DRIP IRRIGATION OF ALFALFA

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INTRODUCTION

The Treasure Valley of Idaho produces many diversified and specialized crops. The primary irrigation systems are furrow and sprinkler irrigation. Imperfect irrigation often results in loss of crop yield and quality through water stress, or excessive irrigation that favors diseases. Irrigation induced erosion causes sediment, phosphate, and temperature contamination in surface waters and deep percolation causes nitrate contamination in groundwater. For these and other reasons, in recent years there has been increased interest in using drip irrigation on Treasure Valley crops.

Some of the most advanced irrigation technology is drip irrigation. Drip irrigation is the slow, frequent application of small amounts of water to the soil through emitters located on a delivery line placed either on top of, or beneath the soil surface. Drip allows for highly productive crop production without leaching or runoff. Only the amount of water needed by the crop on a daily, or other very frequent basis need be diverted from a stream or reservoir, thus helping to protect water quality.

BENEFITS OF DRIP IRRIGATION

- Increased water and nitrogen use efficiency
- Reduced water percolation through the root zone
- Reduced runoff from the tail end of gravity irrigated fields
- Reduced evaporation from the soil surface
- Increased water distribution uniformity throughout a field
- Reduced energy usage
- Reduction of moisture stress to plants

In my view, two of the greatest benefits of drip irrigation are increased water and nitrogen use efficiency (WUE and NUE). In unpublished research conducted from 2003 to 2007, I was able to demonstrate an increase in NUE and WUE in drip irrigated Treasure Valley onion fields as compared to furrow irrigated onion fields. Over the five year period of this project, the furrow irrigated fields averaged 46.9 inches of applied water per acre, while the drip irrigated fields received an average of 30.1 inches of water per acre, a difference of nearly 17 inches. The furrow irrigation system produced an average of 22.3 Cwt of onions per inch of applied irrigation water while the drip irrigation system produced an average of 33.1 Cwt per inch of applied water. In the same study, the drip irrigated onion fields were more efficient in the use of nitrogen. Over the five years of this project, the furrow irrigated onions received an average of 275 pounds of nitrogen per acre (0.52 lbs N/Cwt) while the drip irrigated onions received an average of 162 pounds of nitrogen per acre (0.42 lbs N/Cwt).

LIMITATION OF DRIP IRRIGATION

- High initial investment cost with a smaller recurring annual cost
- Steep learning curve compared to other irrigation systems

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- Additional novel equipment is required to convert to drip irrigation
- Initial drip irrigation design and service is highly recommended
- Drip tape recycling for annual systems is burdensome
- Gophers can cause significant damage to the system when used for perennial crops

Drip irrigation also has some drawbacks, it is not for everyone. If you choose to install a drip system for some of your crops you must make sure to take proper care of the system to insure its long term viability. If you plug the emitters on a drip system, there are not many options available for fixing it. As you irrigate, you will most likely need to treat your irrigation water to lower the pH. This can usually be done with acid based fertilizers. You will need to flush fine sediment from the system on a regular basis so the emitters do not become plugged. You will need to monitor the flow rates and pressures regularly to insure the system is performing the way it was designed. If these, and other measures, are not adequately addressed it is likely your experience with drip irrigation will be troublesome.

DRIP IRRIGATION IN ALFALFA SEED

In the spring of 2001 an eight acre subsurface drip irrigation (SDI) system consisting of two four acre blocks was installed in a one year old alfalfa seed field in Canyon County. Ten mil dripperline was shanked into the field to a depth of approximately 12 inches on 44 inch centers. Emitters in the tape were 18 inches apart and delivered 0.36 gallons of water per hour per emitter. The water source was groundwater filtered with sand media filters.

Water use and yield data were collected from the SDI field in 2001 and 2002. In 2001, 8.5 inches of water was applied to the SDI field, and in 2002 10.9 inches of water was applied to the SDI field. During the same years, a furrow irrigated field of alfalfa seed received between 30 to 35 inches of water. In 2001, the clean seed yield was 880 pounds per acre on the SDI field and 820 pounds per acre on the furrow irrigated field. Seed yield in 2002 on the SDI field was 1018 pounds of seed. Two years of system operation show that SDI uses water very efficiently in alfalfa seed. In this project we maintained seed yields while using considerably less water than with furrow irrigation.

As mentioned earlier, gophers can cause significant damage to drip systems in perennial crops, especially alfalfa. In the spring of 2002 the drip system had many leaks caused by overwintering gophers. Many hours of repair work was required to fix approximately 150 gopher strikes to the drip tape. Additionally, the water distribution uniformity of the system and ultimately seed yield were negatively impacted by the gophers.

DRIP IRRIGATION IN ALFALFA HAY

In the summer of 1995, an SDI system consisting of 18 plots was installed and planted to alfalfa hay at Lovelock, Nevada. Nine plots on one end of the field were irrigated with dripperline placed at 18 inches in depth and spaced 36 inches apart. Individual emitters were 24 inches apart along the dripperline with each emitter having a flow rate of 0.62 gallons per hour. Nine plots on the other end of the field were established using the same materials and spacing except the tape was placed at a 12 inch depth (Figure 1). Three irrigation treatments of 75, 100 and 125 percent of measured evapotranspiration (ET) were randomly located within each side of the SDI field.

Irrigation with the SDI system was scheduled weekly based on readings taken at the field from an ET Gage Atmometer. An atmometer is an irrigation scheduling device designed to estimate evapotranspiration from the canopy of an alfalfa crop. Readings were taken every few days and then averaged over the time period between two readings to estimate the daily ET rate. The daily ET rate was then multiplied by 0.75, 1.00, and 1.25 respectively to determine irrigation application rates. The flow rates were determined for each set of six plots and an irrigation controller was programmed to apply the correct amount of water for each treatment. Plots were irrigated twice daily starting at 6:00 a.m. and 6:00 p.m.

The SDI system was shut down before yield samples were taken at harvest and remained off until the producer removed the bales from the remaining plot area. Yield samples were taken with a plot-harvesting machine three times a year prior to each cutting. The area sampled was taken from the center of each plot and was 3' wide and 20' long. The forage from the plot was immediately raked and weighed. Grab samples from each plot were bagged to determine moisture percentage of each sample by drying in a soil oven at 105 degrees Fahrenheit for 24 hours.

Maintenance operations on the system were performed after startup in the spring, after each cutting, and at shutdown in the fall. To reduce the growth of algae in the system, the pH of the water was first lowered to approximately 5.0 with sulfuric acid during each maintenance operation. Then, twelve percent chlorine was injected downstream of the acid injection point at a concentration of 50 parts per million total chlorine (ppm). This solution was allowed to fill the system and then flushed out after about 12 hours. The irrigation clock was then reprogrammed to start irrigating again. In late October just before the system was shut off for the winter, Treflan herbicide was injected into the system to stop root intrusion into the emitters, then all above ground equipment was drained and the laterals were blown out with compressed air.

Water Use Efficiency

Jensen and Miller (1988) conducted a study near Wadsworth, Nevada during the 1984 and 1985 growing seasons and determined that required ET rates ranged from 6.1 to 8.4 inches to produce a ton of alfalfa. Wadsworth is located approximately 60 miles southwest of the Lovelock in a similar climatic zone, making direct comparisons of water use efficiencies meaningful. WUE values on the SDI plots ranged from 1.94 to 6.65 inches per ton (rainfall included) over the 1997 growing season (Figure 2). In 1998 WUE values ranged from 2.33 to 6.08 inches of water per ton (Figure 3). The control plot wasn't included in the WUE comparisons because we weren't able to accurately quantify the amount of applied water. In both years of this study the cooperating grower used his full allotment of 3 acre-feet per acre on the control plot.

The publication entitled "Evaluation of Empirical Methods for Estimating Crop Water Consumptive Use for Selected Sites in Nevada" (1980) shows the historical amount of pan evaporation from April to the end of September is approximately 31.6 inches at Lovelock. In the same publication the Modified Penman and Blaney Criddle ET estimates are 36.7 and 41.8 inches respectively for the same time period. During the 1997 growing season, 27.9 inches of water was applied to the 125 percent ET plots, 22.5 inches was applied to the 100 percent ET plots, and 18.5 inches was applied to the 75 percent ET plots. In 1998 these values were 26.8, 22.8, and 18.6 (Figure 4). The data shows that SDI maintained acceptable production while using less water than estimated ET cited in the literature or the normal water allotment of 36" per year in the PCWCD.

Yield

The average alfalfa yield in Nevada in 1997 was 4.5 tons per acre and the average yield in Pershing County during the same time period was 5.2 tons per acre (Nevada Agricultural Statistics, 1997-98). Average yields in the SDI plots for 1997's three cuttings ranged from 7.45 to 8.07 tons per acre and the

Control plot yield was 6.80. Average yields in the SDI plots for 1998's cuttings ranged from 5.83 to 6.71 tons per acre and the Control plot was 5.83 (Figure 5). All yield values are based on a zero percent moisture basis. Nearly the entire difference in the average yields between 1997 and 1998 is attributable to the first crop of 1998. That crop received excessive rainfall and consequently had a reduced yield. Yield reductions for the first cutting of 1998 ranged from 37 to 63 percent less than the first cutting of 1997. The average precipitation from April to September at Lovelock is 2.66 inches. In 1997, precipitation at Lovelock was 2.20 inches and in 1998 Lovelock's precipitation was 11.43 inches for this time period. The precipitation amounts from May, June and July of 1998 are records that still stand today. In fact, the control plots were not even irrigated for the first cutting of 1998.

CONCLUSION

Drip irrigation is used on a variety of crops in the Treasure Valley because of the benefits it provides. Water use efficiency and other benefits found in Treasure Valley crops are consistent with research results reported in Nevada. However, in most Treasure Valley drip irrigated fields drip tape is installed in the spring and taken out in the fall prior to harvest. There are a few applications where drip irrigation is being used in perennial crops. Even though data demonstrates the benefits of drip irrigation in alfalfa hay and alfalfa seed, the gopher strikes occurring during the winter months are a very serious problem. There are some products that can be injected into the drip system to repel gophers during the growing season, but there is nothing available for use during the winter months when the most damage occurs. Until the gopher damage problem is resolved, using drip irrigation on perennial crops such as alfalfa hay or alfalfa seed is not recommended.

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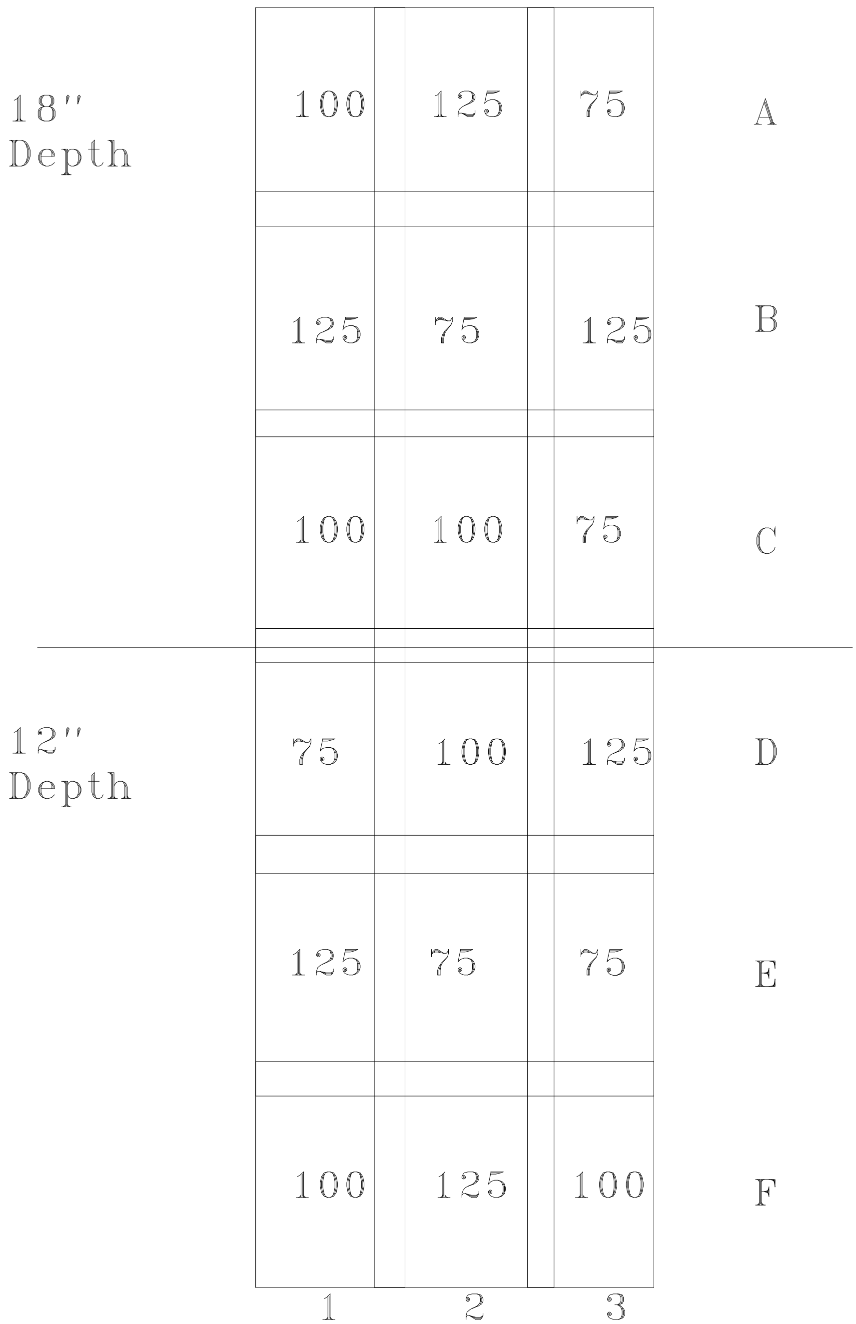

Figure 1. Plot diagram for subsurface drip irrigation of alfalfa at Lovelock, Nevada.

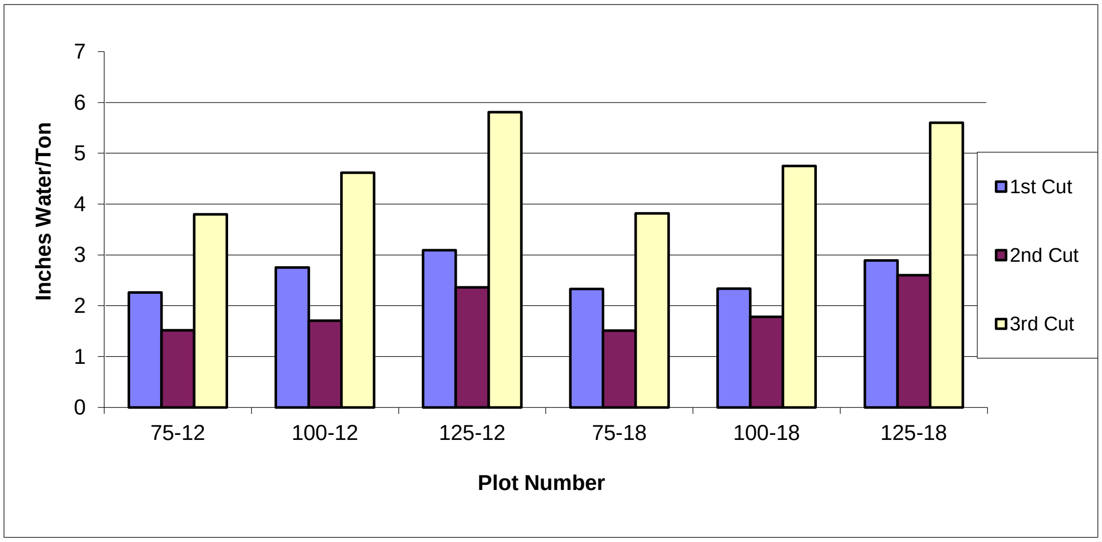

Figure 2. Amount of water used to produce one ton of alfalfa in the SDI plots in 1997 (rainfall included).

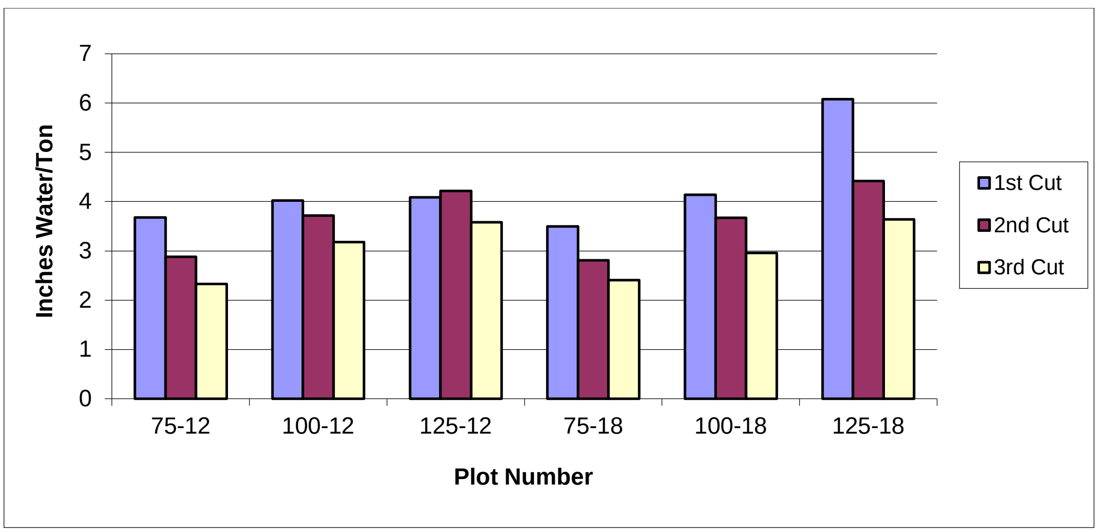

Figure 3. Amount of water used to produce one ton of alfalfa in the SDI plots in 1998 (rainfall included).

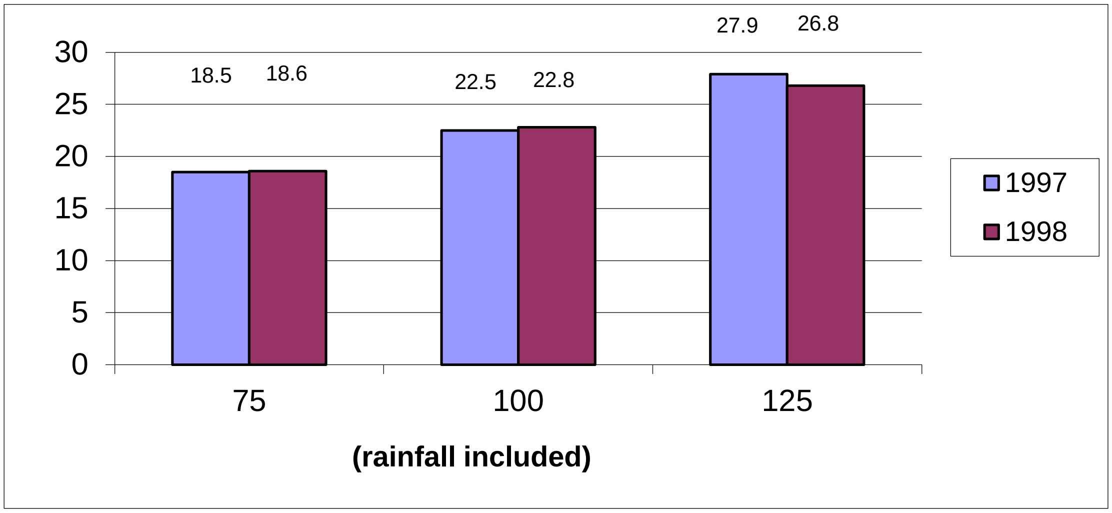

Figure 4. Total water applied to SDI plots in 1997 and 1998 (rainfall included).

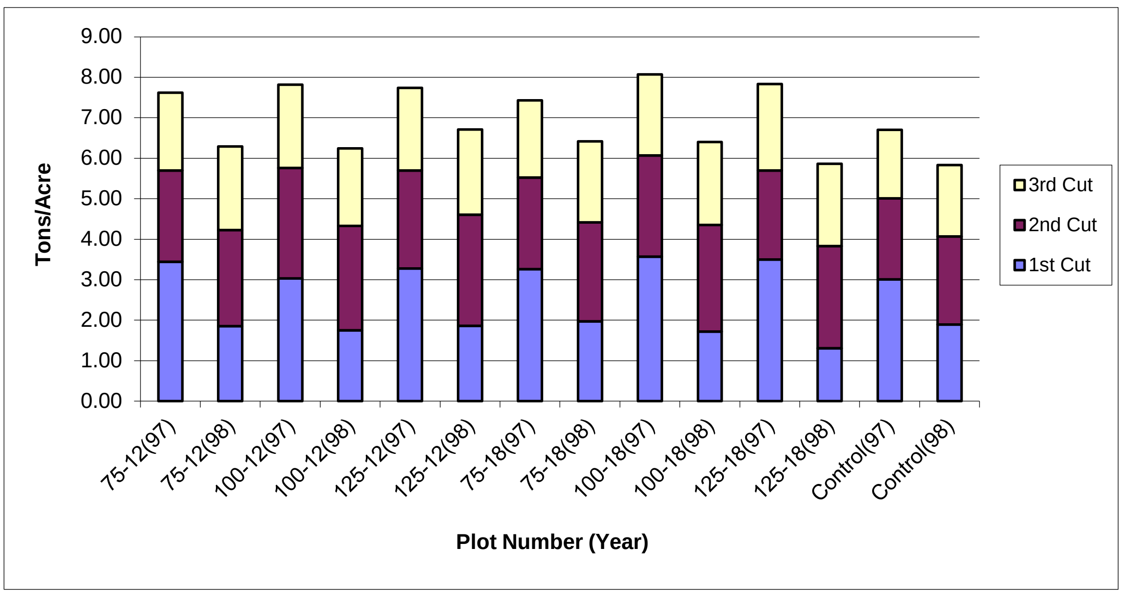

Figure 5. Yield totals for the SDI and control plots for the three cuttings of 1997 and 1998. 0 percent moisture basis.