ASSESSING THE IMPACT OF IRRIGATION MANAGEMENT STRATEGIES ON YIELD AND NITRATE LEACHING IN UPLAND COTTON PRODUCTION

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Abstract

Although the cost for water is one of the largest expenditures in a grower's budget, many growers still over-irrigate their fields to assure that there will be no yield losses. Although these over-irrigations usually do not cause any negative effect to the crop, they can cause the loss of available nitrogen to the plant and the potential of nitrate contamination of groundwater resources. To assess what impact over-irrigation may have on yield and the potential for groundwater contamination, a drainage lysimeter study was initiated at the Maricopa Agricultural Center, Maricopa Arizona. Drainage lysimeters are large steel boxes with the tops open. In this study, three lysimeters were installed. The lysimeters were 80" wide (two row widths), five feet long, and six feet deep. They were placed 18 inches below the soil surface and filled with soil as to best represent the soil in its natural condition. On April 10, cotton was dry planted and watered up. Throughout the season, water samples were taken from the lysimeters and from suction lysimeters placed in the field. Nitrogen applications were made according to field conditions and weekly petiole sampling. Irrigations were made according to field conditions and using the AZSCHED irrigation scheduling program. Treatment one was irrigated according to the schedule and amount recommended by AZSCHED. In treatment two, the timing was the same as treatment one, but the amount applied was 0.25 times more. Treatment three was also irrigated at the same time but with 0.5 times more water. Yield samples were taken at the end of the season and showed no significant differences between treatments, with yields averaging about 1100 lbs/acre of lint. The drainage amounts ranged from 4" in treatment three to 1.5 inches in treatment one. The corresponding nitrate-N losses were 33 lbs/acre for treatment three and 20 lbs/acre for treatment one. Monitoring will continue over the winter to assess the impact of winter rainfall.

Introduction

Although many cotton growers are aware of the relationship between irrigation water applied and yield, very few know how their irrigation effects nitrate losses out of the rootzone. Usually, growers know that too little water can reduce yields while too much water could cause excessive vegetative growth and a reduction in yields. However, what happens to nitrogen in the soil if too much water is applied? This paper discusses an ongoing project to study the interaction between irrigation strategy and the loss of nitrate below the rootzone in cotton production.

Materials and Methods

In the Spring of 1994, three large, stainless steel drainage lysimeters were constructed and placed into the ground at the Maricopa Agricultural Center, Maricopa, AZ. The drainage lysimeters are large steel boxes with the tops open. The lysimeters used in this study were 80" wide (two row widths), five feet long, and six feet deep. At the site of lysimeter placement, the soil was removed, layer by layer, and separated into individual piles. Once all of the soil was removed, the lysimeters were set in place, approximately 18 inches below the soil surface and filled with soil, again layer by layer, as to best represent the soil in its natural condition.

This study consisted of three treatments: 1) Irrigation water applied based on AZSCHED recommendations and soil moisture readings; 2) One and 1/4 times the application of treatment one; 3) One and ½ times the application of treatment one. Thus, when treatment one called for 4 inches of water to be applied, treatment two received 5" (4*1.25) and treatment three received 6" (4*1.5). Each treatment was replicated four times with one plot in each treatment containing a drainage lysimeter. The nitrogen applications were made based on University of Arizona recommendations using preseason soil sampling and in-season petiole sampling.

On April 10, cotton was dry planted and watered up. Each plot consisted of four rows. Throughout the season, water samples were taken from the lysimeters. Nitrogen applications were made according to field conditions and weekly petiole sampling. Irrigations were made according to field conditions and using the AZSCHED irrigation scheduling program. The field was irrigated using gated pipe and a flow meter to monitor the total amount of irrigation water applied. At the end of the season, yield data were collected using scales and a weigh wagon. Two rows from each plot were harvested and weighed. Sub-samples of seed cotton from each plot were ginned to determine lint percent.

Results and Discussion

The total amount of water applied to each treatment is shown in Table 1. The amount of water applied to each treatment remained the same until layby (July 19). Before this time, approximately 4" of water was applied to each treatment when irrigation was called for. This was done because 4" was the minimum amount of water that could be applied and still effectively cover the entire plot. In many cases, the target amount was less than 4" but 4" was still applied.

Nitrogen applications were made based on preseason soil sampling and in-season petiole sampling. The preseason soil tests showed a deficient level of soil nitrogen, so 40 lbs/acre of N were applied. Another application of 50 lbs/acre of N was made to the field on June 18 due to low petiole nitrate levels. All of the plots showed the same relative petiole nitrate concentrations and there were little or no differences between treatments throughout the entire season.

Yield data were collected on November 22, 1995 (Table 1). There was no significant difference in yield between the treatments. Treatment one had the highest yield and treatments two and three had virtually the same yield. Further analysis also showed no differences in seed yield.

The lysimeters began to drain almost immediately after the first irrigation. However, the lysimeter in treatment two did not continue to drain and there was no water recovered beyond the first irrigation. However, based on data gathered from the other two lysimeters, treatment two was estimated. The seasonal drainage data are shown in Table 1 and presented in graphic form in Fig. 1. As seen in Fig. 1, the lysimeters drained at approximately the same rate until about July 19 (layby). This makes sense since the amount of water applied prior to July 19 was the same for all treatments. Also, we can see from the graph that lysimeter one (treatment one) had little or no drainage after layby. This was because after layby, the target amount could be obtained and treatment one did not receive any excess irrigation water. Lysimeter three had the most irrigation water applied and the most drainage, while lysimeter one received the least amount of water and had the lowest total drainage. Since the termination of irrigation, very little drainage has occurred (data not shown).

The total amount of nitrogen recovered in the drainage water is shown in Table 1 and Fig. 2. The nitrate-N losses follow the drainage water closely. This would be expected since nitrates move with water quite easily. As with the drainage water, lysimeter three lost the most nitrate-N (33 lbs/acre) and lysimeter one lost the least (20 lbs/acre).

Summary

The lysimeters followed the expected patterns. However, it was thought that the extra water might produce excessive vegetation in treatment three. The expected excess growth caused by the water may have been offset by the additional loss of nitrogen, though this cannot be determined from these data. It was hoped that these lysimeters could also be used to evaluate the effect of winter rains on nitrate movement. However, there have been no significant winter rains this year and little drainage has occurred. This study will be continued in 1996.

Table 1. Data for the three treatments in the lysimeter study at Maricopa Agricultural Center, Maricopa, AZ, 1995.

Treatment	Total Water Applied (inches)	Yield* (lbs/acre)	Water Drained (inches)	Nitrate-N Leached (lbs/acre)
One	49	1095a	1.8	20.0
Two	55	1070a	3.0**	27.0**
Three	60	1169a	4.2	33.0

* Means followed by the same letter are not significantly different ($P \leq 0.05$) according to the S-N-K test.

** Lysimeter two values are estimated.

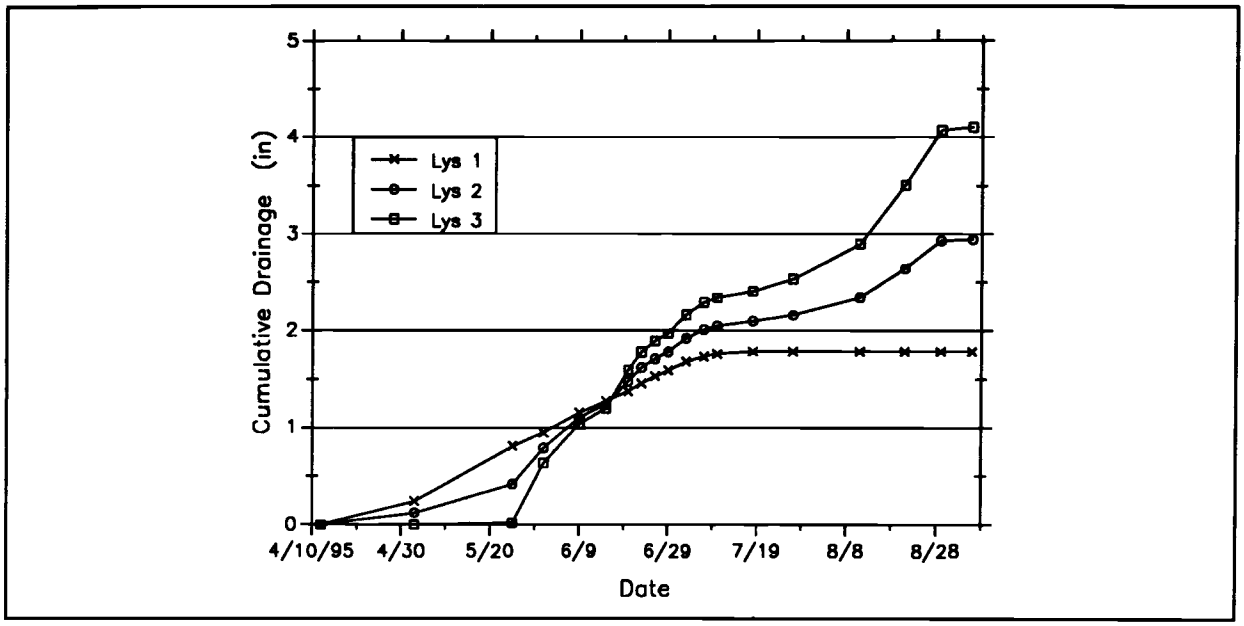

Figure 1. Cumulative drainage (inches) from the three lysimeters under upland cotton production at the Maricopa Agricultural Center, Maricopa, AZ, 1995.

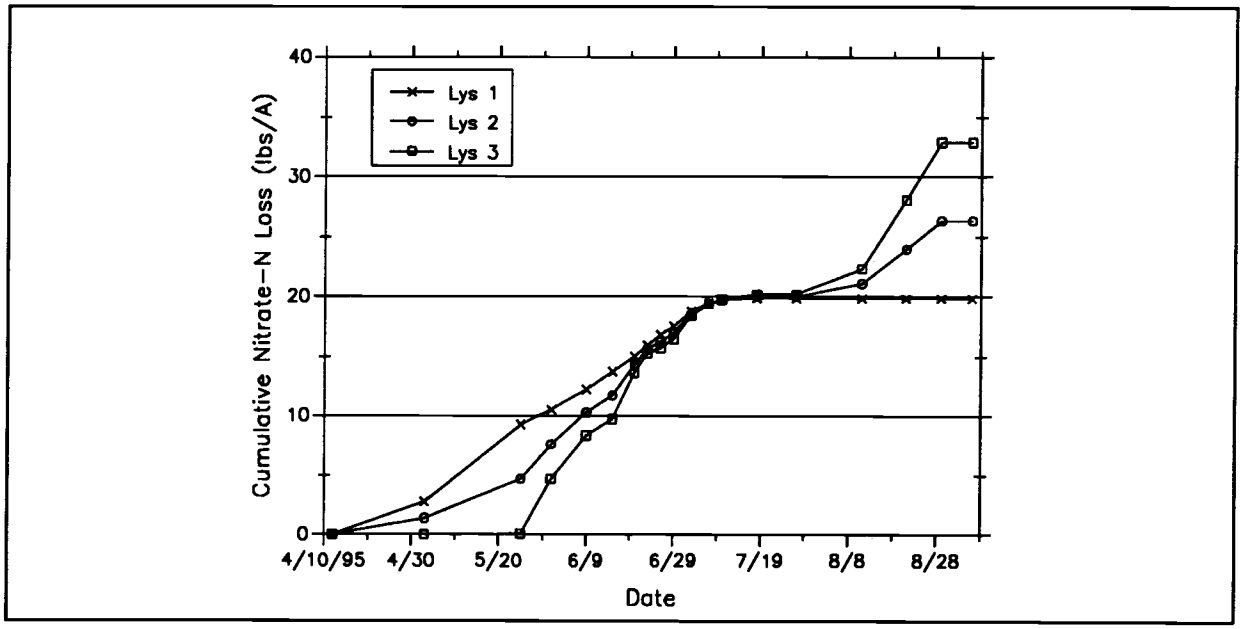

Figure 2. Cumulative Nitrate-N losses (lbs N/acre) from the three drainage lysimeters under upland cotton production at the Maricopa Agricultural Center, Maricopa, AZ, 1995.