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

El-Khatib, S. I. and S.A. El-Kady

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 m³/fed) and the highest results distribution uniformity (93.53), water distribution efficiency (95.85 %), water use efficiency (1.78 kg/m³) 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 ardeb (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 tended 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.

<table>
<thead>
<tr>
<th>Depth, cm</th>
<th>Coarse sand, %</th>
<th>Fine sand, %</th>
<th>Silt %</th>
<th>Clay %</th>
<th>Texture</th>
<th>Organic matter, %</th>
<th>CaCO₃</th>
<th>Bulk density, gm/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0-15)</td>
<td>4.67</td>
<td>15.96</td>
<td>17.53</td>
<td>61.84</td>
<td>clay</td>
<td>6.00</td>
<td>3.50</td>
<td>1.11</td>
</tr>
<tr>
<td>(15-30)</td>
<td>4.50</td>
<td>14.00</td>
<td>17.50</td>
<td>64.50</td>
<td>clay</td>
<td>5.00</td>
<td>4.00</td>
<td>1.09</td>
</tr>
<tr>
<td>(30-45)</td>
<td>4.40</td>
<td>14.50</td>
<td>17.60</td>
<td>63.50</td>
<td>clay</td>
<td>2.00</td>
<td>3.90</td>
<td>1.14</td>
</tr>
<tr>
<td>(45-60)</td>
<td>3.00</td>
<td>16.00</td>
<td>16.00</td>
<td>65.00</td>
<td>clay</td>
<td>2.00</td>
<td>3.50</td>
<td>1.14</td>
</tr>
</tbody>
</table>

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

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)**

   \[
   AE = \frac{\text{Average depth of infiltrate d and stored water in the root zone}}{\text{Average depth of applied water}} \times 100
   \]

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

   \[
   AE = \frac{\text{Average depth of infiltrate d and stored water}}{\text{Average depth of applied water}} \times 100
   \]

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

   \[
   DU = \frac{\text{Average low quarter depth of water infiltrate d}}{\text{Average depth of infiltrate d water}} \times 100
   \]

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 m³/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:
   \[ \text{Water use efficiency} = \frac{\text{Total yield kg/fed}}{\text{Total applied water m}^3/\text{fed}} \] kg/m³

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 an 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\text{op}) (time while water was above the ground), T\text{op} 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.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Time (min)</th>
<th>Distance from border inlet (m).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional leveling</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>T adv.</td>
<td>0</td>
<td>6.50</td>
</tr>
<tr>
<td>T rec.</td>
<td>117</td>
<td>121</td>
</tr>
<tr>
<td>T op.</td>
<td>117</td>
<td>115</td>
</tr>
<tr>
<td>Zero level slope</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>T adv.</td>
<td>0</td>
<td>113</td>
</tr>
<tr>
<td>T rec.</td>
<td>113</td>
<td>109.5</td>
</tr>
<tr>
<td>T op.</td>
<td>113</td>
<td>108.5</td>
</tr>
<tr>
<td>0.03% slope</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>T adv.</td>
<td>0</td>
<td>110</td>
</tr>
<tr>
<td>T rec.</td>
<td>110</td>
<td>107.5</td>
</tr>
<tr>
<td>T op.</td>
<td>110</td>
<td>107.5</td>
</tr>
</tbody>
</table>

T\text{adv.}: advance time  T\text{rec.}: recession time  T\text{op.}: opportunity time
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.
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.

![Graph showing Actual application efficiency of low-quarter vs Leveling slope degree.](image1)

**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.

![Graph showing Distribution uniformity vs Leveling slope degree.](image2)

**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 m³/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 m³/fed at traditional leveling, zero level, 0.03% slope and 0.05% slope respectively.

![Graph showing water applied vs. leveling slope degree]

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/m³) as presented in Fig. (7). On the other hand the water use efficiency in traditional treatment was (0.98 kg/m³).

![Graph showing water use efficiency vs. leveling slope degree]

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.

![Graph showing wheat yield vs leveling slope degree](image)

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 m³/fed) and the highest results distribution uniformity (93.53), water distribution efficiency (95.85 %), water use efficiency (1.78 kg/m³) and wheat yield (3.225 Mg/fed) were recorded at 0.05 % soil slope laser leveling.

REFERENCES


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أجريت هذه التجربة في محافظة سوهاج – مركز جهينة موسم 2009/2010 وذلك لدراسة تأثير ميل الشريحة عند النسوبية بالليزر بمستويات 0.03، 0.05، 0.07 وتلتقي جمع العمليات الزراعية المعتادة في زراعتة القمح مثل تجهيز التربة والتسوية، إلخ وأوضحت النتائج أنه عند استخدام النسوبية بالليزر بعيمية 0.05% كان أقل عمق ترشيح 50.55 مم، كفاءة تطبيق 77.7%، وكمية ماء 1815 م3/هكتار، كما كانت أعلى نتائج كفاءة إنتاجية التوزيع 93.53 %، وكفاءة التوزيع 95.85 %، وكفاءة استخدام المياه 1.78 ميغا جرام/هكتار، وإنتاجية المحصول 3.225 ميغا جرام/هكتار ونح.

قام بتحكيم البحث

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