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EFFECT OF PRECESSION LAND LEVELING ON WHEAT YIELD USING DEVELOP SURFACE IRRIGATION

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ABSTRACT

The current study was carried out at Gehena, Sohag Governorate during 2009-2010 seasons in clay soil, to study the effect of soil surface slope by laser (traditional, 0.0, 0.03 and 0.05 %) under irrigation gated pipe system on the wheat yield and irrigation efficiency. Wheat grains (Giza 168) was planted in 27/11/2009 and received 6 irrigations. All the experimental treatment received the same agricultural practices as usual in the area. From the results it can be concluded that the lowest results for infiltrated depth (50.25 mm), application efficiency (77.52 %), actual application efficiency of low- quarter (72.51%) and water applied (1815 m^3/fed) and the highest results distribution uniformity (93.53), water distribution efficiency (95.85 %), water use efficiency (1.78 kg/m^3) and wheat yield (3.225 Mg/fed) were recorded at 0.05 % soil slope laser leveling.

Keywords: Gated pipes, Laser leveling, Infiltration, Advanced time, Water distribution uniformity, Applied water.

INTRODUCTION

In Egypt wheat is the most important cereal crop. It is occupies about 2.9 millions feddan with a national average grain yield of about 2.28 Mgs, producing about 53 millions ardab (Ministry of agriculture ARE, 2008). According to water shortage in the soon future days, then the methods to diminish the irrigation water is the vital. These methods must not effect on the water comportment and the crop yield. Solomon (1990) indicated that irrigation uniformity is also linked to the efficiency with which agricultural resources are used. Non uniformity irrigation resulted in the application of excess water. Smith *et. al.* (1997) indicated that, using gated pipe system provided many benefits:-

1- Demonstrated that water applied more evenly and more efficiently could increase crop yields.
2- Provided control able, consistent and a accurate delivery of the water right.
3- Reduced the need to divert 5.5 acre- feet per acre from the clear – water ditch to 3.3 acre – feet per acre.
4- Improved water quality in the Lostine River by reducing tail water return flows and reducing sediment yield.

Hassan (1998) indicated that, there are many methods for improving the performance of surface irrigation, but all of them depend on the main factors related to soil characteristics, leveling and application method. He also stated that the use of perforated pipe system instead of ditches for conveying and distributing the irrigation water over the entire field many improve the surface irrigation, avoid weed problems, avoid losses of productive land, avoid losses of water by seepage and evaporation and also decreases the irrigation water losses up to 25% during distributing the irrigation water. Osman (2002) stated that using gated pipes, meanwhile water saving was 29.64, 29.90, 14.50 and 19.70% in cotton, wheat, corn and rice respectively compared with traditional (flooding) system. Mohammed (2008) concluded that uniformity coefficient, as well as, distribution uniformity increased when inlet discharge increased but acceptable values achieved for all discharge treatments although the UC (95.70%) and DU (93.10%) were the highest for 6 m^3/h inlet flow. Application efficiency achieved a value of 92.80% for 6 m^3/h discharge due to increasing water deficit in root zone, but storage efficiency a achieved the value of 94 % for 4.50 m^3/h due to decreasing drier soil content in root zone. Zhaohui Wang *et al.* (2005) showed that wheat at tillering, stem elongation and grain-filling growth stages was more sensitive to water deficit then at dormant stage. Water deficit at stem elongation or grain-filling stage not only decreased biomass, but it also appeared to have inhibited the translocation of assimilates from the vegetative plant parts to the heads, especially when water deficit occurred during grain-filling stage. Water deficit at dormant stage had no significant effect on biomass production, but it may have hindered the allocation of assimilates to the heads. Water deficit at tillering tented to increases grain harvest index but decreased biomass. Grain yield was significantly decreased (15-91%) by water deficit at all four growth stages.

The aim of this study defines the effect of the irrigation with using gated pipes under different soil surface slope on wheat grain quality.

MATERIALS AND METHODS

An area of 48m width and 60 m length was divided into 4 plots each plot 12 m wide, each plot divided into 3 strips each of 4m wide. Each plot has three passes of chisel plow at 20 cm depth and the slopes of land strip surface are S1 = 0, S2 = 0.03 % and S3 = 0.05 % laser leveling and traditional leveling (T). There was tile drainage for that the end of the border was closed. The first sub-plot area was irrigated with traditional method by pumping irrigation water through 6-inch flow meter into a concrete canal to flow from the canal to the border. The second experimental area sub-plot was irrigated by 6- inch aluminum gated pipes. The distance between two consecutive gates was to be 0.5 m (Hassan 2004). The flow rate recommended per meter width in clay soil was about 2 l/s according to (Hassan 1998). The calibration of the used gated pipes for each treatment and pumping unit was tested through closed water re-circulation system. Wheat seeds (Giza168) was planted in 27/11/2009 and received 6 irrigations. All the experimental treatment received the same agricultural practices as usual in the area. Before beginning the experimental work, soil samples were taken from three locations, at the head, the middle and the tail of the experimental field. These soil samples were taken for the determination of soil mechanical and chemical analysis, soil bulk density, field capacity, and the welting point according to Anter *et al.* (1987) at harvest time, the weight of the crop in each plot was measured for each treatment, the water application efficiency (Ea), the water distribution efficiency (Ed), the water use efficiency (WUE) were determined. During the execution of experimental work, soil samples were collected two days after irrigation from each strip for the determination of soil moisture content and soil moisture distribution pattern. Also, soil samples were taken just before irrigation to determine soil moisture distribution pattern. The samples were taken every 5 meters for each strip. The samples were taken at four depth: (0-15 cm), (15-30 cm), (30-45 cm) and (45-60 cm).

Table (1): The mechanical analysis, chemical and the bulk density of the different layers of the experimental area.

Dep, cm	Coarse sand, %	Fine sand, %	Silt %	Clay %	Texture	Organic mater, %	$CaCo_3$	Bulk density, gm/cm^3
(0-15)	4.67	15.96	17.53	61.84	clay	6.00	3.50	1.11
(15-30)	4.50	14.00	17.50	64.50	clay	5.00	4.00	1.09
(30-45)	4.40	14.50	17.60	63.50	clay	2.00	3.90	1.14
(45-60)	3.00	16.00	16.00	65.00	clay	2.00	3.50	1.14

The performance of the wheat irrigation system under the studied variables can be determined using the following confirmed

1- Infiltration depth

The depth of infiltration is the basic function for evaluating the distribution uniformity and application efficiency. It is, therefore an index for selecting the best surface irrigation regime **(Guirguis 1988)**. The basic infiltration rate was determined by using a double ring infiltrometer.

2- Application efficiency (AE)

$$AE = \frac{\text{Average depth of infiltrated and stored water in the root zone}}{\text{Average depth of applied water}} \times 100$$

3- Actual application efficiency of low-quarter (AELQ)

$$AE = \frac{\text{Average depth of infiltrated and stored water}}{\text{Average depth of applied water}} \times 100$$

4- Distribution uniformity (DU) (Merrian and Keller, 1978)

$$DU = \frac{\text{Average low quarter depth of water infiltrated}}{\text{Average depth of infiltrated water}} \times 100$$

5- Water distribution efficiency (Ed)

$$Ed = 1.0 - \frac{\sum |y - d|}{N \times d} \times 100$$

Where:-

Ed = Water - distribution efficiency, %.

D = Average depth of stored water along the run during the irrigation.

$|y - d|$ = Average absolute numerical deviation from d.

N = Number of reading.

6- Water applied:

The pumping unit discharge rate was adjusted to be as close as possible to pumping discharge rate 90 m^3/h measured by 6 inches flow meter and measuring gate outflow by direct method (by measuring the time to fill a certain volume of a tin), after adjusting the sliding gates manually to obtain a uniform discharge from each gate before irrigating . The stream of irrigation was cut off at 90 % of the irrigation run (as traditional practice). After that, for all treatments, all the agricultural processes were the same .

7- Water use efficiency (WUE)

It was determined according to Awady *et al.* (1976) and using the following equation:

$$\text{Water use efficiency} = \frac{\text{Total yield kg/fed}}{\text{Total applied water } m^3/\text{fed}} \quad kg/m^3$$

8- Wheat yield

RESULTS AND DISCUSSION

The yield versus water relationship for any crops is a complicated function. If the irrigation system provides a uniform distribution of water, then each plant should receive on identical amount of water. For this reason, not only the average application, but also the spatial distribution of the application is important.

1- Infiltrated Depth

At each station along the length of the border, the opportunity time (T op) (time while water was above the ground), top was found by measuring the time interval between the advance and the recession times as recorded in table (2).

Table (2): The time of the calculated water in the soil under different slopes.

Treatments	Time (min)	Distance from border inlet (m).						
		0	10	20	30	40	50	60
Traditional leveling	T adv.	0	6.50	11	17	27	39	55
	T rec.	117	121	124.5	127	131	133	136
	T op.	117	115	113.5	110	104	94	81
Zero level slope	T adv.	0	5.50	9.50	14.50	22.50	31	48
	T rec.	113	115	117	119.5	121	123	126
	T op.	113	109.5	107.5	105	98.5	92	78
0.03% slope	T adv.	0	4.5	11	16	23	33	46
	T rec.	111	113	115	117.5	119	121	123
	T op.	111	108.5	104	101.5	96	88	77
0.05% slope	T adv.	0	4	9	14	21	31	43
	T rec.	110	111.5	113	116	118.5	119.5	120.5
	T op.	110	107.5	104	102	97.5	88.5	77.5

T adv.: advance time T rec.: recession time T op.: opportunity time

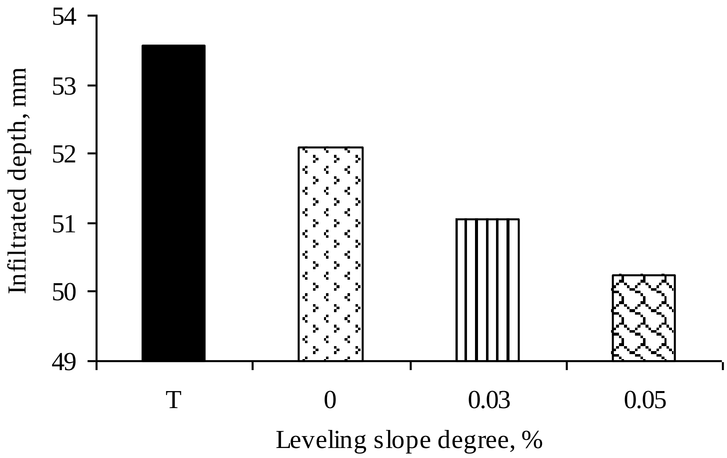

Fig. 1: The effect of leveling slope degree and the traditional leveling on infiltrated dept.

The corresponding depth of infiltration was calculated. Fig. (1) represents the calculated depth for the different treatment at all station. The average depth of the infiltration for entire border was found to be approximately 53.57, 52.08, 51.05 and 50.25 mm for traditional leveling, zero, 0.03% and 0.05% slopes respectively. The results show that the advanced time was about 55, 48, 46 and 43 min for previous leveling slopes. It can be noticed that the advanced time decreased with 12.72, 16.36 and 21.82 % for zero, 0.03% and 0.05% slopes compared with traditional leveling respectively.

2- Application efficiency

The application efficiency (AE) is the ratio of the average depth of the irrigation water infiltrated and stored in the root zone to the average depth of irrigation water applied Fig. (2). The actual border average depths of irrigation water applied were 99.47, 73.93, 69.28 and 64.82 mm. for traditional leveling, zero, 0.03% and 0.05% slopes respectively.

Fig. (2) illustrate the application efficiency (AE) was computed for the studied treatments were 53.86, 70.45, 73.69 and 77.52 % for traditional leveling, zero, 0.03% and 0.05% slopes respectively.

3- Actual application efficiency of low- quarter

The actual application efficiency of low – quarter (AELQ) is the ratio of the average low – quarter (LQ) depth of irrigation water infiltrated and stored in the root zone to the average depth of irrigation water applied expressed as a percent. Soil moisture deficiency (SMD) is the average depth of the lowest one – fourth for the least 15 m in this study are 45.5, 46.0, 46.8 and 47.0 mm for the treatments traditional leveling, zero, 0.03% and 0.05% slopes respectively. Fig. (3) shows the values of the actual application efficiency of low – quarter were 45.74, 62.22, 67.55 and 72.51% for the previous leveling slopes respectively. The results show that, the application efficiency of low – quarter increased by using gated pipes and the border slope % increased.

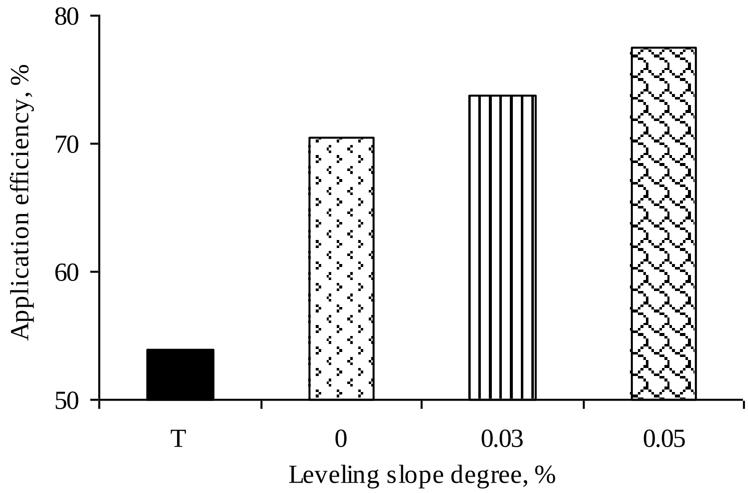

Fig. 2: The effect of leveling slope degree and the traditional leveling on application efficiency.

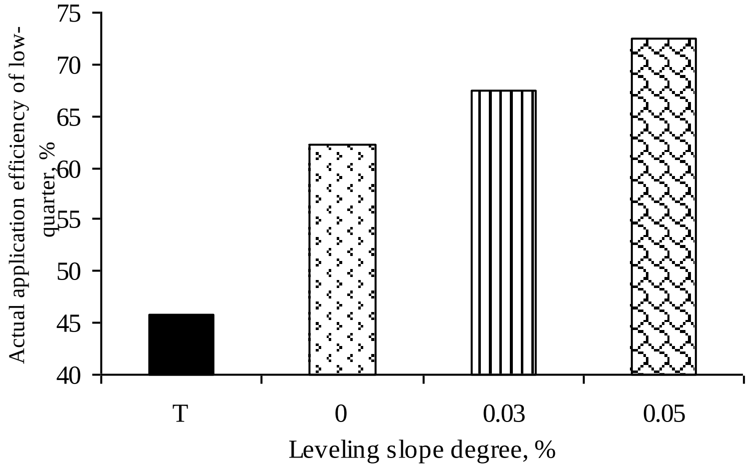

Fig. 3: The effect of leveling slope degree and the traditional leveling on actual application efficiency of low- quarter.

4- **Distribution uniformity**

The distribution uniformity, (DU) is the average depth infiltrated at the end of the field divided by average depth infiltrated over actual border length. The (DU) describes how the border for the water was distributed along the border for the condition tested. A high percentage would indicate that the advance and recession curves are parallel but would not tell whether the irrigation was adequate. For this percentage, which concerns only the infiltrated water, run off is not pertinent. Fig. (4) cleared that the calculated value of (DU) were 84.94, 88.33, 91.67 and 93.53 % for traditional leveling, zero, 0.03% and 0.05% slopes respectively.

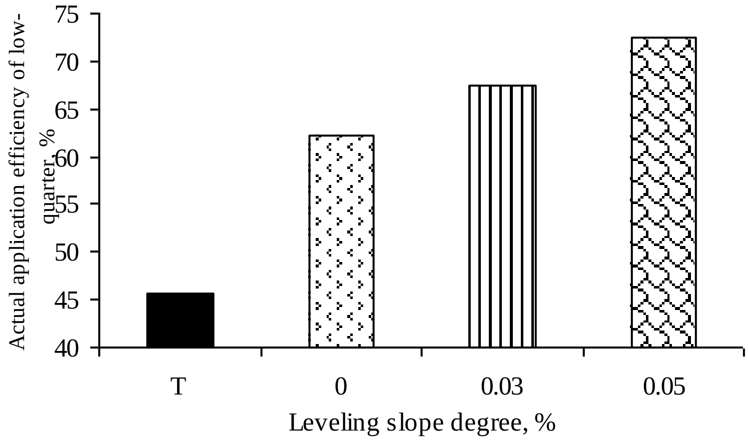

Fig. 4: The effect of leveling slope degree and the traditional leveling on distribution uniformity.

5- Water distribution efficiency (Ed)

From the experiments data the average depth infiltration (d) for the 60 m found to be 53.57, 52.08, 51.05 and 50.25 mm, for traditional leveling, zero, 0.03% and 0.05% slopes respectively. Fig. (5) indicated that the values of distribution efficiency (Ed) were 94.06, 94.39, 94.55 and 95.85 % at traditional leveling, zero, 0.03% and 0.05% slopes respectively. The result shown that distribution efficiency (Ed) increased by using the gated pipes and the border slope % increased.

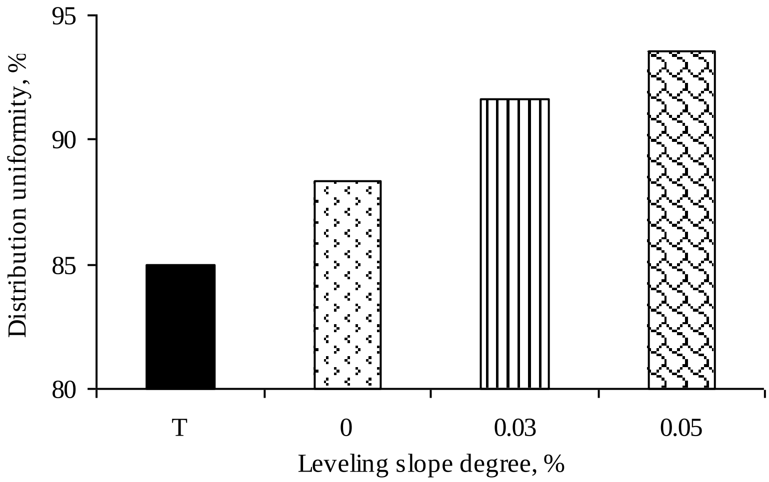

Fig. 5: The effect of leveling slope degree and the traditional leveling on distribution efficiency.

6- Water applied

In traditional leveling the quantity of water applied was about 2785 m^3/fed. for wheat crop meanwhile it was decreased in this work due to using the laser leveling and irrigated by using gated pipes Fig. (6) show that the water applied was 2070, 1940 and 1815 m^3/fed at traditional leveling, zero level, 0.03% slope and 0.05% slope respectively.

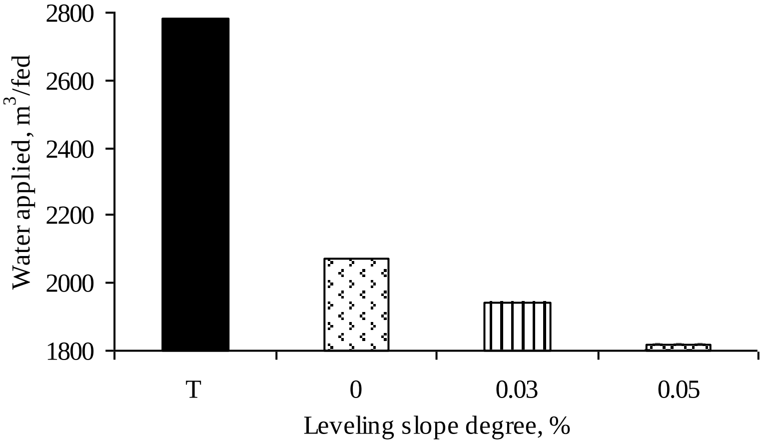

Fig. 6: The effect of leveling slope degree and the traditional leveling on water applied.

7- Water Use Efficiency (WUE)

Considering the water use efficiency, it can be concluded that the 0.05% slope treatment is the higher value (1.78 kg/m^3) as presented in Fig. (7). On the other hand the water use efficiency in traditional treatment was (0.98 kg/m^3).

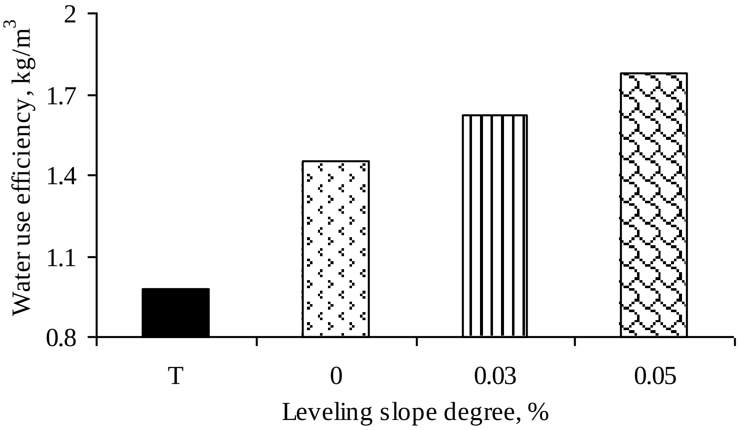

Fig. 7: The effect of leveling slope degree and the traditional leveling on water use efficiency.

8- Wheat yield

The wheat yield (Fig. 8) recorded that the highest was 3225 kg/fed recorded at 0.05% slope treatment while the lowest wheat yield was 2733 kg/fed observe at traditional leveling.

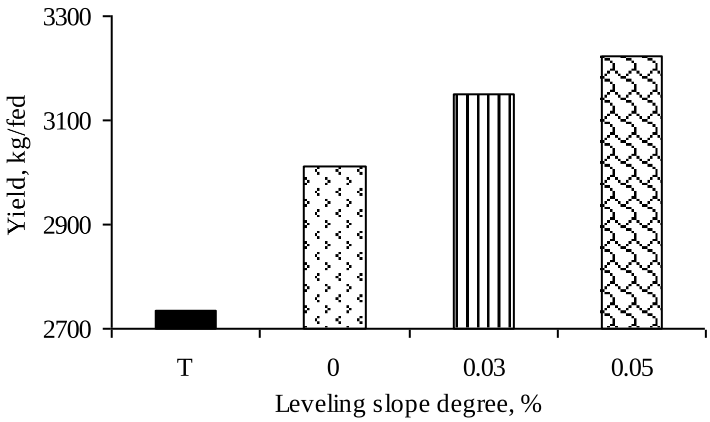

Fig. 8: The effect of leveling slope degree and the traditional leveling on yield.

Conclusions

From the results it can be concluded that the lowest results for infiltrated depth (50.25 mm), application efficiency (77.52 %), actual application efficiency of low- quarter (72.51%) and water applied (1815 m^3/fed) and the highest results distribution uniformity (93.53), water distribution efficiency (95.85 %), water use efficiency (1.78 kg/m^3) and wheat yield (3.225 Mg/fed) were recorded at 0.05 % soil slope laser leveling.

REFERENCES

Anter, I.M.; A. Negm and M.I. Meacheal (1987). Analysis methods of agriculture soils. Soil and Water Res. Inst. Agric. Res. Center, Tech. Rep. No 8/1986 pp 1-22.

Awady, M.N.; G.W. Amerhom and S.M. Zaki (1976). Trickle irrigation trial on pea in conditions of Qalubia. Egypt J. Hort., 3, No. 1, pp. 99-110.

Guirguis, A. (1988). Evaluation studies for surge flow furrow irrigation. M. Sc. Thesis, Fac. of Agric. Alex. Univ., Egypt.

Hassan, S.S.A. (1998). Engineering studies for increasing water distribution uniformity. PH.D. Thesis, Agric Agric. Eng. Dept. Fac. of Agric., Cairo Univ. pp97-98.

Hassan, S. S. A., (2004): Effect of border irrigation gated pipe technique on the irrigation efficiency of corn crop yield. Misr. J. Agr. Eng. 21 (1): 501 – 523.

Merria, J. L. and J. Keller (1978). Farm Irrigation System Evaluation: A guide for Management 3rd Edition Utah state Univ., 188-255.

Ministry of Agriculture and Land Reclamation Economic Affairs Sector (EAS) (2008). Study of the indicators agricultural statistics.
Mohammed, A. S. H. (2008). Engineering Studies on Developing the Gated Pipes for Surface Irrigation in Small Holdings. PH.D. Thesis, Agric. Eng. Dept., Fac. of Agric., Minufiya Univ. pp.89.
Osman, H. E. (2002). Evaluation of Surface Irrigation Using Gated Pipes Techniques in Field Crops and Old Horticultural Farm. Annals Agric. Sci., Ain Shams Univ., Cairo 47 (2): 461-475.
Smith, T.; J. Haynes And R. Golus (1997). Carman Ranch Gated Pipeline Project Partnerships in Water Conservation Columbia.
Solomon, K. H. (1990). Irrigation Systems and their Water Application Efficiencies. Agribusiness word wide, July/ August special report.
Zhaohui, W.; Li Shengxiuli; V. Cecil and M. Sukhdev. (2005). Effect of Water Deficit and Supplemental Irrigation on Winter Wheat Growth, Grain Yield and Quality Nutrient Uptake, and Residual Mineral Nitrogen in Soil. Communications in Soil and Plant Analysis, volume 36, pp 1405-1419.

تأثير التسوية الدقيقة للتربة على إنتاج محصول القمح بإستخدام الرى السطحى المطور

صلاح الدين اسماعيل الخطيب و شريف أحمد القاضى
معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية

أجريت هذه التجربة فى محافظة سوهاج – مركز جهينة موسم 2010/2009 وذلك لدراسة تأثير ميل الشريحة عند التسوية بالليزر بمستويات 0.0، 0.03، 0.05 % مقارنة بالنظام التقليدى للتسوية على إنتاجية محصول القمح وكفاءة الرى عند الرى بإستخدام الأنابيب المبوبة. تم زراعة القمح صنف جيزة 168 فى 2009/11/27 كما تم ريه 6 ريات وتلقى جميع العمليات الزراعية المعتاده فى زراعة القمح مثل تجهيز التربة والتسميد و........ إلخ وأوضحت النتائج أنه عند إستخدام التسوية بالليزر بميول 0.05 % كان أقل عمق ترشيح 50.55 مم، كفاءة تطبيق 77.52%، وكمية مياه 1815 م^3/فدان، كما كانت أعلى نتائج لكفاءة إنتظامية التوزيع 93.53 %، وكفاءة التوزيع 95.85 %، وكفاءة إستخدام المياه 1.78 ميجا جرام/م^3، وإنتاجية المحصول 3.225 مجا جرام/فدان نتج.

قام بتحكيم البحث

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