PERFORMANCE OF SURFACE AND SUBSURFACE DRIP FERTIGATION ON YIELD AND WATER USE EFFICIENCY OF SUGARCANE

R. Mahesh¹, N. Asoka Raja² and H.A. Archana³

ABSTRACT

The present investigation was taken up with an aim to assess the effects of surface and subsurface drip fertigation with Water Soluble Fertilizer (WSF) and Normal Fertilizers (NF) for maximizing the cane productivity and water use efficiency of sugarcane. WSF and NF were tried at two doses viz., 100 and 75% of RDF and also in combination with WSF and NF (75%WSF+25%NF, 50WSF+50%NF and 25%WSF and 75%NF) by subsurface drip fertigation and 100% RDF by surface drip fertigation. These were compared to surface drip fertigation with 100 RDF with WSF and NF and surface irrigation and soil application of NF at 100% RDF. Chipbud seedlings were planted with Paired row with triangular (Zig Zag pattern) planting (40/125 x 45 cm). Imported water soluble fertilizers viz., Mono Ammonium Phosphate (12:61:00), Polyfeed (19:19:19), Potassium Nitrate (13:00:45) and Urea (46:00:00) were tried under surface and subsurface drip fertigation. Both surface and subsurface drip irrigation were scheduled based on crop evapotranspiration (ETc) once in two days. Fertigation was scheduled once in seven days with different forms of fertilizer grades.

The experiment was laid out in a randomized block design with three replications of sugarcane raised under surface and subsurface drip fertigation. Results from the investigation showed that sugarcane responded well to different forms of fertilizers grades and fertigation regimes on yield and water use efficiency of sugarcane under both surface and subsurface drip fertigation. The result revealed that considerable saving of irrigation water was noticed under both SSDI (30.73%) and SDFI (22.70%) over surface irrigation. This revealed that adoption of SSDI has resulted 8-9% additional water saving compared to SDFI. Increased water use efficiency (WUE) was registered with SSDI over to SDFI and surface irrigation. Among SSDI, SDF and surface irrigation with soil application of NF, SSDI has recorded higher WUE (1.52 t ha. cm-1) compared to SDFI (1.23 t ha. cm-1) at 100% RDF with WSF and surface irrigation with soil application of 100% RDF with NF (0.53 t ha. cm-1). The increase in WUE was to the tune of 2.75 to 2.86 times higher under SSDF and 2.23 times higher under SDF at 100% RDF with WSF compared to surface irrigation with soil application of NF at 100% RDF. The result of present study clearly indicated that SSDF has achieved an additional WUE of 23% over SDFI. In terms of sugarcane productivity, maximum cane yield of 193.94 tonnes per hectare was achieved by SSDF at 100% RDF with WSF which was 10.51 and 89.63 per cent over than SDF at 100% RDF with WSF (175.14 tonnes per hectare) and surface irrigation with soil application of NF at 100% RDF (98.38 tonnes per hectare) respectively. It was concluded that subsurface drip fertigation with WSF at 100% RDF in Sugarcane (chipbud seedlings planting) has resulted higher water saving, cane yield and water use efficiency.

Keywords: Surface Drip fertigation, Subsurface Drip fertigation, cane yield, water saving, water use efficiency.

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1. INTRODUCTION

Sugarcane (Saccharum officinarum L.) is the world’s primary sugar crop. Current global production stands at 1685.44 million tonnes of cane from an area of 23.8 million hectares in worldwide (Anonymous, 2011). India is the second largest sugar producing country in the world and contributes around 22 and 25% in terms of area and production of sugarcane. In India, sugarcane is cultivated over an area of 5.31 million hectares with annual production of 361 million tonnes of cane with an average productivity of 66.36 t ha\(^{-1}\). In Tamil Nadu, the sugarcane crop is cultivated in an area of 3.46 lakh hectares with a production of 3.85 million tonnes and the average productivity of cane is 111.37 t ha\(^{-1}\). The sugar production is about 26 million tonnes in India and 22 lakh tones in Tamil Nadu (Anonymous, 2013).

Water is the most vital input in agriculture and has made a significant contribution in providing stability of food grain production. Due to monsoon failures and drawdown of ground water level, the demand of water rises day by day. Because of increasing water scarcity, it is paramount important to proper management of the irrigation systems is essential for achieving maximum efficiency of irrigation water use. The use of subsurface drip irrigation (SDI) systems may provide an improvement in irrigation water use efficiency. These systems apply irrigation water directly inside the ground instead of on the surface (Ayars et al. 1999). This procedure reduces soil water evaporation losses from the wet bulb as the soil surface is not wetted, especially in low-density crops.

SSDI has many benefits over conventional drip irrigation (Singh and Rajput, 2007). SSDI system can contribute to maximizing water use efficiency due to negligible soil evaporation, percolation, runoff (Phene et al. 1992) and also improve crop yield and quality (Zhou et al. 2001). Providing optimum soil moisture conditions throughout the crop growing period through drip irrigation is therefore of paramount importance to realize higher yields.

Further, SSDI offers application of water and nutrients at optimum amounts to the most active part of the crop root zone, with timing appropriate for maximum plant response, while minimizing the potential for nutrient leaching. Drip fertigation offers a more great scope to enhance cane productivity (Senthil kumar, 2009), saves 40-50 per cent irrigation water and enhances nutrient efficiency by 40 per cent (Solomon, 2012), low mobility of nutrients into the soil and also offer the possibility to optimize the water and nutrient distribution over time and space (Nanda, 2010).

Narayananamoorthy (2010) reported an yield increase of 23 per cent in drip cultivation compared to the farmer’s method of irrigation. However very limited work has been reported in this field, under the Indian situation. Hence, a field experiment was conducted to study the performance of subsurface drip fertigation on yield attributes, yield, water saving and water use efficiency of sugarcane.

2. MATERIALS AND METHOD

2.1 Experimental site, climate and soil

The experiment was carried out at farmer’s holding (Iyyar Thottam), Puttuvikki, nearer to Tamil Nadu Agricultural University, Coimbatore, which lies in western agro climatic zone of the Tamil Nadu. The experimental site is geographically situated at 10°97’ North latitude and 76°92’ East longitude at an altitude of 418 meters (1,371 ft) above mean sea level. During sugarcane crop growing period, a total rainfall of 530.50 mm in 38 rainy days was received and this was 14.15% less than normal rainfall. Monthly mean maximum temperature ranged from 29.20 °C to 35.89 °C, while monthly mean minimum temperature ranged from 19.00 °C to 24.53 °C during January to December. The monthly
mean morning relative humidity ranged from 78.84 to 88.73%. The monthly mean
evening relative humidity ranged from 34.74 to 60.81%. The monthly mean sunshine
hours ranged from 2.85 to 8.32 hours. The monthly mean maximum wind velocity was
observed in July (12.84 km hr\(^{-1}\)). The monthly mean maximum pan evaporation was
observed from April to May and the monthly mean maximum solar radiation of 428.55
cal cm\(^{-2}\) min\(^{-1}\) during January and monthly mean solar radiation of 288.62 and 288.71
cal cm\(^{-2}\) min\(^{-1}\) during June were observed.

The soil of the experimental site was sandy clay loam type and belongs to suborder
Chromoustert of the order Vertisol, taxonomically classified as Typic ustocept (Soil
Survey and Land Use Organization, 1998). Analysis made before the start of the trials
indicated the following characteristics: clay 35%, silt 11%, sand 54%, slightly alkaline
in pH (7.65), non saline in EC (0.45 dS m\(^{-1}\)), low (i.e., up to 280 kg ha\(^{-1}\)) in available
N (199 kg ha\(^{-1}\)), high (i.e., more than 22 kg ha\(^{-1}\)) in available P (44 kg ha\(^{-1}\)), high (i.e.,
more than 280 kg ha\(^{-1}\)) in available K (676 kg ha\(^{-1}\)) and high in organic carbon status
(0.54%). The field capacity at 0-20 cm was 29% and the wilting point at 0-20cm was
18%. Bulk density (1.25 to 1.33 g cm\(^{-3}\)) found to be slightly affecting root growth.
Infiltration rate (1.95 to 1.77 cm hr\(^{-1}\)) found to be moderately slow.

2.2 Experimental design and treatments

The layout of the experiment was a randomized block design with three replications.
The experimental area was 3680 m\(^2\), divided into three blocks. Each block consisted
of eleven plots, 8.25 m \times 13.33 m each. Each plot had five rows, 1.65 m apart. The
treatments comprised of two sources of fertilizers (WSF and NF), two fertigation levels
(100 and 75% RDF) and also combination of fertilizers with WSF + NF (75% WSF+
25% NF, 50% WSF + 50% NF and 25% WSF + 75% NF) under SSDF and SDF at
100% RDF in both WSF and NF. A control plot of surface irrigation with soil application
of 100% RDF with NF was also maintained. The recommended dose of fertilizer for
sugarcane used was 300:100:200 kg N, P\(_2\)O and K\(_2\)O ha\(^{-1}\). From this recommendation,
100% of N, P and K were applied by fertigation with Polyfeed (All 19), Mono Ammonium
Phosphate (MAP), Potassium Nitrate (PN) and Urea under water soluble fertilizer (WSF)
treatments (T\(_2\), T\(_3\), T\(_6\), T\(_7\), T\(_8\) and T\(_9\)). For T\(_1\) treatment alone, Polyfeed (All 19), Urea
Phosphate (UP), Sulphate of Potash (SOP) and Urea were used as water soluble
fertilizer (WSF). Whereas, Urea, Di Ammonium Phosphate (DAP) and Muriate of
Potash (MOP) were used as normal fertilizer for T\(_4\), T\(_5\), T\(_6\), T\(_7\), T\(_8\) and T\(_10\). Fertigation
was scheduled once in seven days starting from 15 to 210 DAP.

2.3 Design and layout of SDI and SSDI

The bore well was fitted with 12 HP submersible motor pump. Subsurface and
surface drip fertigation unit was installed in the experimental site with plots measuring
of 13.3 m length and 8.25 m width for all the treatments (T\(_1\) – T\(_10\)). SSDF and SDF
units were consisted of water filtration unit at the base of system with hydro cyclone
filter (20 m\(^3\)) and disc filter (2.0") with a mesh of 200 microns filtrations capacity,
ventury (3/4"), water meter (2"), bypass valve (2"), pressure gauge, air cum vacuum
release valve (40 mm) and control valve (2"). After filtration unit, PVC main line (75
mm OD) and sub mainline (63 mm OD) was installed to take water from filtration unit
to experimental field. The separate sub mains of 40 mm OD and control valves (PVC
Ball valves) of 1" was fitted to each plot to impose fertigation treatments as per
schedule.

The inline drip laterals of 16 mm OD size LLDPE with emitters spacing at 40 cm apart
with 4 lph discharge rate were laid out at a distance of 165 cm apart. One inline drip
lateral was placed for two rows of sugarcane both SSDF and SDF treatments. Under
SDF, the laterals were placed at the soil surface. Whereas in SSDF, the laterals were
placed at 20 cm deep from the soil surface in the centre of every subsurface of trench. In each of the treatments, 5 sugarcane rows at a distance of 165 cm apart and 13.3 meter length were grown. The operating pressure of 1.5 kg cm$^{-2}$ was maintained at the head unit and 1.0 kg cm$^{-2}$ at the end of laterals.

For fertigation, a separate 0.5 HP motor pump was attached with 3/4" ventury for maintain required pressure for ventury operation and desired suction rate (60 lph) while doing fertigation to individual treatments. Due care was exercised to apply the required quantity of fertilizers as per treatment specification. Along the main line an air cum vacuum release valve has to be fitted. At the tail end of the main and sub main line, flush valves of appropriate size have been fitted. In each plot, a collecting sub main of 40 mm OD PVC pipe was provided with separate control valve (40 mm) to connect the group of five laterals at the tail end with flush and air cum vacuum release valve under SSDF. Whereas, under SDF, end cap was provided at the tail end of laterals. After installation, trial run was conducted to assess mean emitter discharge and uniformity coefficient (95%) of the system. Separate outlet with control valve (2") was given for surface irrigation.

### 2.4 Planting method

The experimental field was thoroughly ploughed using tractor drawn tiller and then properly levelled. After levelling, After uniform leveling, trenches were dug out at a width of 40 cm at 125 cm apart. The trench depth was maintained at 20 cm. Under SSDF, after laying inline drip laterals in 20 cm deep trenches, the laterals were closed with loose soil at a depth of 5 cm above the laterals. The transplanting of chipbud seedlings was done in two rows in the subsurface trench at 15 cm depth from the soil surface with triangular planting (Zig-Zag pattern) system. Under SDF, transplanting of chipbud seedlings was done at the soil surface. The spacing between two rows was 40 cm while the spacing between two chipbud seedlings was 45 cm along the row (Figure 1.). A plant population of 26,933 chipbud seedlings ha$^{-1}$ was maintained in paired row planting system. In control treatment, chipbud seedling was planted by SSI method as done by the farmers under surface irrigation.

![Figure 1. Method of planting of sugarcane under SSDF and SDF](image)

*Figure 1. Method of planting of sugarcane under SSDF and SDF*
2.5 Irrigation water requirement

Water requirement was calculated by using the following formula, \( ETc (\text{mm}) = 2 \text{ days} \times CPE \times Kp \times Kc \times Wp \times IE \). CPE is the cumulative pan evaporation on the two days between two consecutive irrigation events (drip irrigation was scheduled once every two days).

**Table 1. Crop factor (Kc) for sugarcane**

<table>
<thead>
<tr>
<th>Crop growth stages</th>
<th>DAP</th>
<th>Crop factor (Kc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination and Establishment</td>
<td>1-60</td>
<td>0.40</td>
</tr>
<tr>
<td>Tillering and Canopy establishment</td>
<td>60-90</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>90-120</td>
<td>1.05</td>
</tr>
<tr>
<td>Grand growth</td>
<td>120-270</td>
<td>1.20</td>
</tr>
<tr>
<td>Ripening</td>
<td>270-300</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>300-330</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>330-360</td>
<td>0.75</td>
</tr>
</tbody>
</table>

The data were obtained from the local meteorological station; Kp is the pan coefficient for which we assumed a value of 0.8; Kc is the crop co-efficient, dimensionless value indicates the relationship between the reference grass crop and the crop actually grown. The Kc value depends on the type of crop, growth stage of the crop and climate. The Kc values used in the experimentation are presented in Table 1; Wp is the percentage area of wetting by the drip irrigation system and it was assumed as 80%; IE is the irrigation efficiency and it was assumed as 0.95 for SSDI and 0.85 for SDI.

Surface irrigation was scheduled based on IW/CPE ratio of 0.75, 0.75 and 0.50 with irrigation depth of 50 mm during tillering, grand growth and maturity phases respectively. Whenever the rainfall occurred, irrigation was postponed accordingly.

2.6 Total water use (mm)

Quantity of water applied through subsurface drip irrigation (SSDI) and surface drip irrigation (SDI) systems at each irrigation were summed up to estimate total irrigation water applied through the use of water meter. The total water used was computed by adding irrigation water applied + effective rainfall and expressed in mm.

2.7 Water use efficiency (t ha. cm\(^{-1}\))

Water use efficiency is the yield that can be produced from a unit quantity of water and this was worked out by using the following formula and expressed in t ha. cm\(^{-1}\).

\[
WUE (\text{t ha. cm}^{-1}) = \frac{\text{Cane yield (t ha}^{-1})}{\text{Total water used (cm)}}
\]

2.9 Statistical analysis

The data pertained to growth, yield and yield parameters were subjected to statistical analysis by Analysis of Variance (ANOVA) using AGRES (Data Entry Module for AgRes Statistical software version 3.01, 1994 Pascal Intl. Software Solutions).
Differences between means were evaluated for significance using least significant differences (LSD) at 5% probability level as suggested by Gomez and Gomez (2010).

3. RESULT And DISCUSSION

3.1 Number of millable cane

In the present study, the increased number of millable canes to the tune of 63.86 was noticed due to fertigation at 100% RDF with WSF under SSDF compared to surface irrigation with soil application of NF at 100% RDF (Table 2). This result is in conformity with the findings of Khandagave et al. (2005). It was also observed in the present study that number of millable canes was increased to the extent of 25.93% under WSF than NF at 100% RDF under SDF. Similarly under SDF also, WSF enhanced the number of millable canes than NF at 100% RDF in both the crops. These results are in agreement with the findings of Shinde et al. (2000). The higher number of millable canes production under SSDF with WSF was mainly due to the enhanced supply of plant nutrients and continuous availability of water in effective the root zone of crop and without any stress (Asoka Raja and Mahesh, 2013).

3.2 Individual cane weight

Individual cane weight is one of the most important yield attributing character in sugarcane. In the present study, source of fertilizers and fertigation levels under both in SSDF and SDF were significantly influenced the individual cane weight (Table 2). The enhanced individual cane weight to the tune of 40.28% was noticed under SSDF at 100% RDF with WSF compared to surface irrigation with soil application of NF at 100% RDF. The result was in agreement with findings of Gui-Fen Chen et al. (2012). Among WSF and NF, fertigation with WSF has enhanced the individual cane weight to the tune of 20.96% than NF at 100% RDF through SSDF in the present study. Further, it was also observed in the present investigation that higher fertigation dose (i.e. 100% RDF) has resulted increased individual cane weight than lower fertigation dose (i.e. 75% RDF) under SSDF with WSF. These observations are in accordance with findings of Asoka Raja and Mahesh (2013), wherein fertigation at 125% RDF with WSF has increased individual cane weight over 75% RDF with WSF.

3.3 Cane and sugar yield

The results of the present investigation clearly indicated that SSDF at 100% RDF with WSF recorded significantly higher cane yield (193.94 t ha\(^{-1}\)) and sugar yield (26.95 t ha\(^{-1}\)) over surface irrigation with soil application of 100% RDF with NF (control) (cane yield: 90.92 t ha\(^{-1}\); sugar yield: 10.23 t ha\(^{-1}\)) (Table 2.). This result is in agreement with findings of Veeraputhiran et al. (2012). Previous reports indicated that increase in cane yield due to drip irrigation and fertigation was to the extent of 30 to 50% over furrow irrigation and conventional fertilization (Patel, 2005). Hapase (1992) attributed that the increase in tonnage in sugarcane was due to maintenance of soil moisture and air at optimum level in drip irrigation. Among WSF and NF, the increased cane yield under fertigation with WSF was to the extent of 30.45% higher under SSDF and 25.52% higher under SDF than NF at 100% RDF. The results are in consonance with the findings of Hebbar et al. (2004) who opined that drip fertigation with normal fertilizer gave significantly lower yield compared to fertigation with water soluble fertilizers due to less solubility and availability of normal fertilizer compared to water soluble fertilizer. It was also found from the present investigation that the increased cane yield of 12.61% was noticed with fertigation with WSF at 100% RDF than 75% RDF under SSDF. This result is in conformity with findings of Pawar et al. (2014).
Table 2. Effect of WSF and NF on individual cane weight, cane and sugar yields of sugarcane under SSDF and SDF

<table>
<thead>
<tr>
<th>Treatments</th>
<th>NMC (lakhs ha⁻¹)</th>
<th>Cane weight (kg)</th>
<th>Cane yield (t ha⁻¹)</th>
<th>Sugar yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁: SSDF at 75% RDF with WSF</td>
<td>1.18</td>
<td>1.78</td>
<td>167.63</td>
<td>21.81</td>
</tr>
<tr>
<td>T₂: SSDF at 100% RDF with WSF</td>
<td>1.36</td>
<td>2.02</td>
<td>193.94</td>
<td>26.95</td>
</tr>
<tr>
<td>T₃: SSDF at 75% RDF with WSF</td>
<td>1.15</td>
<td>1.80</td>
<td>172.22</td>
<td>21.49</td>
</tr>
<tr>
<td>T₄: SSDF at 100% RDF with NF</td>
<td>1.08</td>
<td>1.67</td>
<td>148.67</td>
<td>17.08</td>
</tr>
<tr>
<td>T₅: SSDF at 75% RDF with NF</td>
<td>1.03</td>
<td>1.60</td>
<td>132.58</td>
<td>14.83</td>
</tr>
<tr>
<td>T₆: SSDF at 75% WSF + 25% NF RDF</td>
<td>1.33</td>
<td>1.97</td>
<td>184.41</td>
<td>24.87</td>
</tr>
<tr>
<td>T₇: SSDF at 50% WSF + 50% NF RDF</td>
<td>1.13</td>
<td>1.75</td>
<td>163.48</td>
<td>20.62</td>
</tr>
<tr>
<td>T₈: SSDF at 25% WSF + 75% NF RDF</td>
<td>1.11</td>
<td>1.71</td>
<td>156.52</td>
<td>19.01</td>
</tr>
<tr>
<td>T₉: SDF at 100% RDF with WSF</td>
<td>1.20</td>
<td>1.86</td>
<td>175.14</td>
<td>23.30</td>
</tr>
<tr>
<td>T₁₀: SDF at 100% RDF with NF</td>
<td>1.06</td>
<td>1.64</td>
<td>139.53</td>
<td>16.14</td>
</tr>
<tr>
<td>T₁₁: SI + SA of 100% RDF with NF</td>
<td>0.83</td>
<td>1.44</td>
<td>98.38</td>
<td>10.23</td>
</tr>
<tr>
<td>SEd</td>
<td>0.05</td>
<td>0.07</td>
<td>8.08</td>
<td>0.99</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.11</td>
<td>0.14</td>
<td>16.86</td>
<td>2.08</td>
</tr>
</tbody>
</table>

T₁: alone - Urea Phosphate, All 19, SOP and Urea were used as WSF

SSDF : Subsurface Drip Fertigation  WSF : Water Soluble Fertilizer
SDF : Surface Drip Fertigation      NF : Normal Fertilizer
SI : Surface Irrigation            SA : Soil application

3.4 Total water requirement

In the present study, total water requirement under subsurface drip irrigation (SSDI) was only 1279 mm which resulted water saving of 30.73% compared to surface irrigation (1846 mm) (Table 3.). The similar results were also reported by Dhotre et al. (2008). The low water requirement under SSDI was mainly due to only a portion of the subsoil around effective root zone was wetted which might have resulted lower water requirement under subsurface drip irrigation (Khandagave, 2013).

Similarly the water requirement under surface drip irrigation (SDI) also was very much lower with water requirement of 1427 mm thus resulting water saving to the tune of
22.70% compared to surface irrigation (1846 mm) in the present study. This is in agreement with earlier findings of Esther Shekinath et al. (2013). The water saving under both SSDI and SDI was due to low application rate at frequent intervals matching the actual crop water needs at various stages. It was also observed from the present study that SSDI achieved additional water saving of 8-9% higher than SDI which indicated that SSDI was found to be superior to SDI. Similar result was reported by Khandagave (2013).

**Table 3.** Total water use and water saving under SSDI, SDI and surface irrigation in sugarcane

<table>
<thead>
<tr>
<th>Particulars</th>
<th>SSDI</th>
<th>SDI</th>
<th>Surface irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied irrigation water (mm)</td>
<td>1102</td>
<td>1241</td>
<td>1478</td>
</tr>
<tr>
<td>Effective rainfall (mm)</td>
<td>177</td>
<td>187</td>
<td>368</td>
</tr>
<tr>
<td>Total water use (mm)</td>
<td>1279</td>
<td>1427</td>
<td>1846</td>
</tr>
<tr>
<td>Water saving (%) over surface irrigation</td>
<td>30.73</td>
<td>22.70</td>
<td>-</td>
</tr>
</tbody>
</table>

SSDI : Subsurface Drip Irrigation  
SDI : Surface Drip Irrigation

### 3.5 Water use efficiency

The results of the present study have clearly indicated that both SSDF and SDF were superior to surface irrigation with soil application of fertilizers in terms of water use efficiency (WUE) (Figure 1.). The increased WUE was to the tune of 2.75 to 2.86 times higher under SSDF and 2.23 to 2.32 times higher under SDF at 100% RDF with WSF compared to surface irrigation with soil application of NF at 100% RDF were achieved in the present study. Similar results were reported by Yadav et al. (2012). Among SSDF and SDF methods, SSDF achieved an additional WUE of 23% over SDF in both the crops. This result is in agreement with findings of Dhotre et al. (2008). Increased WUE under SSDF was mainly due to better performance of the crop and increased cane yield by effective utilization of available water and nutrients that were supplied at regular intervals throughout the crop period to meet the crop demand. Subsurface drip irrigation allows uniform soil moisture, minimize the evaporative loss and delivery water directly to the plant root zone which increases use efficiency and yield (Douh et al. 2013).

In the present investigation, surface irrigation had lower WUE compared to all other treatments due to lower cane yield besides higher total water requirement. Among WSF and NF at 100% RDF, under same level of total water requirement, WSF has registered higher WUE than NF in both SSDF and SDF. This result is in conformity with findings of Deshmukh (2010). Higher WUE under fertigation with WSF was mainly due to cane yield under WSF was superior compared to NF and this has resulted higher WUE with same level of total water requirement in both SSDF and SDF.
Figure 1. Effect of SSDF, SDF and surface irrigation on total water use and water use efficiency in sugarcane

4. CONCLUSION

A field experiment was conducted to assess the performance of an alternative subsurface drip irrigation method (SSDI system) and to compare it to a surface drip irrigation method (SDI system). It was experimentally observed that the cane and sugar yields were always significantly higher with the SSDI system than with the SDI system. It has been also tested that the SSDI system has improved the irrigation water use efficiency in comparison with a SDI system. The SSDI system provided relevant yield increases for the same irrigation water use and fertigation. In this experimental research, water savings up to 30.73% have been achieved with this new irrigation method (SSDI). The increase in yield and water savings experimentally observed in the SSDI system could be due to the absence of water losses caused by evaporation from the soil and the better water redistribution in the wet bulb.

The fertigation levels and source of fertilizers have proved to be a very significant factor affecting crop yield, in terms of both cane and sugar yield. SSDF at 100% RDF with WSF and SSDF with 75% RDF with WSF + 25% RDF with NF treatments provided very similar results. However, in the most restrictive treatment (SSDF at 100 and 75% RDF with NF) the yield was significantly reduced. The results found in this work seem to indicate that the use of the new SSDI systems together with the fertigation of fully water soluble fertilizers (100% RDF) could be a recommendable option to save water in areas where water resources are particularly scarce without compromising the crop yield. The new subsurface drip fertigation method has many advantages and is easy to install. For this reason, its expansion could contribute to relevant water savings in areas where water is especially scarce.

REFERENCES


