Subsurface Drip Irrigation for Alfalfa

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Abstract

A field study on suitability of using subsurface drip irrigation (SDI) for Alfalfa provided some answers to questions of alfalfa producers of western Kansas. The results are from the first year of observation and the study will require continuation to arrive at definite conclusions. The treatments in the study included placement of drip tapes at (a) 1.5 m spacing at 0.46 m and 0.30 m depth, (b) 1.0 m spacing at 0.46 and 0.30 m depth, (c) 0.76 m spacing at 0.46 m depth, and (d) a center pivot sprinkler irrigated plot seeded to alfalfa at the same time. Emergence of seedlings was adversely affected at 1.5 m spacing showing 'striping'. The total yield for the season was slightly reduced for tape spacing of 1.5 meters. During the hot dry cycles in the growing period, one could visualize the location of drip laterals at 1.5 m spacing from the color and bloom setting of the plants farthest from the tape. July harvest for the treatment with 1.5 m spacing at 0.46 depth of placement produced the lowest yield of the year. The total yields for the year were slightly reduced for spacing of 1.5 meters. The depth of placement (0.46 and 0.30 m) produced similar yields.

Keywords: subsurface drip, SDI, alfalfa

Introduction

Alfalfa was grown on more than 85,000 ha in southwest Kansas (24 counties) in 1996 (KWO and KDA, 1996). The net irrigation requirement of alfalfa exceeds the pumping allocation of 610 mm in most of the years in water short western Kansas. Alfalfa is the highest water user. K-State research has shown the advantages of SDI and its suitability for field crops like corn (Lamm et al, 1998). The application is efficient at eliminating losses and the distribution is uniform. These research studies indicate that it is possible to save 25% of total water in a season by using SDI (Lamm and Trooien, 1999). SDI is an emerging technology in the Great Plains of the USA. However, knowledge gap exists for use of SDI for alfalfa in the Great Plains. The objective of this study was to,

- Demonstrate the use of SDI for alfalfa in a cooperator's field,
- Measure alfalfa dry matter yields at various SDI spacing and depths,
- Compare to nearby sprinkler irrigated alfalfa yield seeded at the same time, and
- Measure soil water content midway between drip lines to observe the distribution of water in the soil.

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Methods and Materials

SDI was established on a grower field in the corner of a center pivot irrigated cornfield. The field is located south of Garden City, Kansas, in the sand hills south of the Arkansas River valley. The soil belongs to Otero-Ulysses complex with undulating slopes. The soil texture for this particular field falls in the category of sandy loam. This particular field had been previously leveled for flood irrigation. The drip tubes were plowed in using a deep shank and a tube guide in September 1998. The treatments were placement of drip laterals at,

- 1.5 m spacing by 0.46 m depth
- 1.5 m spacing by 0.30 m depth
- 1.0 m spacing by 0.46 m depth
- 1.0 m spacing by 0.30 m depth
- 0.76 m spacing by 0.46 m depth, and
- Check treatment, nearby center pivot system.

Nelson[2] 7000 path drip tape of 22-mm diameter and 0.61 m emitter spacing was installed in the fall of 1998. The emitter flow rate is 1.4-liter hr^{-1} per emitter at 55 kPa. A 200-mesh rotary disk filter with semi-automatic flush system manufactured by Rain Bird was installed for filtration. Alfalfa was seeded at 0.15 m spacing soon after installation of the system to avoid delay in planting season. The seedbed was relatively dry and irrigation was applied using drip before installing the flow meters. So, actual water application could not be recorded. Later, Fluidyne vortex flow meters operated by 12-volt DC batteries were installed along with a solar panel for continuous recharging. The meters were installed soon after, and an application of 19mm additional water was recorded during the fall.

Seed germination showed distinct lines indicating where the drip tapes were buried in the plot, especially for the wider spaced drip placements. A rain amounting to 7mm in late September helped germination of the remaining seed. However, some of these late seedlings failed to survive since they were not well established before the winter. As a result, a 'striping' effect was visible. The owner of the field re-seeded in early spring of 1999. There may have been some benefit for the lower end of the field, but no significant change of plant stand was visible.

Four samples of one square meter each were cut to obtain dry matter yield from each plot. The harvest samples were hand clipped. The harvest spot was randomly selected across the block. The cool wet spring created little demand on irrigation and the likelihood of any yield response to irrigation was absent, and as such samples were not collected for the first harvest. The 1999 season started with a relatively wet spring. Earlier growth was supported by rainfall. Irrigation was started on 1st of July. Gypsum block soil water sensors were installed at mid point between two laterals to represent the farthest point from the wetted line. The midpoint was chosen to represent the worst-case

[2] Manufacturer and product names are presented for information to the reader and do not imply endorsement of any products by the authors nor criticism to products not mentioned.

scenario from the standpoint of water availability but provides an idea as to the spread of water. The depth of placement was at 0.30 m, 0.60 m, and 0.90 m below the soil surface. The irrigation control valve for each treatment was manually operated and a water pressure of 55 kPa was maintained. Irrigation application was stopped when desired depth applied. Minor fluctuations occurred in the depth of application due to the nature of the control being manual. Interval of irrigation depended on the irrigation timing decided by the producer to coincide with the main field crop of the quarter section irrigated from the same well.

Results

The total water account from July 1 through September 29 amounted to,

- Irrigation:
    - SDI - 343 mm
    - Sprinkler- 503 mm
- Rainfall: 152 mm
- Estimated modified Penman ET: 526 mm

Total dry matter yields for the SDI treatments for 1999 are shown in Figure 1.

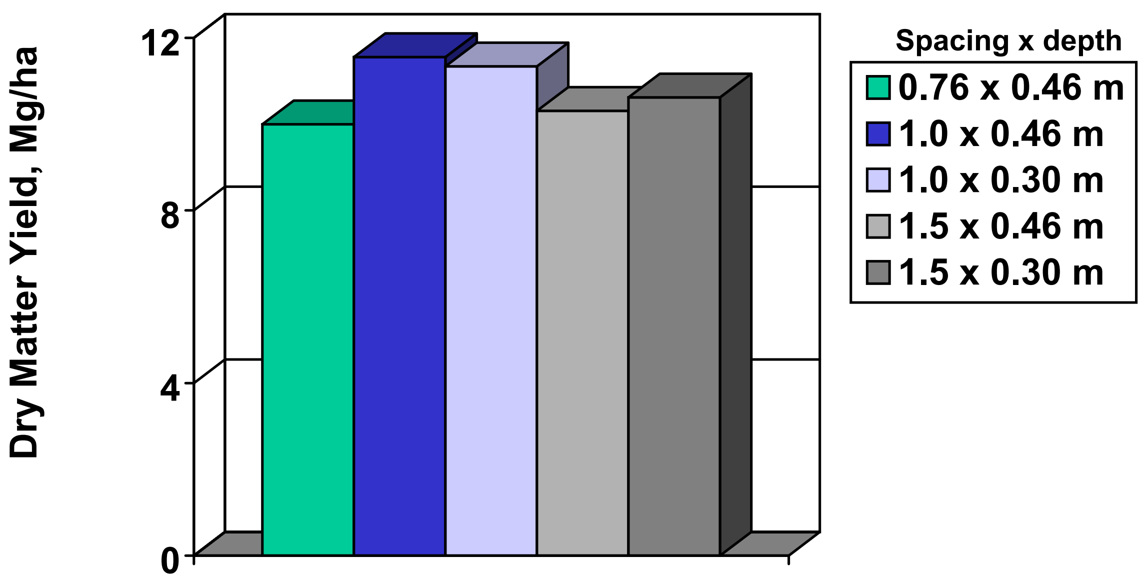

Figure 1. Total Dry Matter Yield of SDI Treatments for 1999

The yield of sprinkler-irrigated field is not included in this chart since we missed two harvests. The highest yield was 11.56 Mg ha^{-1} for the treatment of 1.0 meter drip lateral spacing with 0.46 meter depth of placement.

Figure 2 shows the dry matter yield as affected by spacing. Spacing of drip laterals at one meter showed a slight advantage over one and half meter spacing in this study. The yield difference between the two was 0.98 Mg ha^{-1}.

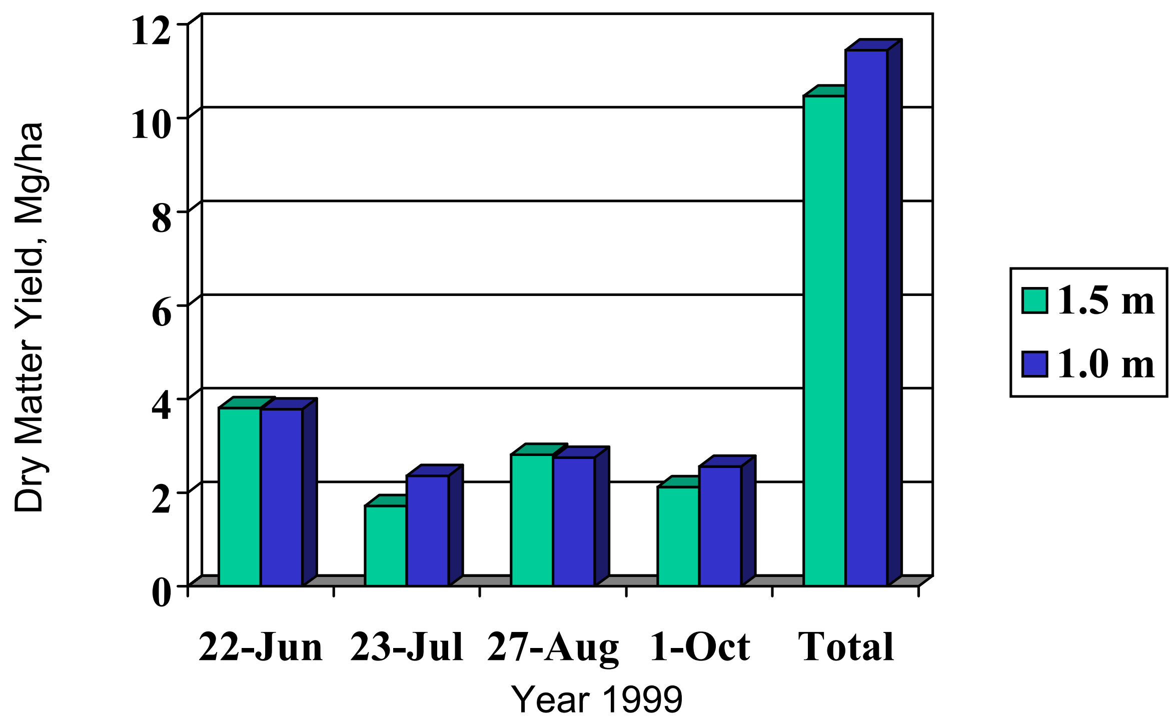

Figure 2. Dry Matter Yield as affected by Drip tape Spacing

The dry matter yield response to depth of placement of the drip laterals was similar, about 11 Mg ha^{-1}.

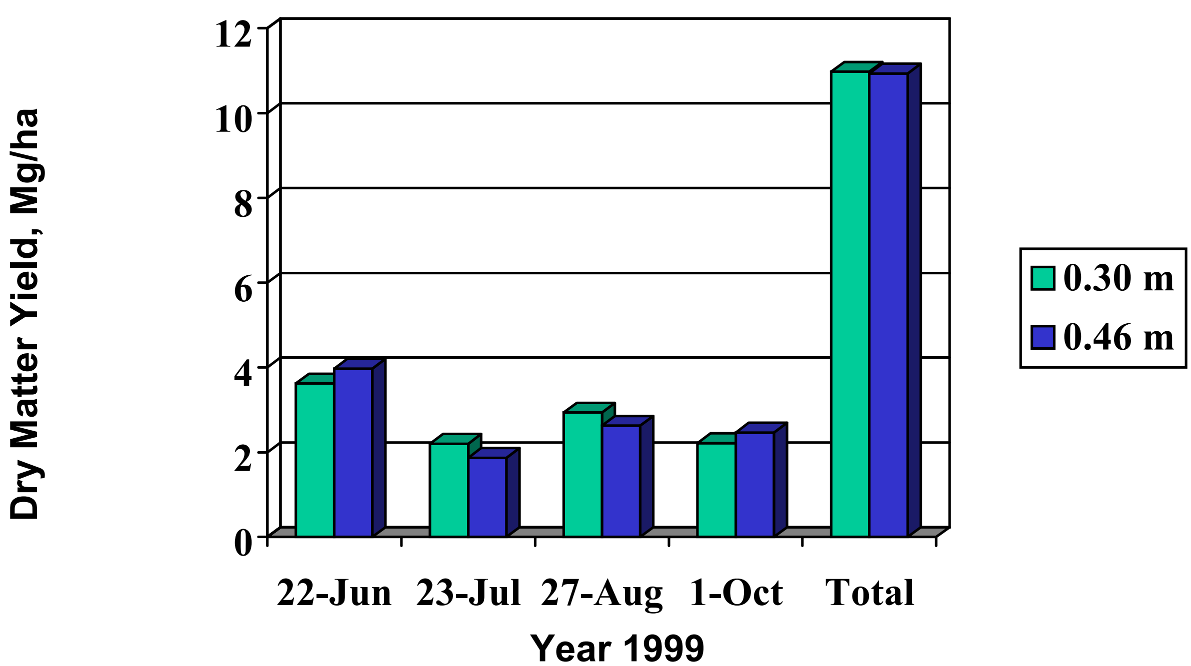

Figure 3. Effect of Drip Tape Depth on Dry Matter

Dry matter yield of each individual harvest for all treatments is shown in Figure 4. The yield for treatment of 1.5 m spacing with 0.46 m drip depth produced lowest yield during the dry hot period of the season, June-July, harvested on July 23rd. Dry matter yield data from center pivot sprinkler irrigated field was available for August 27th and October 1st.

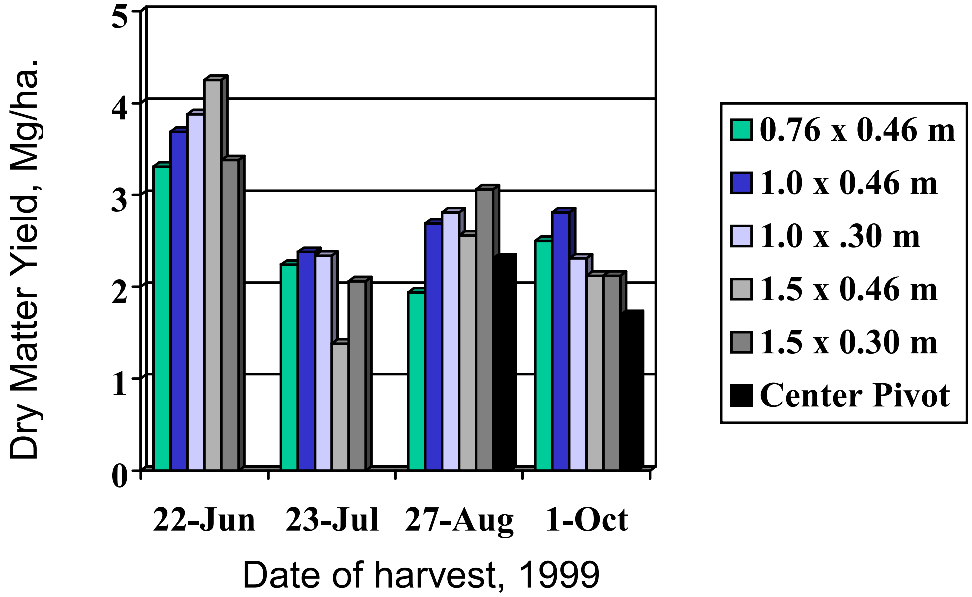

Figure 4. Effect of treatments on dry matter harvest for the growing season

The soil water readings from the gypsum blocks for 1.5 m spacing at 0.46 and 0.30 m depth placement are presented in figure 5 and 6. Soil water was always low at the mid-point between the drip tape laterals at 1.5 m spacing with depth of placement at 0.46 m, Figure 5.

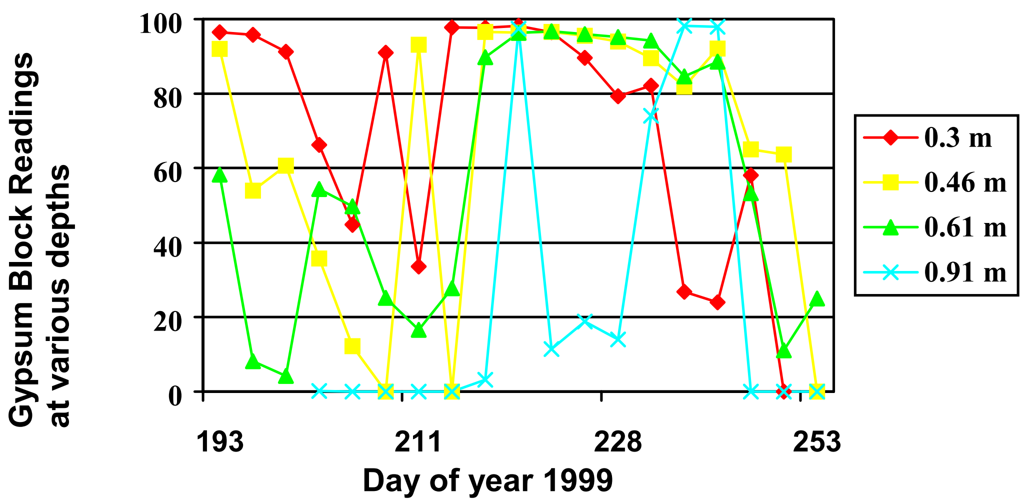

Figure 5. Soil water readings from gypsum block at a mid-point between tapes for 1.5 spacing by 0.46 m depth.

The data presented are the readings from the gypsum blocks placed at different depths, which were read by use of a meter. A reading of zero indicates zero available soil water or a depletion of hundred percent, whereas, a reading of 99 indicate 99% available water with very little depletion. These data indicate how well the water reached midpoint between the tapes. A rainfall of two inches on day 214 of the year (August 2) shows up as increased meter reading indicating a bounce back to higher available soil water content.

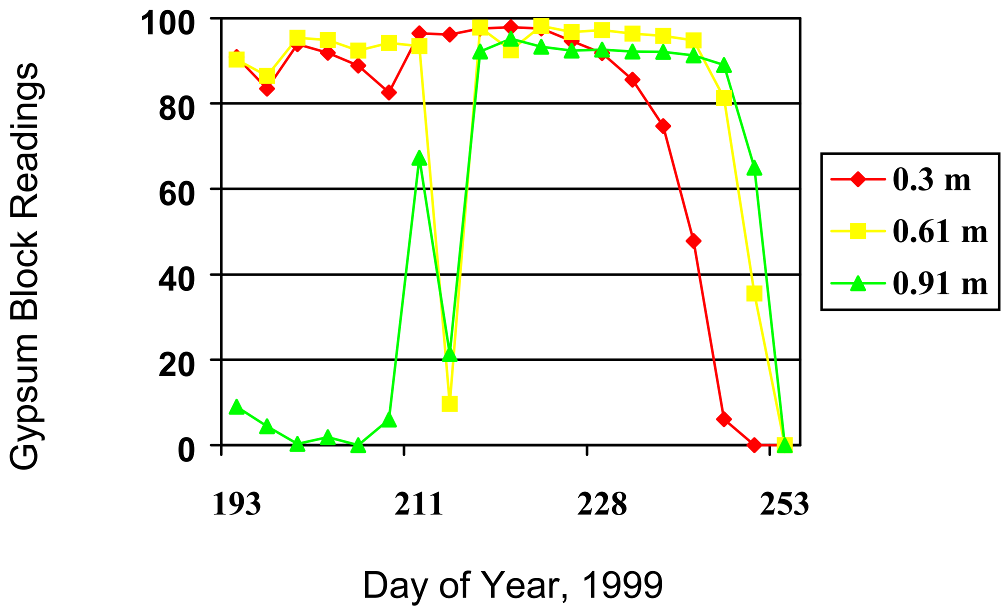

Figure 6. Soil water reading for drip tape spacing 1.5 m by 0.30 m depth, Gyp. Block at different depths at midpoint from tape.

The shallower placement at 0.30 m depth however improvement in lateral distribution for the soil type (sandy loam) as seen in Figure 6.

Conclusion

The data presented represents the first year of the study. The emergence was adversely affected at 1.5 m spacing. We observed some "striping" at emergence in the first year during the establishment period. Yields were slightly reduced for spacing of 1.5 m. Depth of placement of drip laterals did not affect the yield. Yields were similar for depths of 0.30 and 0.46 m. The long-term yield differential may provide a more definite answer for the most appropriate spacing and depth of SDI for alfalfa in western Kansas.

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