GRAPE YIELD RESPONSE TO SUBSURFACE DRIP IRRIGATION IN OLD VALLEY

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(Manuscript received 16 June 1999)

Abstract

This investigation aims to study the response of King Ruby seedless grapes to subsurface drip irrigation system in old valley. The field experiments were carried out during the two seasons, of 1996 and 1997, in "Gharbia Governorate". Soil moisture, salinity distribution, weeds growth and crop yield (quantity and quality), were measured. Water use efficiency by grapes was also considered.

In a comparison between subsurface drip irrigation system and surface drip irrigation system, the results showed that highest yield and best quality of grapes were obtained when irrigated the grapes by using subsurface drip irrigation system.

INTRODUCTION

Sustainable agricultural system can be established if the basic water management, water conservation, salinity and erosion control are recognized.

The main objectives of the agricultural strategy are to increase agricultural production per unit of land and water, through more efficient use of these limited resources. Modern irrigation technologies would provide significant benefits in improving crop yield and quality, reducing cost of production and improving environmental conditions while minimizing environmental stresses.

In the last few years, the planted area of grape were increased gradually to 125000 feddan, producing about 740000 metric tons in the year 1996 according FAO (1998).

King Ruby grape is chosen in this study as example of seedless grape yield in Egypt.

James (1988) mentioned that trickle irrigation encompasses several systems of irrigation, including drip, subsurface, bubbler, and spray irrigation.
Awady et al. (1975) studied trickle irrigation on pea crop in Qalubia Governorate using trickle plastic tubes with about 1.3 mm I.D. They found that, trickle system successfully operated with very low pressure (about 40 cm head), with less plugging troubles.

Turner and Anderson (1980) reported that, in subsurface irrigation water is applied below the surface by porous or perforated plastic pipe.

This method of applying water is somewhat similar to trickle irrigation. But instead of the pipe being placed on top of the ground, it is "planted" under the row in the root zone.

Zamber (1989) reported that drip irrigation is an efficient method of providing water directly into the soil at the root zone of the plant.

Lamm et al. (1995) defined subsurface drip irrigation system as a technology that can make significant improvements in water use efficiency through better management of irrigation water.

Bakeer et al. (1996) studied subsurface drip irrigation management for vegetable production at North Sinai and found that cantaloupe production under subsurface drip irrigation was higher by about 40% than that under surface drip irrigation.

Saad and Firzzonet (1996) also defined trickle irrigation as a convenient and efficient method of supplying water directly to the root zone of row crops or to individual plants, such as trees and vines. Also, they studied the water requirement for subsurface drip irrigation of corn in northwest KANSAS. They found that, careful management of subsurface drip-irrigation system can reduce net irrigation needs by about 25%, while still maintaining top yield of 12.5 ton/ha. Most of these water savings can be attributable to minimizing nonbeneficial water balance components such as soil evaporation. El-Gindy (1988) stated that the moisture content of the top soil (0.20 cm) was higher in the drip irrigation field than those of surface and sprinkler ones.

Hanafy (1993) showed that seasonal irrigation volumes applied to the surface drip irrigation treatments were equal to that applied to subsurface drip irrigation treatments.

El-Morsy (1996a) indicated that in flat area the moisture was distributed symmetrically around the tree. On the other hand, Abd El-Razek et al. (1992) indicated
that, the larger of maximum salinity was found near the soil surface at the midpoints between emitters and laterals as well as the deeper depths.

Ismail et al. (1994) also indicated that salt distribution was found to be a function of the distance from the dripper and soil layer depth under drip irrigation system before and 24 h after irrigation.

El-Morsy (1996b) also indicated that the salt distribution was oppositely related to the soil moisture distribution. The salt accumulated at the soil surface and the boundaries of the wetted zone. He also found that, the electric conductivity (Ec) values increased in the surface layer and decreased by going down in the soil profile from the surface layer into the bottom one.

**MATERIALS AND METHODS**

2.1. The experimental site.

The field experiments were carried out at El-Beltagy farm (15 km west south El-Mahalla El Kabre, Qarbia Governorate) during the seasons of 1996 and 1997. The farm has been planted by king rubey seedless grape vines (3.00 m rows spacing and 1.50 m vines spacing in the row) for five successive years. The soil experimental site is silt loamy texture in the top soil (50 cm) changing to clayey soil in the sub-surface soil layers (50-100 cm layer). Soil physical properties of the soil and classification are shown in Tables (1 and 2).

2.2. Irrigation treatments and systems.

Two drip irrigation systems were selected for this study, surface drip lines using built in drip lines (4 Lph / 50 cm) and sub-surface drip lines using the same type of surface system but lateral depth was below the ground surface by 30 cm. Full details of the setup and treatments were described by Bondok (1998).

Four different treatments were imposed on both surface and subsurface drip irrigation systems. So the eight treatment were as follows:

1- A₁ B₁ C₁ surface drip irrigation with one irrigations daily using 100% of farm amount of irrigation water which estimated in the farm by using pan evaporation class "A".

2- A₁ B₁ C₂ surface drip irrigation with two irrigations daily (50% of the total amount at each irrigation) using 100% of farm amount of irrigation water.
3- \( A_1 B_2 C_1 \) surface drip irrigation with one irrigation daily using 80% of the total amount of irrigation water.

4- \( A_1 B_2 C_2 \) surface drip irrigation with two irrigations daily (50% of the total amount at each irrigation) using 80% of the total amount of irrigation water.

5- \( A_2 B_1 C_1 \) subsurface drip irrigation with one irrigation daily using 100% of the total amount of irrigation water.

6- \( A_2 B_1 C_2 \) subsurface drip irrigation with two irrigations daily (50% of the total amount at each irrigation) using 100% of the total amount of irrigation water.

7- \( A_2 B_2 C_1 \) subsurface drip irrigation with one irrigation daily using 80% of the total amount of irrigation water.

8- \( A_2 B_2 C_2 \) subsurface drip irrigation with two irrigations daily (50% of the total amount at each irrigation) using 80% of the total amount of irrigation water.

The eight treatments were replicated three times each. Fig. (1) shows the drip irrigation network.

2.3. Data recording:

Data recorded in this study may be summarized as follows:

2.3.1. Soil moisture and salinity distribution:

Moisture and salt distribution in the root zone under and around the drippers were measured by collecting soil samples from the different layers (0-25, 25-50, 50-75 and 75-100 cm) across the laterals, and 25.50 and 75 cm (from the dripper) along the laterals. The moisture content samples were collected before and after five hours of irrigation. While soil salinity was measured by using electrical conductivity meter in 1:5 soil water suspension samples as described by Black (1965). Soil samples were taken from the same layers (0-25), (25-50), (50-75) and (75-100) cm along and across the laterals at the end of the season.

2.3.2. Grape yield:

Grape was harvested when total soluble solids (T.S.S) reached about 16-17% in berry juice (El-Banna, 1968). The following measurements were conducted on the yield:

The average weight of cluster.

The average number of clusters/vine.
Table 1. The physical properties of the soil.

<table>
<thead>
<tr>
<th>The physical properties</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Field capacity</td>
<td>39.14% (by weight)</td>
</tr>
<tr>
<td>Wilting point</td>
<td>17.4%</td>
</tr>
<tr>
<td>Infiltration rate</td>
<td>0.8 cm/h</td>
</tr>
<tr>
<td>Soil bulk density</td>
<td>1.09 g/cm³</td>
</tr>
</tbody>
</table>

Table 2. Soil data and classification.

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Mechanical analysis (%)</th>
<th>Soil classification</th>
<th>CaCO₃ (%)</th>
<th>O.M. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25</td>
<td>26.12 59.5 14.35</td>
<td>silty loam</td>
<td>2.95</td>
<td>1.81</td>
</tr>
<tr>
<td>25-50</td>
<td>26.12 59.5 14.35</td>
<td>silty loam</td>
<td>2.95</td>
<td>1.54</td>
</tr>
<tr>
<td>50-75</td>
<td>48.31 39.49 12.20</td>
<td>clayey</td>
<td>2.30</td>
<td>1.73</td>
</tr>
<tr>
<td>75-100</td>
<td>48.31 39.49 12.20</td>
<td>clayey</td>
<td>2.60</td>
<td>1.59</td>
</tr>
</tbody>
</table>
1- Main line (Φ = 160 mm)
2- Water pump
3- Filter
4- Pressure gauge
5- Pressure regulator
6- Flow meter
7- Valve
8- Submain line (Φ = 75mm)
9- Manifold (Φ = 32mm)
10- Surface lateral (Φ = 16 mm)
11- Subsurface lateral (Φ = 16 mm)
12- Dripper

Fig. (1) The drip irrigation network.
The average weight and the volume of 100 berries.

The average juice volume and juice % of 100 berries.

-Total soluble solids (T.S.S.):%

This was estimated as a percentages in juice of mature fresh berries by using a certzeiss hand refractometer according to A.O.A.C (1990).

-Total acidity%:

It was determined by titrating 10 ml of clear juice against 0.1N of NaOH after the addition of 2-3 drops of phenolphalein as an indicator. The free acidity was expressed as grams of tartaric acid in 100 ml of juice. It was calculated according to A.O.A.C. (1990) using the following formula.

\[ \text{ml NaOH} \times \text{N NaOH} \times 0.075 \]
\[ \text{mg of tartaric acid} = \frac{\text{ml juice}}{100} \]

where:

0.075 = milliequivalent weight of tartaric acid.

N = Normality of NaOH.

- Vitamin C:

Vitamin C as mg / 100 ml juice was determined in grape juice according to Ranganna (1979). Two ml grape juice was taken and mixed with 2 ml oxalic acid (3%) antioxidant and then titrated just below end point with 2.6 dichlorophenol-indophenol as an indicator.

2.3.3. Weeds growth:

Five random samples of each treatment were taken at the end of the season to determine the amount of weeds under and around emitters by using a wooden frame (1 m X 1 m). Dry weight of weeds inside the frame have been determined.

2.3.4. Water use efficiency (WUE):

It was determined according to the following equation:

\[ \text{Water use efficiency} = \frac{\text{average yield kg/m}^2}{\text{applied water m}^3/\text{m}^2} = \text{kg/m}^3 \]
RESULTS AND DISCUSSION

The aim of this study was to evaluate the response of grape to sub-surface drip irrigation system in old valley of Egypt where the soil is silt loamy texture. So more emphasis is placed on soil moisture and salinity patterns, crop yield (quantity and quality) and water use efficiency for both surface and subsurface drip system.

3.1. Soil Moisture and Soil Salinity Distribution:

Data in Figures 2,3,4 and 5 show the soil moisture distribution before and after 5 h of irrigating grapes under surface and subsurface drip irrigation systems for all irrigation treatments. It can be seen that the wetted areas under surface and sub-surface drip irrigation systems were affected by quantities and timing of applied water and soil texture. On the other hand, the soil moisture pattern was varied according to laterals location. In other words, the variations in wetted areas under surface and sub-surface drip irrigation systems may be attributed to factors related to quantities, timing of applied water and soil texture.

Data in Figures 2,3,4 and 5 indicated also that the moisture content increased under the emitter. The maximum moisture content values (more than 90 % of F.C) were found around and below the emission point directly in sub-surface drip irrigation. While the lowest values (75% of F.C or less) were found at the mid-distance between both emitters and laterals for all treatments. Regarding salt accumulation, the soil salinity distribution more or less coincided with moisture distribution patterns. Less salt accumulation was observed in the root-zone in case of sub-surface drip irrigation system as shown in Figures 6 and 7.

3.2. Grape Yield:

Higher grape yield (4.33 Kg/m2) was obtained under sub-surface drip irrigation with treatment A2B2C1 (one irrigation daily using 80 % of farm amount of irrigation water). While the lower yield (3.20 Kg/m2) was obtained under surface drip irrigation treatment A1B1C2 (two irrigations daily with 100% of farm amount of irrigation water).

Data in Table 3 show that the maximum grape yield was 19.53 kg/vine for treatment (A2B2C1). While the minimum grape yield was 14.43 kg/vine for treatment (A1B1C2). This means that, subsurface drip irrigation system produced higher yield compared with surface drip irrigation system.
Table 3. The effect of irrigation treatments on grape yield, weight of cluster and number of cluster.

<table>
<thead>
<tr>
<th>Irrigation water treatment</th>
<th>Grape yield (kg/vine)</th>
<th>Average weight of cluster (gr)</th>
<th>Average number of cluster per vine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface drip irrigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A₁B₁C₁</td>
<td>15.80</td>
<td>500.00</td>
<td>32.33</td>
</tr>
<tr>
<td>A₁B₂C₁</td>
<td>18.07</td>
<td>512.67</td>
<td>35.00</td>
</tr>
<tr>
<td>A₁B₁C₂</td>
<td>14.43</td>
<td>493.00</td>
<td>36.33</td>
</tr>
<tr>
<td>A₁B₂C₂</td>
<td>16.00</td>
<td>450.00</td>
<td>37.33</td>
</tr>
<tr>
<td>Subsurface drip irrigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A₂B₁C₁</td>
<td>28.26</td>
<td>523.00</td>
<td>46.67</td>
</tr>
<tr>
<td>A₂B₂C₁</td>
<td>19.53</td>
<td>530.00</td>
<td>36.00</td>
</tr>
<tr>
<td>A₂B₁C₂</td>
<td>18.83</td>
<td>510.67</td>
<td>32.33</td>
</tr>
<tr>
<td>A₂B₂C₂</td>
<td>18.63</td>
<td>512.67</td>
<td>37.33</td>
</tr>
</tbody>
</table>

Table 4. The effect of irrigation treatments on King Ruby seedless grape measurements.

<table>
<thead>
<tr>
<th>Irrigation water treatment</th>
<th>weight of 100 berries (gr)</th>
<th>volume of 100 berries (ml)</th>
<th>juice volume of 100 berries (ml)</th>
<th>Juice (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface drip irrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A₁B₁C₁</td>
<td>333</td>
<td>200</td>
<td>180</td>
<td>90</td>
</tr>
<tr>
<td>A₁B₂C₁</td>
<td>413</td>
<td>280</td>
<td>205</td>
<td>73</td>
</tr>
<tr>
<td>A₁B₁C₂</td>
<td>347</td>
<td>180</td>
<td>165</td>
<td>91</td>
</tr>
<tr>
<td>A₁B₂C₂</td>
<td>322</td>
<td>280</td>
<td>225</td>
<td>80</td>
</tr>
<tr>
<td>Subsurface drip irrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A₂B₁C₁</td>
<td>312</td>
<td>190</td>
<td>185</td>
<td>86</td>
</tr>
<tr>
<td>A₂B₂C₁</td>
<td>527</td>
<td>350</td>
<td>285</td>
<td>81</td>
</tr>
<tr>
<td>A₂B₁C₂</td>
<td>385</td>
<td>220</td>
<td>205</td>
<td>93</td>
</tr>
<tr>
<td>A₂B₂C₂</td>
<td>441</td>
<td>310</td>
<td>250</td>
<td>80</td>
</tr>
</tbody>
</table>
Table 5. The effect of irrigation treatments on King Ruby seedless grapes measurements.

<table>
<thead>
<tr>
<th>Irrigation water treatment</th>
<th>T.S.S (%)</th>
<th>Vitamin C (mg/100 cm³)</th>
<th>Acidity (mg/100 cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface drip irrigation</td>
<td>A₁B₁C₁</td>
<td>17.00</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>A₁B₂C₁</td>
<td>16.00</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>A₁B₁C₂</td>
<td>17.00</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>A₁B₂C₂</td>
<td>16.70</td>
<td>3.6</td>
</tr>
<tr>
<td>Subsurface drip irrigation</td>
<td>A₂B₁C₁</td>
<td>17.00</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>A₂B₂C₁</td>
<td>18.40</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>A₂B₁C₂</td>
<td>17.90</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>A₂B₂C₂</td>
<td>16.40</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Table 6. The effect of irrigation treatments on weeds growth (gr/m²)

<table>
<thead>
<tr>
<th>Surface drip</th>
<th>Subsurface drip</th>
<th>The reducing</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Dry weight</td>
<td>Treatment</td>
<td>Dry weight</td>
</tr>
<tr>
<td>A₁B₁C₁</td>
<td>250.90</td>
<td>A₂B₁C₁</td>
<td>186.19</td>
</tr>
<tr>
<td>A₁B₂C₁</td>
<td>224.60</td>
<td>A₂B₂C₁</td>
<td>120.18</td>
</tr>
<tr>
<td>A₁B₁C₂</td>
<td>280.16</td>
<td>A₂B₁C₂</td>
<td>120.60</td>
</tr>
<tr>
<td>A₁B₂C₂</td>
<td>226.12</td>
<td>A₂B₂C₂</td>
<td>160.09</td>
</tr>
</tbody>
</table>
Fig. 2. Soil moisture distribution around dripper before irrigation under surface drip irrigation system.
Fig. 3. Soil moisture distribution around dripper after irrigation under surface drip irrigation system.
Fig. 4. Soil moisture distribution around dripper before irrigation under subsurface drip irrigation system.
Fig. 5. Soil moisture distribution around dripper after irrigation under subsurface drip irrigation system.
3.2.1. The average weight of cluster:

Data in Table 3 show the effect of irrigation treatment on cluster weight. The data indicated that, the maximum value of the cluster weight was 530.0 gr (treatment $A_2B_2C_1$). While the minimum value of cluster weight was 403.0 gr (treatment $A_1B_1C_2$). This means that higher applied water encouraged the plant towards the vegetative growth which have greater number of clusters but less weight per cluster, compared with the other lower rates in other treatments.

3.2.2. The average number of clusters per vine:

Data in Table 3 also indicated that, the maximum number of the cluster number was 46.7 for treatment ($A_2B_1C_1$). While, the minimum number was 32.3 for treatment ($A_1B_1C_1$), and ($A_2B_1C_2$) for surface and subsurface drip irrigation respectively.

This means that, when the plant received much water, the plant was encouraged towards the vegetative growth which increased the number of clusters. But when the plant received less irrigation water the number of cluster were limited.

3.2.3. The average weight and the volume of 100 berries:

Data presented in Table 4 indicated that, the maximum weight of 100 berries was 527.0 gr for the treatment ($A_2B_2C_1$). The minimum weight of 100 berries was 312.0 gr for the treatment ($A_2B_1C_1$).

The maximum volume of 100 berries was 350.0 ml for the treatment ($A_2B_2C_1$). But the minimum volume was 180.0 ml for the treatment ($A_1B_1C_2$).

3.2.4. The average juice volume and juice % of 100 berries:

The maximum juice volume of 100 berries was obtained from treatment ($A_2B_2C_1$), and found to be 285 ml. While maximum juice % in 100 berries was obtained from treatment ($A_2B_2C_2$), and found to be 93% as shown in Table 4. On the other hand, the minimum juice volume of 100 berries was obtained from treatment $A_1B_2C_2$ (surface irrigation) and $A_2B_1C_2$ (subsurface irrigation), and found to be 165 ml. While minimum juice % in 100 berries was obtained from treatment ($A_1B_2C_1$) and found to be 73%.

3.2.5. Total soluble solids (T.S.S)%:

Data in Table 5 show the effect of irrigation treatments on maximum and mini-
Fig. 6. Soil salinity distribution around dripper under surface drip irrigation system.
Fig. 7. Soil salinity distribution around dripper under subsurface drip irrigation system.
mum values of T.S.S. It can be seen that for surface drip irrigation treatment maximum and minimum values were 17.0% for treatments A_1B_1C_1 and A_1B_1C_2, and 16.5% (for treatments A_1B_2C_1). On the other hand for subsurface irrigation maximum and minimum values of T.S.S were 18.4% and 16.40% for treatments A_2B_2C_1 and A_2B_2C_2.

3.2.6. Total acidity:

The maximum values of juice of acidity under different irrigation treatments were 0.60 mg/100 cm^3 for treatment A_2B_2C_2 (subsurface irrigation) and 0.58 mg/100 cm^3 for treatments A_1B_1C_1 and A_1B_2C_2 (surface irrigation) as shown in Table (5). On the other hand minimum values of acidity were 0.56 for treatments A_2B_1C_1, A_2B_2C_1 and A_2B_1C_2 (subsurface irrigation) and 0.56 for treatment A_1B_1C_2 (surface irrigation).

3.2.7. Vitamin C:

Table 5 also shows the values of vitamin C (mg/100 cm^3) for the different irrigation treatments. The maximum value was 3.6 mg/100 cm^3 for treatments A_2B_1C_1, A_2B_2C_2 (subsurface irrigation) and A_1B_2C_2 (surface irrigation). While the minimum values were 2.5 and 2.4 for treatments A_2B_2C_1 and A_1B_2C_1 (for subsurface and surface drip irrigation systems respectively).

3.3. Weeds Growth:

Table 6 show the values of values of dry weight of weeds growth (gr/m^2) for the different treatments. It can be seen that, the minimum amount of weeds (dry weight) was 100.18 gr/m^2 obtained under subsurface drip irrigation for treatment A_2B_2C_1. While, the maximum value was 280.18 gr/m^2 obtained under surface irrigation for treatment A_1B_1C_2.

Data in Table 6 show the effect of using subsurface drip irrigation system in reducing weeds growth. It can be seen that for all treatments subsurface irrigation reduced weeds growth. The Percent of reduction in the dry weight of weeds ranged from 20.35 to 56.95.

3.4. Water use Efficiency (WUE):

Higher grape yield (15624 kg/fed) and water use efficiency (6.18 kg/m^3) were
recorded for subsurface drip irrigation treatment \((A_2B_2C_1)\). While the lower grape yield and water use efficiency were recorded for surface drip irrigation treatment \((A_1B_1C_2)\), it were 11544 kg/fed and 3.65 kg/m³ respectively as shown in Table (7).

Table (7) The effect of irrigation treatments on water use efficiency (WUE)

<table>
<thead>
<tr>
<th>Irrigation water treatment</th>
<th>Average yield (kg/fed)</th>
<th>Amount of irrigation water (m³/fed)</th>
<th>WUE (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface drip irrigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A_1B_1C_1)</td>
<td>1240</td>
<td>3160</td>
<td>4.00</td>
</tr>
<tr>
<td>(A_1B_2C_1)</td>
<td>14456</td>
<td>2528</td>
<td>5.75</td>
</tr>
<tr>
<td>(A_1B_1C_2)</td>
<td>11544</td>
<td>3160</td>
<td>3.65</td>
</tr>
<tr>
<td>(A_1B_2C_2)</td>
<td>12600</td>
<td>2528</td>
<td>5.06</td>
</tr>
<tr>
<td>Subsurface drip irrigation</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(A_2B_1C_1)</td>
<td>15408</td>
<td>3160</td>
<td>4.88</td>
</tr>
<tr>
<td>(A_2B_2C_1)</td>
<td>15624</td>
<td>2528</td>
<td>6.18</td>
</tr>
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<td>(A_2B_1C_2)</td>
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<td>4.69</td>
</tr>
<tr>
<td>(A_2B_2C_2)</td>
<td>14904</td>
<td>2528</td>
<td>5.90</td>
</tr>
</tbody>
</table>

3.5. Economic Costs-Benefit Analysis:

The highest value of net income of grape yield and the lower economic costs for grape yield were 12948 and 2640 L.E./feddan under subsurface drip irrigation.

From the previous conclusion, it is clear that, the response of using subsurface drip irrigation for irrigating grape was high.

CONCLUSION

The following conclusions may be drawn:

* Soil moisture distribution and soil salinity:
  - Soil moisture distribution increases under the emitters.
  - Soil moisture distribution pattern was affected by the vertical up and downward movement under subsurface drip irrigation, while it was affected by vertical
downward movement under surface drip irrigation.

- The salt content increases with depth and the distance from emitters in both systems.

- Salt movement depends on the amount of water applied and its interval.

* Grape yield:

   Higher grape yield, maximum volume of juice and maximum value of T.S.S. were obtained under subsurface drip irrigation system (treatment A₂B₂C₁).

* Weeds growth:

   The minimum value of dry weight (g/m²) of weeds growth was also obtained under the same treatment (A₂B₂C₁). In general one may say that subsurface drip irrigation system reduced the weeds growth compared with surface drip irrigation system.

* Water use efficiency:

   The highest value of water use efficiency was obtained under subsurface drip irrigation system (treatment A₂B₂C₁). While the minimum value of it was obtained under surface irrigation (treatment A₁B₁C₂).

In general, the results showed that the highest value of net income and the lower economic costs were 12948 and 2640 L.E./fed. under subsurface drip irrigation. It also showed that, the response of using subsurface drip irrigation for irrigating grape was high.
REFERENCES


أجريت هذه الدراسة على محصول النعناع البناني (صف. كنغ روبي) خلال عامي 1996 و1997 في منطقة العلا بموجب عقد إستجابة المحصول لنظام الري بالتنقيط السطحي وتحديداً تأثيره على الإنتاجية وذلك مقاولة باستخدام نظام الري بالتنقيط السطحي. وقد تم دراسة تأثير نظام الري المستخدم على:

- توزيع الرطوبة والملوحة في الفترات.
- كمية الري المستهلك ودورة احتراق النبات.
- كفاءة الاستخدام للماء.
- التكلفة.

وقد أظهرت النتائج ما يلي:

- إرتفاع نسبة الرطوبة تحت الأوراق في كل النباتات.
- تأثير توزيع الرطوبة في الأوراق بالحركة الرأسية لفطي لتقدم الري بالتنقيط السطحي. واحداً على فتحة أوراق الري يستخدم نظام الري بالتنقيط السطحي.
- التغير في كمية المياه المستخدمة في كل زاوية على فتحة واحدة.
- ارتفاع نسبة نسبة النمو النباتي بضعة أضعاف تحت نظام الري بالتنقيط السطحي مقاولة.

- كانت أعلى القيم المستمر على كفاءة استخدام ماء الري مع نظام الري البنائي الذي تورى بسلاسل النباتات تحت النبات السطحي بسلاسل آراء الري المستخدم في الزراعة دفع في عادة واحدة.

- كذلك أظهرت تأثير نظام الري بالتنقيط السطحي معاً مع نظام الري المستخدم في الزراعة في انخفاض في مدة سباق، وذلك لزيادة الكفاءة بالоборотة بزيادة الماء.

وما سيأتي يمكن القول أن إستجابة محصول النعناع الباني للري باستخدام نظام الري بالتنقيط السطحي أكثر منها بالمقارنون ببنظام الري بالتنقيط السطحي.