (%)under sugar beet and wheat crops for all treatments.**

| Treatments | Soil depth (cm) | Sager beet | | Wheat | |
|---|---|---|---|---|---|
| | | Bulk density ($gcm^{-3}$) | Total porosity (%) | Bulk density ($gcm^{-3}$) | Total porosity (%) |
| Above drain line. | 0-15 | 1.01 | 61.89 | 1.08 | 59.25 |
| | 15-30 | 1.08 | 59.25 | 1.10 | 58.49 |
| | 30-60 | 1.29 | 51.32 | 1.29 | 51.51 |
| | 60-90 | 1.35 | 49.06 | 1.35 | 49.25 |
| | Mean | 1.18 | 55.38 | 1.20 | 54.62 |
| 1/4 Distances from drain line. | 0-15 | 1.08 | 59.25 | 1.12 | 57.92 |
| | 15-30 | 1.20 | 54.72 | 1.26 | 52.64 |
| | 30-60 | 1.32 | 50.19 | 1.32 | 50.19 |
| | 60-90 | 1.41 | 46.79 | 1.42 | 46.42 |
| | Mean | 1.25 | 52.74 | 1.28 | 51.79 |
| 1/2 Distances from drain line. | 0-15 | 1.13 | 57.36 | 1.15 | 56.60 |
| | 15-30 | 1.29 | 51.32 | 1.26 | 52.64 |
| | 30-60 | 1.32 | 50.19 | 1.37 | 48.49 |
| | 60-90 | 1.43 | 46.04 | 1.45 | 45.28 |
| | Mean | 1.29 | 51.23 | 1.31 | 50.75 |
| Traditional leveling | 0-15 | 1.11 | 58.11 | 1.13 | 57.36 |
| | 15-30 | 1.27 | 52.08 | 1.24 | 53.21 |
| | 30-60 | 1.33 | 49.81 | 1.38 | 47.92 |
| | 60-90 | 1.44 | 45.66 | 1.47 | 44.53 |
| | Mean | 1.29 | 51.42 | 1.31 | 50.75 |
| Laser land leveling | 0-15 | 1.29 | 51.32 | 1.30 | 50.94 |
| | 15-30 | 1.33 | 49.74 | 1.35 | 48.98 |
| | 30-60 | 1.37 | 48.30 | 1.40 | 47.17 |
| | 60-90 | 1.47 | 44.53 | 1.47 | 44.53 |
| | Mean | 1.37 | 48.47 | 1.38 | 47.91 |

**Infiltration rate (IR) and hydraulic conductivity (K)**

The values of basic infiltration rate (IR) of soil as affected by different treatments are presented in Table (5). Data show that basic infiltration rate values above the drain line were higher than between drains. The values of basic IR were 1.08, 0.91 and 0.77 cm $h^{-1}$ under sugar beet and 1.18, 0.89 and 0.75 cm $h^{-1}$ under wheat for above drain line, 1/4 and 1/2 distances from drain line, respectively. This may be due to more effectiveness of drainage system near the drain line than far from the drain line. Similar results were obtained by Ibrahim *et al*. (1999) and Antar (2005).

Laser land leveling application was reduce IR compared to traditional land leveling (Table, 5). Basic IR values were 0.55 and 0.78 cm $h^{-1}$ under sugar beet and 0.51 and 0.76 cm $h^{-1}$ under wheat, for laser and traditional land leveling, respectively.

Data in Table (5) show that hydraulic conductivity above the drains was higher than that between drains. Hydraulic conductivity above drain line were higher than 1/4 and 1/2 distance from drain line by 5.6 and 8.9 cm $day^{-1}$

under sugar beet and 7.3 and 10.2 cm day$^{-1}$ under wheat, respectively. Similar results were obtained by Alakukku and Turtola (2010). On the other hand, the application of laser land leveling were decrease soil K by 1.6 and 1.9 cm day$^{-1}$ for beet and wheat, respectively compared to traditional land leveling.

**Table (5): Basic infiltration rate (cm h$^{-1}$) and hydraulic conductivity (cm day$^{-1}$) under sugar beet and wheat crops for all treatments.**

| Treatments | Sugar beet | | wheat | |
|---|---|---|---|---|
| | Basic infiltration rate (cm h$^{-1}$) | Hydraulic conductivity (cm day$^{-1}$) | Basic infiltration rate (cm h$^{-1}$) | Hydraulic conductivity (cmday$^{-1}$) |
| **Above drain line.** | 1.08 | 17.3 | 1.18 | 18.8 |
| **1/4 Distances from drain line.** | 0.91 | 11.7 | 0.89 | 11.5 |
| **1/2 Distances from drain line.** | 0.77 | 8.4 | 0.75 | 8.6 |
| **Traditional land leveling** | 0.78 | 8.7 | 0.76 | 8.8 |
| **Laser land leveling.** | 0.55 | 7.1 | 0.51 | 6.9 |

**Pore size distribution (Average under sugar beet and wheat):**

Pore size distribution (quickly drainable pores (QDP), slowly drainable pores (SDP), water holding pores (WHP) and fine capillary pores (FCP)) of the studied soil are presented in (Table, 6 and Fig, 3). Results show that, the percent of QDP and SDP were higher in above the drain and gradually decreased towards the midway between drains because of more water will be removed by gravitational force near the drains. Data also, showed that percent of FCP were lower near the drains and increased far from the drains. Mean values of QDP, SDP and FCP are 13.16, 14.85 and 19.59%, respectively with above drains. The corresponding values, respectively are 11.94, 12.03 and 24.03 % with 1/4 distances from drains, 9.93, 11.44 and 27.69% with 1/2 distances from drains. While, no obvious different in WHP with distances from drain line. These results are in agreement with Wahdan *et al*. (1992) and Antar (2000).

Regarding to land leveling, data (Table, 6 and Fig, 3) showed that laser land leveling application realized decrease for QDP, SDP and WHP and increase in FCP compared to traditional land leveling. This may be due to the compaction resulted from laser land leveling operation. The mean values of QDP, SDP and WHP were 8.80, 10.20 and 20.00% with laser land leveling and were 10.00, 11.70 and 22.31%, respectively with traditional land leveling. On the other hand, FCP percent under laser land leveling was higher than traditional land leveling by 11.69%. These high values of FCP which are often filled with water and cause water logging, while plants grown in these soils suffer from drought.

**Table (6): Pore size distribution (QDP, SDP, WHP, FCP %) with soil depths for all treatments (Average under beet and wheat).**

| Treatments | Depth(cm) | QDP% | SDP% | WHP% | FCP% |
|---|---|---|---|---|---|
| Above drain line | 0-15 | 13.46 | 14.64 | 22.24 | 19.22 |
| | 15-30 | 13.39 | 15.08 | 22.17 | 19.11 |
| | 30-60 | 12.64 | 14.83 | 21.73 | 20.44 |
| 1/4 distance from drain | 0-15 | 12.58 | 12.22 | 22.89 | 22.74 |
| | 15-30 | 11.87 | 11.49 | 23.07 | 23.68 |
| | 30-60 | 11.38 | 12.39 | 20.55 | 25.68 |
| 1/2 distance from drain | 0-15 | 9.88 | 11.24 | 23.67 | 26.97 |
| | 15-30 | 9.50 | 12.07 | 21.95 | 28.22 |
| | 30-60 | 10.40 | 11.01 | 22.24 | 27.89 |
| Traditional land leveling | 0-15 | 9.60 | 12.10 | 22.47 | 27.68 |
| | 15-30 | 9.29 | 12.55 | 22.17 | 27.83 |
| | 30-60 | 11.11 | 10.46 | 22.30 | 27.71 |
| Laser land leveling | 0-15 | 8.54 | 10.15 | 20.36 | 30.61 |
| | 15-30 | 8.88 | 9.91 | 20.11 | 30.87 |
| | 30-60 | 8.99 | 10.01 | 19.53 | 31.47 |

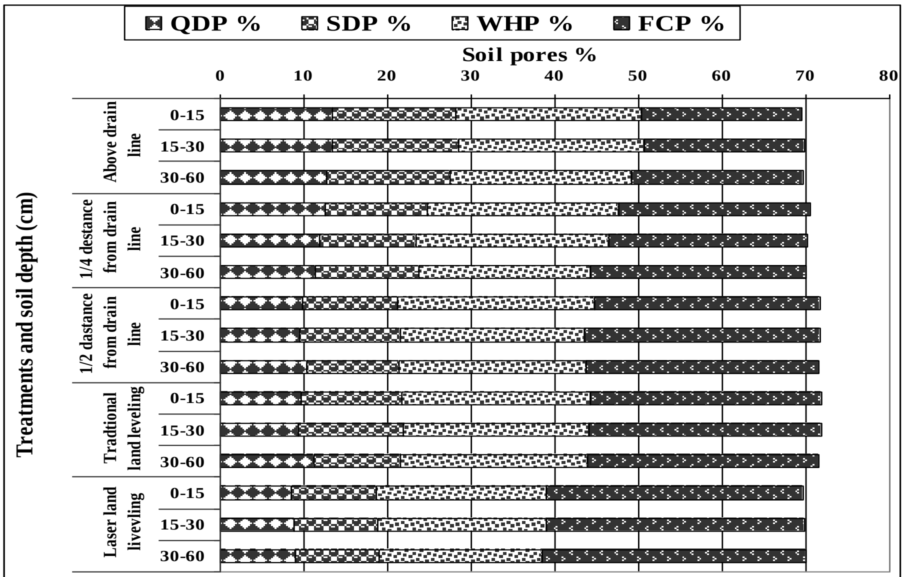


Fig (3): Pore size distribution (QDP,SDP,WHP and FCP) as affected by different treatments.

## Yields:

### Sugar beet crop:

Data indicated that, distance from drain line and land leveling treatments affect significantly clearly sugar beet production. Results show the sugar beet yields in relation to water table depth, soil salinity and soil bulk density in the different treatments. Data in Table (7) showed that there was an increment in sugar beet production with decrement the distance from drain line treatments. The average root yield being 34.01, 32.02 and 31.24 tonfed$^{-1}$ for above drain line, 1/4 and 1/2 distance from drain line, respectively. The corresponding values of shoot yield were 3.55, 3.40 and 3.43 ton fed$^{-1}$. These increments of sugar beet production with decrement the distance from drain line treatments are the result of deeper water table depth, and consequently improving soil properties which affects water-air relationships in the root zone and root penetration. Similar results were obtained by Moukhtar *et al*. (2010).

Laser land leveling application were reduced root of sugar beet production by 2.51 tonfed-1 compared to traditional land leveling.

Data in Table (7) show that, there were no obvious differences between sugar percentages in all treatments. Gross sugar yield in all treatments were paralleled to the yields values. Gross sugar yield were higher above drain line by 0.36 and 0.53 tonfed$^{-1}$ than 1/4 and 1/2 distances from drain line, respectively. Gross sugar yield was lower with laser land leveling than traditional land leveling by 0.49 ton fed$^{-1}$.

Data in Table (7) show clearly that the N-uptake (kgfed$^{-1}$) by root and shoot were paralleled to the yields values. N-uptake of root was higher above drain line by 3.11 and 4.7kgfed$^{-1}$ than 1/4 and 1/2 distances from drain line, respectively. This is due to improved drainage conditions near the drain line which caused water-air balance in the root zone, and increasing the amount of available nutrients for the plant. Similar results were obtained by Moustafa *et al*. (1987), Sharma and Komal (1998) and Ibrahim *et al*. (1999). N-uptake by root of beet were somewhat decrease about 4.21% with laser land leveling than traditional leveling. On the other hand, there were no obvious differences among N-uptake in shoot of sugar beet with different treatments under study.

**Table (7): Yields (Ton fed$^{-1}$) and N-uptake (kg fed$^{-1}$) by root and shoot of sugar beet plant with all treatments.**

| Treatments | Yield (Ton fed$^{-1}$) | | Sugar % | Gross sugar (Ton fed$^{-1}$) | N-uptake (kg fed$^{-1}$) | |
|---|---|---|---|---|---|---|
| | Roots | Shoots | | | Roots | Shoots |
| Above drain line. | 34.01a | 3.55 | 17.71 | 6.02 | 61.21a | 19.38 |
| 1/4 Distances from drain line. | 32.02ab | 3.40 | 17.69 | 5.66 | 58.10ab | 18.59 |
| 1/2 Distances from drain line. | 31.24ab | 3.43 | 17.56 | 5.49 | 56.51ab | 19.03 |
| Traditional leveling | 31.29ab | 3.45 | 17.81 | 5.57 | 56.64ab | 18.87 |
| Laser land leveling. | 28.78b | 3.53 | 17.66 | 5.08 | 54.35b | 19.18 |

### Wheat crop:

Data in Table (8) showed that there were significant differences in the grain and straw yields with various study treatments. Wheat grain and straw yields were reduced far from drain line than above drain line. The mean values of grain yield were 3.00, 2.76 and 2.52 ton fed$^{-1}$ for above drain, 1/4 and 1/2 distance from drain line, respectively. The corresponding values of straw yield were 3.46, 3.18 and 2.89 ton fed$^{-1}$. This is due to the effect of drainage on conditioning water-air relationship in the root zone and its effect on mobility of nutrients to the plant roots which cause more vegetative growth and subsequently produce a higher yield. Similar results were obtained by Antar (2005) and Gendy, *et al*. (2009). On the other hand, the application of laser land leveling lead to increases in wheat yields. Where as, grain and straw yields under laser land leveling were higher than traditional land leveling by 16.95 and 18.90% , respectively. These decrements in production of wheat crop could be attributed to that under traditional leveling; the chance for more leaching downward for both water and its load of fertilizers could be happened. Similar results were obtained by El-Hamdi and Knany (2000).

Data (Table, 8) clearly that the N-uptake (kgfed$^{-1}$) by grain and straw were paralleled to the yields values. N-uptake above drain line were higher than 1/4 and 1/2 distance from drain line by 3.79 and 7.51 kgfed$^{-1}$ for grains, and 0.78 and 1.64 kgfed$^{-1}$ for straw, respectively. Similar results were obtained by Antar (2005). In relation to land leveling, the average N-uptake under laser land leveling and traditional land leveling, respectively, were 42.99 and 36.83 kg fed$^{-1}$ by grains and there were 8.26 and 7.59kg fed$^{-1}$ by straw.

**Table (8): Yields (Ton fed$^{-1}$) and N-uptake (kg fed$^{-1}$) by grain and straw of wheat plant with all treatments.**

| Treatments | Yield (Ton fed$^{-1}$) | | N-uptake (kg fed$^{-1}$) | |
|---|---|---|---|---|
| | Grain | straw | Grain | straw |
| Above drain line. | 3.00a | 3.46a | 43.17a | 8.50a |
| 1/4 Distances from drain line. | 2.76ab | 3.18ab | 39.38ab | 7.72ab |
| 1/2 Distances from drain line. | 2.52b | 2.89b | 35.66b | 6.86b |
| Traditional leveling. | 2.57b | 2.91b | 36.83b | 7.59b |
| Laser land leveling. | 3.00a | 3.46a | 42.99a | 8.26a |

## Conclusion

It can be concluded that, improving of some soil properties were realized due to lowering of water table to wards the drain line as well as improving production of sugar beet and wheat crops. While, Laser land levelling caused increase of FCP percent which are often filled with water and cause water logging, while plants grown in these soils suffer from drought. Laser lands leveling tend to decrease sugar beet crop production and increase wheat yield. Laser land levelling not desirable in sugar beet field.

## REFERENCES

Abd-El-Hadi, A.H., A.M.A. Aly, A.A. Attiat, M.A. Zidan and F. Zahran (2002). Response of sugar beet to various forms and rates of nitrogenous fertilizer. Egypt. J. Soil Sci., Vol. 42, No. 4: 643-658.

Antar, S.A. (2000). Effect of drainage system on some hydrological, physical and chemical properties of soil in Northern Delta (Egypt). M.Sc. Thesis. Fac. Of Agric. Minufiya University, Egypt.

Antar, S. A. (2005). Movement of some nitrogen forms, atrazine and malathion in clay soil as affected by drain spacings. Ph.D. Thesis. Fac. Of Agric. Tanta University, Egypt.

Baker, B.J., N. R. Fausey and K. R. Islam (2004). Comparison of soil physical properties under two different water table management regimes. Soil Sci. Soc. Am. J. 68: 1973-1981.

Brye, K. R. (2007). Predictability of crop production in a clay soil based on a comprehensive, post-land-leveling soil property evaluation. Online. Crop Management doi:10.1094/CM-2007-0806-01-RS.

Bouma, J., L.W. Dekker and J.C.F.M. Haans (1979). Drainability of some Dutch clay soils: a case study of soil survey interpretation. Geoderma, 22: 193-2003.

Campbell, D.J. (1994). Determination and use of bulk density in relation to soil compaction. In Soane and Ouwerk (Eds). Soil compaction in crop production. Elsever, London and Amsterdam.

Cottenie, A.; M. ver Loo; L. Mjkiekens; G. Velghe and R. Comertynck (1982). Chemical analysis of plant and soil. Lab. Anal. And Agrochem. State Univ., Gent., Belgium, Chapter 2 and 3, pp. 14-54.

De Leenher, L. and M. De Boodt (1965). Soil physics. Intre. Training Center for Post Graduate Soil Scientists, Gent., pp. 126-135.

Garcia, G. (1978). "Soil water Engineering Laboratory Manual". Colorado State Univ. Dept. of Agric. and Chemical Engineering. Fortcollins, Colorado.

Gendy,A.A.S.; I. E. Nasr El-Din and A.S. Antar (2009). Effect of irrigation, potassium application and distance from drain line on wheat crop in clay soil. J. Agric. Res. Kafr El-Sheikh Univ., 35 (3): 897 – 908.

El-Hamdi, Kh.M. and R. E. Knany (2000). Influence of irrigation and fertilization on water use and efficiencies on saline soil. J. Agric. Sci. Mansoura Univ., 25(6): 3711-3720.

Hundal, S.S., G.O. Schwab and G.S. Taylor (1976). Drainage system effects on physical properties of lakebed clay. Soil Sci. Soc. Am. J. 40: 300-305.

Ibrahim, S.M.; J. Blankenburg and H. Kuntze (1999). Drainage effects in marsh soil. II. Effects on soil properties and grain yield. Z.F. Kutturtech and Landentwick, 40(2):72-76.

Alakukku, L. and E. Turtola, (2010). Surface runoff and soil physical properties as affected by subsurface drainage improvement of a heavy clay soil. CSBE10147 – Presented at ASABE's 9th International Drainage Symposium (IDS), Québec City, Canada June 13-17, 2010.

Moukhtar M. M., A. I.N. Abdel-Aal and, M.A. B. El-Shewikh (2010). Drainage in heavy clay soil and sugar beet yield in Eastern North Delta. CSBE10103 – Presented at ASABE's 9$^{th}$ International Drainage Symposium (IDS),Québec City, Canada June 13-17, 2010.

Moustafa,A.T.A.; W.H. Ahmed; C.C. Chang and G.J. Hofman(1987). Influence of depth and spacing of tile drains on crop productivity in Nile Delta. Trans. ASAE, 30(5):1374-1377.

Richards, L.A. (1954). "Diagnosis and Improvement of Saline and Alkali Soils" U.S.D.A. Hand Book No. 60.

Page, A.L.; R.H. Miller and D.R. Keeney (1982). "Methods of Soil Analysis". Part П: Chemical and microbiological properties, 2$^{nd}$ ed. Soil Sci. Soc. Am. Inc., Madison, USA.

Paulo Castanheira (2010). Empty drain and the water level at midway between the drains. aspects regarding management. CSBE11372 – Presented at ASABE's 9th International Drainage Symposium (IDS), Québec City, Canada June 13-17, 2010.

Said H. M. (2002). Effect of deep ploughing on some physical properties and corn yield in calcareous sandy clay loam soil. Egyp. J. Soil Sci. 42: 57-70.

Sendecor, G.W. and W.G. Cochran (1980). "Statistical Methods" 7th ed., 225-330. Iowa state Univ., Press., Ames., Iowa, USA.

Sharma, D.P. and S. Komal (1998). Effect of subsurface drainage system on some physicochemical properties and wheat yield in waterlogged saline soil. J. Indian Soc. SoilSci., 46(2):284-288.

Van Beers. W.F.(1970). The auger-hole method, a field measurement of the hydraulic conductivity of soil below the water table. Bull. No. 1, IlRI, Wageningen The Netherlands.

Wahdan, A. A.; A. M. Helalia and H. M. Nasr (1992). Impact of subsurface drainage on some soil properties in Upper Egypt. Proceeding of the 5th International Drainage Workshop Lahore, Pakistan, ICID, IWASRI, Vol. 111, 671-679.

Yli-Halla, M., Mokma, D., Alakukku, L., Drees, R. and Wilding, L.P. (2009). Evidence for the formation of Luvisols/Alfisols as a response to coupled pedogenic and anthropogenic influences in a clay soil in Finland. Agric. Food Sci. 18: 388-401.

## تأثير الصرف المغطي والتسوية بالليزر علي بعض صفات الأرض وإنتاجية محصولي بنجر السكر والقمح

**عنتر شعبان عنتر، حمدي عبد المنعم خفاجي، إبراهيم السيد نصر الدين و إبراهيم عباس الصياد**

**مركز البحوث الزراعية- معهد بحوث الأراضي والمياه والبيئة- الجيزة – مصر**

أجريت تجربة حقلية في شمال الدلتا بمحافظة كفر الشيخ - مصر وذلك لمعرفة تأثير المسافة من خط المصرف،وتسوية الأرض، على بعض صفات الأرض الطينية والإنتاجية والنيتروجين الممتص لمحصولي البنجر والقمح .

وتوضح النتائج أن هبوط مستوى الماء الأرضي أسرع فوق المصرف عن بين المصارف. وكانت القيم المتوسطة لعمق الماء الأرضي 88، 65، 52 سم فوق المصرف، وعند ربع، ونصف المسافة من خط المصرف علي التوالي في حقل أرض البنجر وكانت القيم المماثلة في حقل أرض القمح 90، 66، 55سم علي التوالي.

وتوضح النتائج انخفاض ملوحة وصودية التربة فوق المصرف عن بين المصارف. حيث انخفضت الملوحة فوق المصرف 0.89، 1.60 ديسيسيمنز على المتر مع البنجر و 0.91، 1.32 ديسيسيمنز على المتر مع القمح مقارنة بربع ونصف المسافة من المصرف علي التوالي. وأيضا كانت القيم المماثلة للصودية 1.90، 2.88 ٪ مع البنجر و2.41، 3.31 ٪ مع القمح علي التوالي. وتوضح النتائج أيضا أن تسوية الأرض بالليزر لم تؤثر في الملوحة والصودية للأرض.

النتائج المتحصل عليها توضح نقص الكثافة الظاهرية للأرض فوق المصرف عن بين المصارف. ومتوسط قيم الكثافة في حقل البنجر كانت 1.18، 1.25، 1.29 جم/سم$^3$ لفوق المصرف، ربع، نصف المسافة من خط المصرف علي التوالي. وكانت القيم المماثلة لها في حقل القمح هي 1.20، 1.28، 1.31 جم/سم$^3$ علي التوالي. وأدت التسوية بالليزر إلي زيادة الكثافة الظاهرية للأرض عن التسوية التقليدية بحوالي 6.06، 5.79 ٪ في البنجر والقمح علي التوالي. وزاد معدل التسرب والتوصيل الهيدروليكي للأرض فوق المصرف عن المسافات بين المصارف فكانت قيم معدل التسرب الأساسي للأرض1.08، 0.91، 0.77 سم/ساعة مع البنجر و1.18،

0.89، 0.75 سم/ساعة مع القمح لفوق المصرف ولربع، نصف المسافة من المصارف علي التولي.وأدت التسوية بالليزر إلي تقليل معدل التسرب والتوصيل الهيدروليكي. فكانت قيم معدل التسرب الأساسي 0.55، 0.78 سم/الساعة مع البنجر وكانت 0.51، 0.76 سم/الساعة مع القمح لكل من التسوية بالليزر، التسوية التقليدية للأرض علي التوالي. وأيضا أدت التسوية بالليزر إلي تقليل التوصيل الهيدروليكي للأرض بحوالي 1.6، 1.9سم/اليوم للبنجر والقمح علي التوالي.

أظهرت النتائج زيادة مسام الصرف السريعة والمتوسطة فوق المصرف وقلت تدريجياً بالبعد عن المصرف.بينما قلت المسام الشعرية الدقيقة قرب المصرف وزادت بعيدا عن المصرف. فكان متوسط قيم مسام الصرف السريعة، المتوسطة، الشعرية الدقيقة 13.16، 14.85، 19.59٪ فوق المصرف. والقيم المماثلة لها علي التوالي9.93، 11.44، 27.69٪ مع نصف المسافة من المصرف. والتسوية بالليزر أحدثت نقص في المسام السريعة والمتوسطة والحاملة للماء وزيادة في المسام الشعرية الدقيقة. فكانت متوسطات قيم المسام السريعة والمتوسطة والحاملة للماء علي التوالي 8.8، 10.2، 20.0 ٪ مع التسوية بالليزر وكانت 10.0، 11.7، 22.3 ٪ مع التسوية التقليدية. وزادت المسام الشعرية مع التسوية بالليزر عن التقليدية بحوالي 11.69٪.

وتشير النتائج أن الإنتاجية تقل بالبعد عن المصرف. حيث كانت إنتاجية البنجر من الجذور 34.01، 32.02، 31.24 طن للفدان فوق المصرف، وعند ربع، نصف المسافة من المصرف غلي التوالي. وكانت القيم المماثلة لإنتاج القمح من الحبوب 3.004، 2.763، 2.516 طن للفدان علي التوالي. أما تسوية الأرض بالليزر أدت إلى انخفاض إنتاج البنجر من الجذور 2.51 طن للفدان مقارنة بالتسوية التقليدية. بينما التسوية بالليزر أدت إلي زيادة القمح من الحبوب 16.95٪ عن التسوية التقليدية. وزاد إنتاج البنجر من السكر الخام فوق المصرف عن ربع، نصف المسافة من المصرف بمقدار 0.36، 0.53 طن للفدان علي التوالي. و التسوية بالليزر أدت إلي نقص إنتاج البنجر من السكر الخام بمقدار0.49 طن للفدان. وأيضا وجدت زيادة للنيتروجين الممتص بواسطة جذور البنجر فوق المصرف 3.11، 4.7 كجم للفدان عن ربع، نصف المسافة من المصرف علي التوالي. وكانت القيم المماثلة 3.79، 7.51 كجم للفدان لحبوب القمح غلي التوالي. وقيم النتروجين الممتص مع التسوية بالليزر والتقليدية علي التوالي 54.35، 56.64 كجم للفدان لجذور البنجر وكانت 42.99، 36.83 كجم للفدان لحبوب القمح.

**قام بتحكيم البحث**

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|---|---|
| **أ.د / احمد عبد القادر طه** | **كلية الزراعة – جامعة المنصورة** |
| **أ.د / محمد رضوان خليفه** | **كلية الزراعة – جامعة كفر الشيخ** |