SUBSURFACE DRIP IRRIGATION FOR ALFALFA IN KANSAS

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ABSTRACT

The result from a two year field study on suitability of using subsurface drip irrigation (SDI) for Alfalfa provided some answers to alfalfa producers of Kansas. The study was set-up in a producer field for demonstration. The soil belongs to Otero-Ulysses complex and sandy loam in texture. The treatments included placement of drip tapes at (a) 1.5 M spacing at 0.46 and 0.30 M depth of placement, (b) 1.0 M spacing at 0.46 and 0.30 M depth, (c) 0.76 M spacing at 0.46 depth, and (d) a center pivot sprinkler irrigated plot seeded to alfalfa. Emergence of seedlings was adversely effected at 1.5 M spacing of drip tapes showing 'striping'. The total yield was reduced for spacing of drip tapes at 1.5 M in both 1999 and 2000. The depth of placement of the drip tapes (0.46 and 0.30 meters) showed no effect on yields.

INTRODUCTION

Alfalfa was grown in 110,000 Ha in western Kansas in 1998 (Kansas, 1999) which, showed an increase of eleven percent from the year before. The net irrigation requirement of Alfalfa exceeds the pumping allocation of 610 mm in most of the years in water short western Kansas. Total diversion need for alfalfa is the highest. A study in California reports 22 to 35% increase in alfalfa yield by subsurface drip irrigation as compared to furrow irrigation (Hutmacher et al., 1992). Alfalfa growth is reduced by water stress which occurs during hay-cutting, drying, and baling. Use of SDI may allow irrigation to continue below the surface during harvest or right after harvest to help start a quick regrowth. The critical stage of water need for alfalfa is after harvest when the crop starts regrowth. Immediate regrowth of alfalfa helps compete with any surface germinated weeds. Subsurface drip irrigation reduces surface wetting which helps cut down the competition from annual weeds that may germinate due to surface wetting from sprinkler irrigation. Alfalfa yield can also be improved by eliminating scalding of leaves that may occur from water left ponded on the surface of the alfalfa leaves after sprinkler irrigation during hot weather (Henggeler, 1995).

Kansas State University research has shown advantages of SDI and its suitability for field crop like corn. The application of water is uniform and efficient eliminating losses. These researches indicate that it is possible to save 25% of total water in a season by using SDI (Lamm et al,. 1995). Subsurface drip irrigation, however, is an emerging technology for the Great Plains of the USA. This technology need to be studied for it's suitability to raise alfalfa crop. The objective of this study was to,

- ☐ Demonstrate the use of Subsurface Drip Irrigation 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 at the midway between drip tapes to observe the spread of water.

METHODS AND MATERIALS

Subsurface drip irrigation for alfalfa was established at a grower field in the corner of a center pivot sprinkler irrigated corn. 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 largest component of the expense for a SDI system is the cost of the drip tube. The closer the drip tapes laterals, the more is the quantity required to cover an acre of ground. The treatments were placement of drip lateral 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
- obtain dry matter yield from nearby center pivot, seeded to alfalfa at the same time

Nelson[1] 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 provided by Rain Bird was installed for filtration.

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

Alfalfa was seeded at 0.15 m spacing soon after installation of the system to avoid delay in planting season. The seed-bed was relatively dry and irrigation was applied using drips before installing the flow meters. So, actual amount could not be recorded. Later, Fluidyne vortex flow meters operated by 12 volt DC battery 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 results form each plot. The harvest samples were hand clipped. The harvest spot was randomly selected across the block.

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 furthest point from the wetted line. The depth of placement was at 0.30 m, 0.60 m, and 0.90 m below the soil surface. This midpoint location was chosen to represent the worst case scenario from the standpoint of water reaching the furthest point which would provide an idea on the spread of water.

Results

1999

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

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

Dry matter yield for 1999 are presented in Table 1.

Table 1: Alfalfa yield of subsurface drip and sprinkler irrigated plots.

Date of Harvest, Dry Matter Mg/ha^{-1}						
Treatment	**22-6-99**	**23-7-99**	**27-8-99**	**1-10-99**	**Total**	**Total B***
1.5 M space(S) by 0.46 M depth(D)	4.25	1.38	2.56	2.12	10.31	4.68
1.5 M (S) by 0.30 M(D)	3.38	2.06	3.06	2.12	10.62	5.18
1.0 M (S) by 0.30 M(D)	3.88	2.34	2.81	2.31	11.34	5.12
1.0 M (S) by 0.46 M(D)	3.69	2.38	2.69	2.81	11.57	5.50
0.76 M(S) by 0.46 M(D)	3.31	2.24	1.94	2.5	9.99	4.44
Sprinkler (Center Pivot)	---	---	2.31	1.69	---	4

* Total B - Total for last two (2) harvests.

First two harvest for center pivot is missing. The comparison for corresponding total yields for last two cuttings indicate a lower yield for sprinkler irrigated field. The highest yield was 11.57 Mg^{-1} ha for the treatment of 1.0 meter drip lateral spacing with 0.46 m depth of placement.

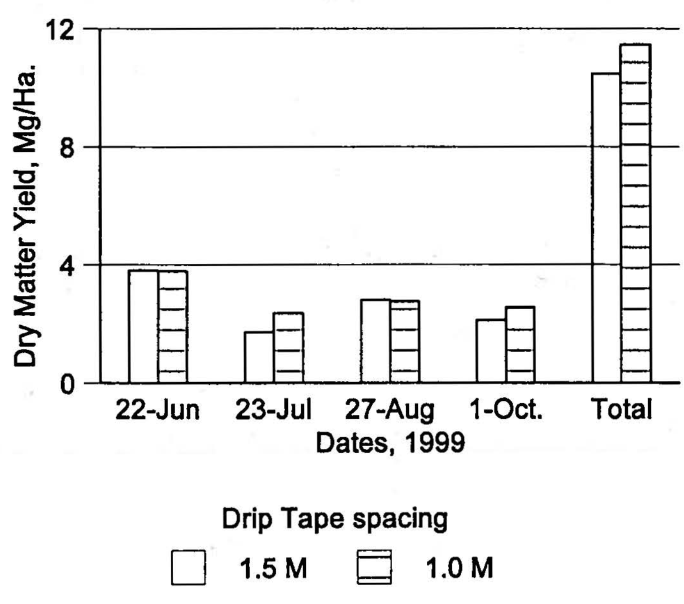

Fig. 1 Dry Matter Yield as affected by spacing

Figure 1 shows the dry matter yield as effected by spacing. Spacing of drip laterals at one meter showed a slight advantage over one and half meter spacing in this study. The differences between two was 0.98 Mg ha^{-1}in 1999.

The depth of placement of the drip laterals were similar for dry matter yield, Fig. 2. Yield for both depth were about 11 Mg ha^{-1}.

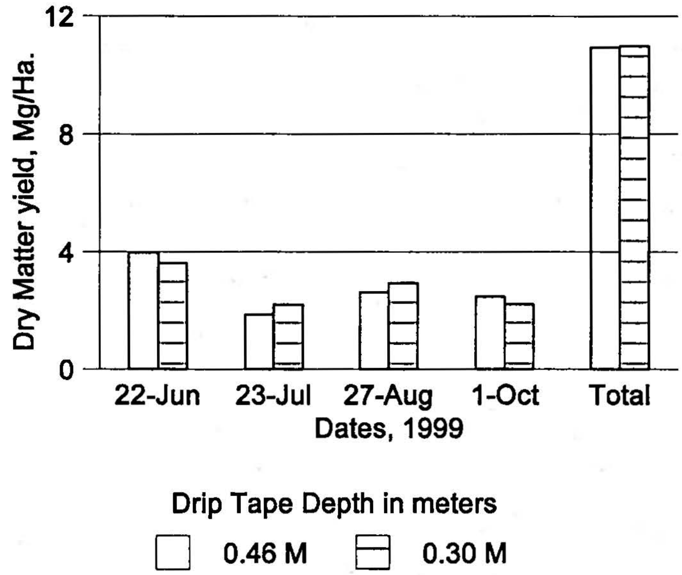

Fig. 2 Dry Matter Yield as affected by the depth of drip tape placement

Gypsum block readings for soil water distribution to the mid-point between drip tapes at 1.5 M spacing placed at 0.46 M below the surface are presented in Fig.3 for 1999.

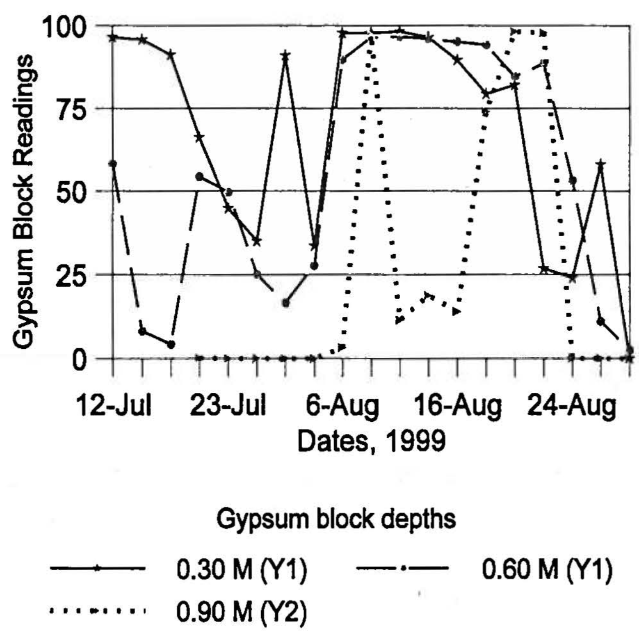

Fig.3 Gypsum block readings at mid-point between drip tapes at 1.5 M spacing

Soil water was always low at the midpoint between two drip tapes for the plot with drip spacing at 1.5 m and the yield was lower. A "stripping" appearance was visible for the 1.5 spacing during the growing season as well. Water distribution from the 1.5 spacing did not reach the midpoint between the tapes at the 0.90 m soil depth until a rain of 50 mm on early August, Fig. 3. However, tape placement at 0.30 m depth for the 1.0 spacing provided a better water distribution for soils at 0.30 m and 0.60 m depths from the beginning of the season, and improved for soils at a 0.9 m depth within a short period (Fig. 4). Irrigation application amount was maintained at the same level for all treatments.

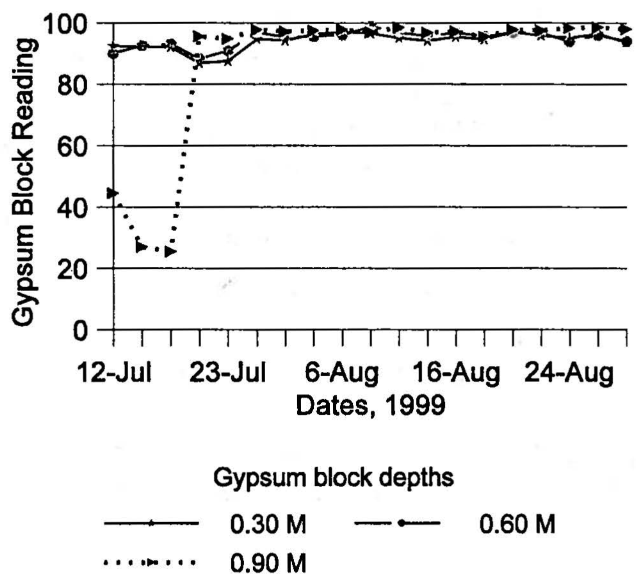

Fig. 4 Gypsum block readings at mid-pont between drip tapes at 1.0 M spacing.

Results for <u>2000</u>

Water applied May 10, 2000 through September 21, 2000

- Irrigation by
    - SDI: 493-635 mm
    - Sprinkler: 644 mm
- Rainfall: 140 mm
- Estimated modified Penman ET: 1060 mm

Dry matter yields of individual harvests within the season including those from the sprinkler-irrigated center pivot field are presented in Table 2 for 2000.

Table 2. Dry Matter yield of subsurface drip and sprinkler irrigated alfalfa for 2000.

Date of Harvest, Dry Matter Mg/ha^{-1}						
Treatment	22-5-00	23-6-00	28-7-00	25-8-00	26-9-00	Total
1.5 M space (S) by 0.46 M (D) depth	5.25	3.51	4.11	2.56	2.48	17.9
1.5 M (S) x 0.30 M (D)	4.88	3.26	3.19	2.53	2.24	16.1
1.0 M (S) x 0.46 M (D)	5.4	4.26	3.9	3.14	2.71	19.4
1.0 M (S) x 0.30 M (D)	5.86	3.65	4.61	3.10	3.02	20.2
0.76 M (S) x 0.46 M (D)	6.06	3.62	3.55	2.91	2.85	19.0
Sprinkler (Center Pivot)	3.65	4.47	4.32	3.56	2.84	18.8

Dry matter yield as affected by spacing and placement depth of the drip tapes for the year 2000 are presented in Fig.5 and 6. The results are similar to the previous year. The drip tape spacing of 1.0 M yielded about 3 tons ha^{-1} more when compared to drip tape spacing of 1.5 M. The depth of placement at 0.30 or 0.46 M produced similar yield.

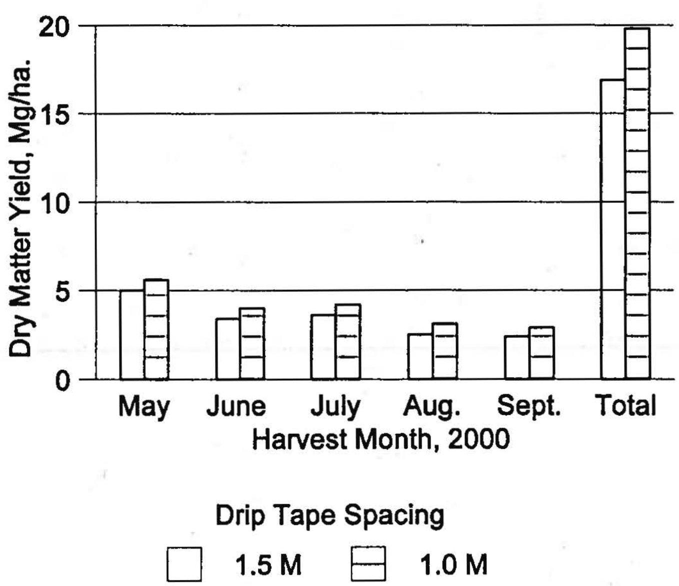

Fig. 5 Dry Matter Yield s affected by drip tape spacing.

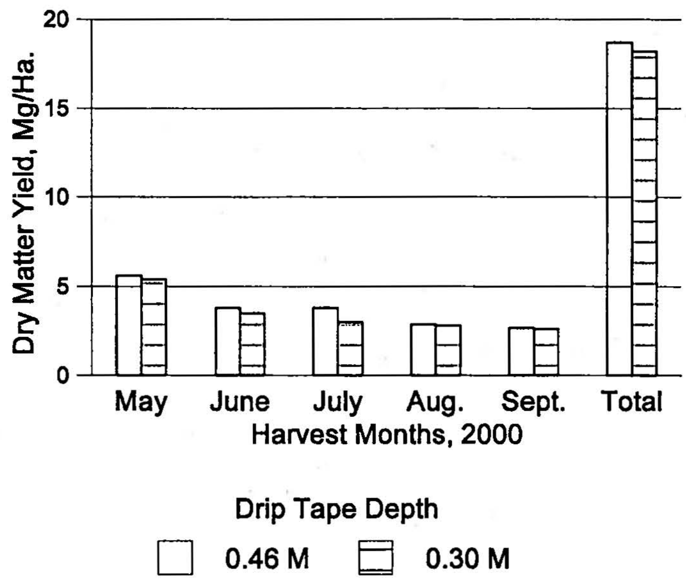

Fig.6 Dry Matter Yield as affected by drip tape placement depth

A similar pattern of water distribution is observed in the year 2000. (Figs. 7 and 8). Distribution somewhat improved for 1.5 m spacing with the increase in frequency of irrigation starting mid July. The hot and dry summer necessitated the increase of frequency of irrigation to 3 times a week.

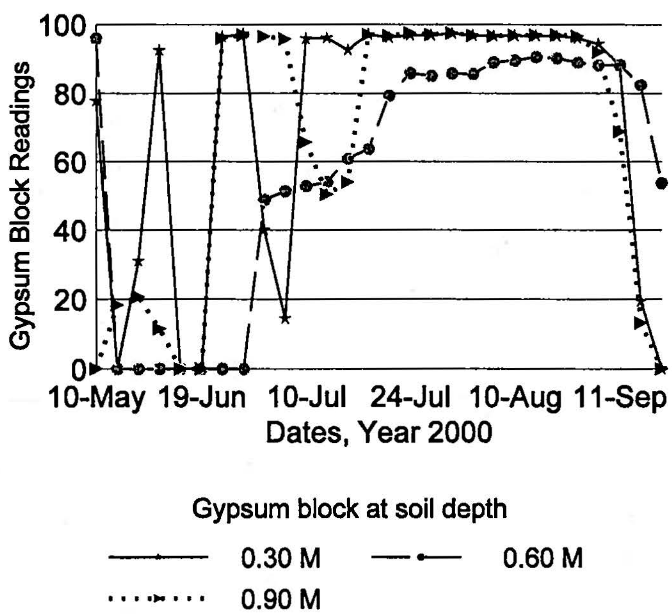

Fig.7 Gypsum Block Readings at mid-point for drip spacing of 1.5 M

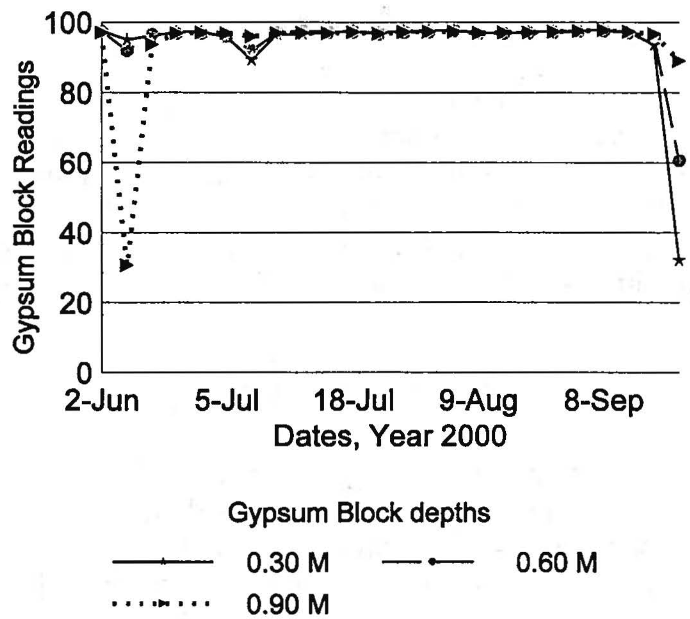

Fig. 8 Gypsum Block Readings at mid-point drip tapes at spacing of 1.0 M

Data presented in the figures for soil water status are the readings of the meter. A reading of zero indicates zero available soil water or a depletion of 100%. The meter readings are presented for simplicity to show the seasonal changes of soil water content and replenishment from irrigation and rainfall. A chart of conversion is given at Table 3 for interpretation of the meter readings in terms of soil water status.

Table 3: Interpretation of Meter Reading to Soil Water

Meter Reading	Available soil water %	Comments
99 to 95	100 to 85	0 to 15% depletion
95 to 85	85 to 70	15 to 30% depletion
85 to 75	70 to 60	30 to 40% initiate irrigation for light soils
75 to 60	60 to 50	40 to 50% initiate for heavy soils
60 to 40	50 to 40	50 to 60% caution
40 to 20	40 to 20	60 to 80% dry
20 to 0	20 to 0	80 to 100% depletion
Negative numbers	None available	Block may lose soil contact

CONCLUSION

Alfalfa seedling emergence was affected adversely at the 1.5 m spacing for this sandy loam soil. We observed some "striping" at emergence in the first year during the establishment period. Yields were reduced slightly for the spacing 1.5 m. Depth of placement of drip tapes did not affect the yields; they were similar for depths of 0.30 and 0.46 m. The second year observation showed similar results, although increasing the frequency of irrigation by SDI reduced striping appearance.

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