

## WATER INTAKE RATES AND ALFALFA GROWTH AS AFFECTED BY TRAFFIC

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There is an increasing awareness that traffic management is an important component in alfalfa production. Conventional practice may result in up to 70 percent of a field receiving traffic thus directly damaging regrowing stems and crown integrity (Sheesley and Grimes, 1977). Besides this direct affect, traffic also alters soil physical characteristics which in turn affect plant growth. The most considered change in the soil is the increase in bulk density (Meek et. al 1983). From the increasing soil density there are a myriad of ramifications of critical consequence when excessive wheel traffic has been applied to a field.

At the USDA Cotton Research Station in Shafter, California, we have been examining how different traffic management systems affect crop growth. We have been looking at two systems with the first system a conventional method of tillage, cultivation, and harvesting. The second system was a controlled traffic or zone production system where all traffic was confined to specific wheel paths within the field. A wide tractive frame spanning 33 feet allowed us to apply cultural practices, make measurements, and harvest within 27 foot wide area without applying wheel traffic to the plots.

### METHODS

The study consists of several treatments representing different degrees of traffic. There are 24 plots (4 treatments and 6 replications) each 100 feet by 25 feet. The soil is a Wasco sandy loam with a field capacity of approximately 2.2 inches per foot. The treatments were:

- None = No compaction before or during planting and no wheel traffic during harvests.
- Preplant = Compacted before planting with a TD9 crawler tractor followed by John Deere 4020 (100% of the area) and no wheel traffic during harvest.
- Repeat = Compacted before planting with a John Deere 4020 (100% of the area) and wheel traffic applied over 100% of the plot four to six days after the alfalfa was chopped using a John Deere tractor 2020 (5,000 lbs. applied to each rear tire, which would be similar to the weight applied by a swather).
- Grower = Compacted during planting and harvests similar in timing and weight to that used by growers. There are four different degrees of harvest traffic within this treatment: Zero (no traffic), and Low, Medium, and Heavy traffic as determined by size and weight of tires used to administer the traffic. Sixty percent of the area was trafficked.

To achieve low soil bulk densities the field was chiseled to a 2 foot depth on 1 foot centers using the wide tractive frame. Compaction was applied to the three treatments Preplant, Repeat, and Grower before the field was planted on October 20, 1982. It was then sprinkle irrigated to assure good seed germination and seedling emergence. Starting with renewed growth each spring, alfalfa was irrigated when 50 percent of the available moisture, averaged over the driest plots, was depleted or sooner.

Since the alfalfa was planted in level basins, measuring water intake was simply a matter of applying approximately 6 inches of water, and determining how fast the level dropped on rulers set into the soil. The average water intake rate for any time interval was the change in water level divided by the time interval. For comparisons of treatments the water intake rates were reported at an arbitrarily selected standard of 120 minutes after the start of water application.

Crown density was determined from two to four randomly placed one foot square grids. These counts were taken two to three times each year. In the Growers treatment crown density was determined for each designated traffic zone or track. These are defined as heavy traffic with numerous passes of heavy tires, medium traffic with one pass of a heavy tire and several light tires, and zero traffic a zone that has never had traffic.

## RESULTS

In 1983, 1984, and 1985 the Repeat treatment, that received 100 percent traffic at each harvest, had significantly lower total yields than the non-traffic treatments (Fig. 1) In 1983 the Grower treatment had a total yield just slightly smaller than the no-traffic treatments. The effect of traffic in the Growers treatments became apparent in 1984 and 1985 when the total yields were 14 to 11 percent less than the non-traffic treatments.

Stand decline has been a general explanation for yield reduction in alfalfa fields over a two to four year period. The average change in crown density for all treatments is shown in Figure 2. There has been the same decline in crown density regardless of traffic treatment. At the end of the 1985 season there were four to five crowns per square foot with yields of 11 to 13 tons per acre. In our study, traffic as yet, does not seem to alter the rate of stand decline, but effects the biomass produced from each crown.

The interaction between degree of traffic and water infiltration has been measured in our study for the past three years. Figure 3 shows infiltration rates from the two non-traffic treatments. The None treatment was highly tilled and disturbed before planting and has never been compacted. The Preplant treatment was also highly tilled, and disturbed, but was lightly compacted when the soil was dry immediately before planting. The slower infiltration rates during the first year in the None treatment, was due, we feel, to the extensive settling of the top soil layers that had no supportive structure from the intensive tillage before planting. The Preplant treatment with the compaction on dry soil produced a more stable soil structure that did not collapse during the first three irrigations. The cultural methods used in preparing these two treatments before planting continue to affect water intake rates very dramatically over a three year period.

Figure 4 compares the two non-traffic treatments to the two traffic treatments. The infiltration rates for the first half of the 1983 season were similar. At the end of the first season there were some differences appearing. In 1984 there were statistically significant differences between the traffic and non-traffic treatments. This difference was maintained throughout the following 1985 season. We hypothesize that the perpetual traffic at each harvest was constricting continuity between soil pores. Where there was no traffic the developing pore structure in the soil was not reduced or constricted.

## CONCLUSIONS

1. With well watered alfalfa, decreasing the area subjected to harvest traffic significantly increased yields. Yield reduction in the simulated Growers treatment was a gradual phenomena requiring two to three years before resulting in statistical differences.

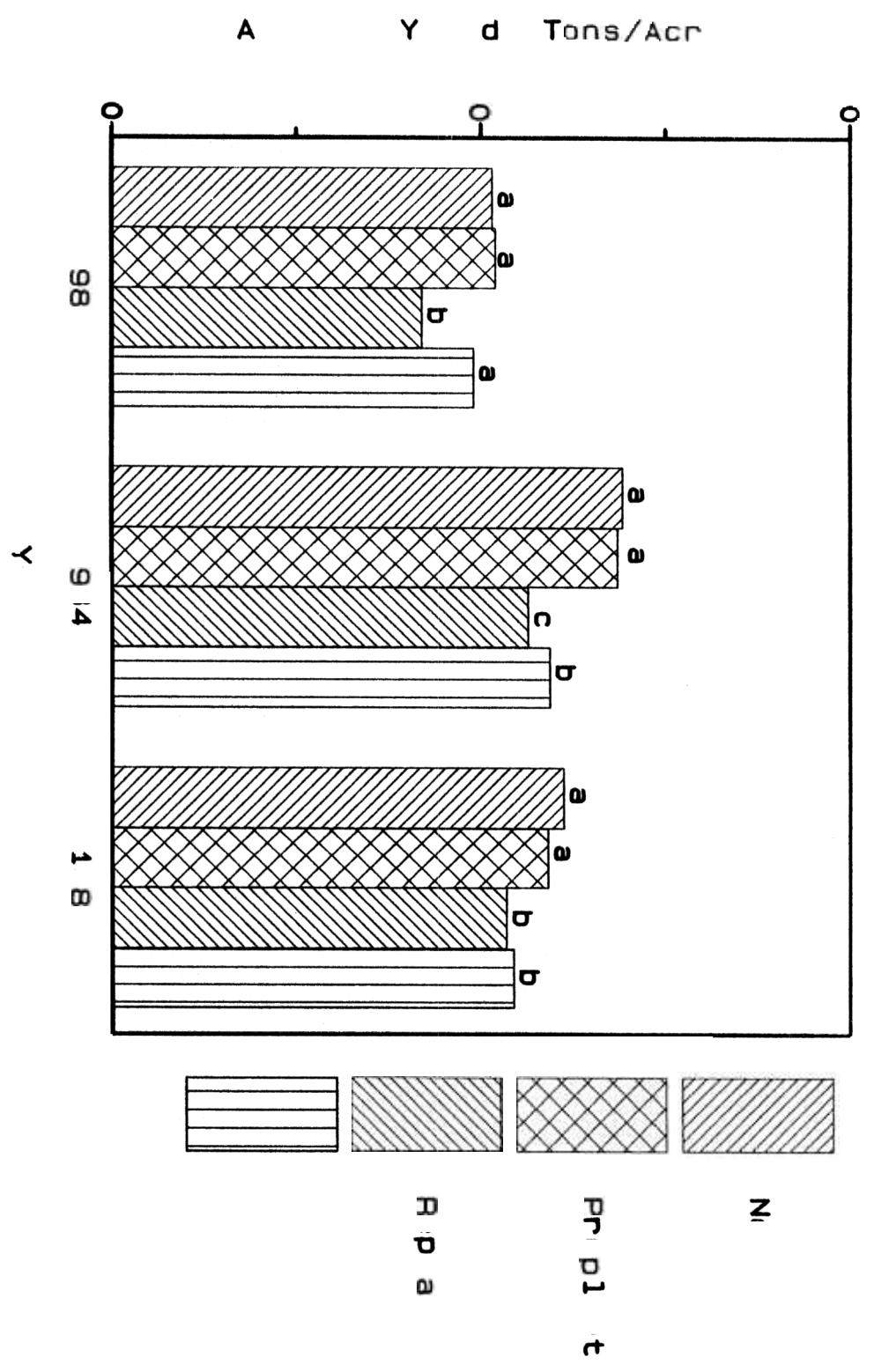
2. In our study the different traffic systems had no affect on stand decline. Total yields were acceptable even with four to five crowns per square foot.

3. Water intake rates were highest with a light preplant compaction on dry soil and controlled or no traffic during each harvest. Water intake rates were lower with repeated traffic over the entire stand and in the simulated Growers treatment with 60 percent of the stand receiving traffic.

## REFERENCE CITED

- Meek, B. D., L. M. Carter, R. H. Garber, and E. A. Rechel. 1983. Regrowth and yield of alfalfa as influenced by wheel traffic. 13th California Alfalfa Sym. pp. 1-5.
- Sheesley, W. R. and D. W. Grimes. 1977. Reduced wheel traffic could boost alfalfa grower incomes. Am. Soc. Agric. Eng. Proc. no. 77-1513.

Fig 1 Alfalfa yield (Tons/Acre) by treatment and year. Error bars represent standard error (SE) of the mean. Letters above bars indicate significant differences (p < 0.05) between treatments within a year.



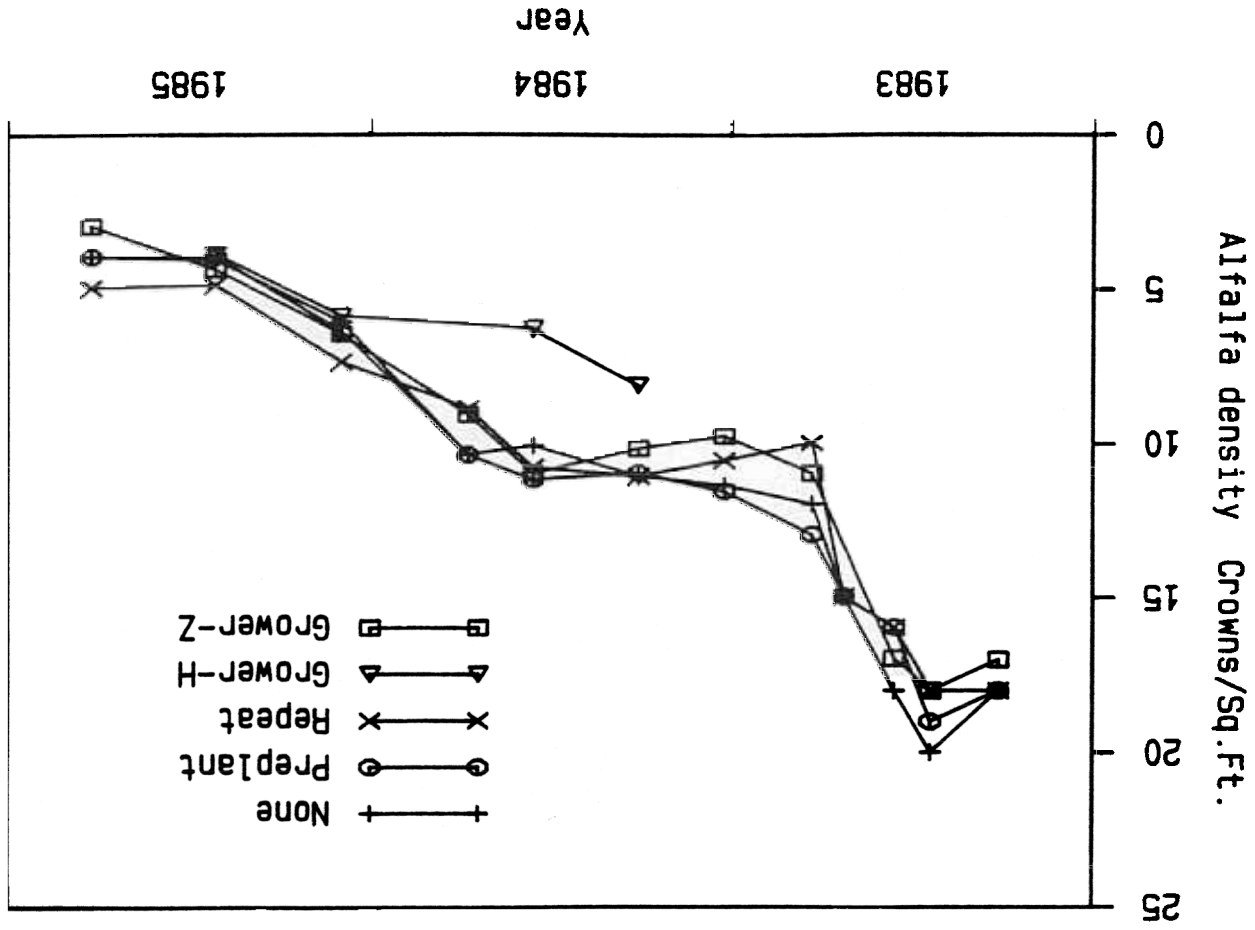
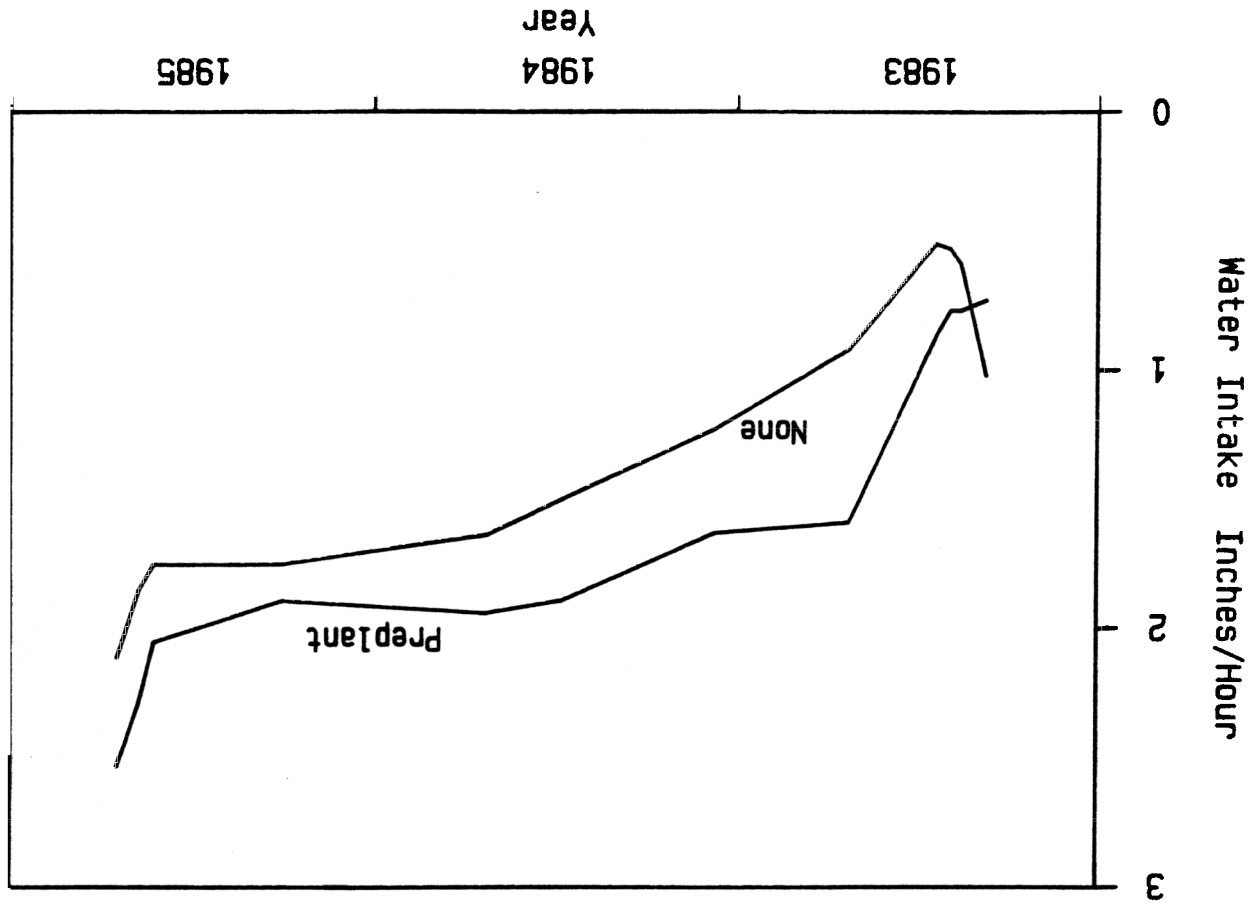


Figure 2. Crown density for alfalfa as affected by different traffic systems.

Figure 3. Water intake rates for alfalfa in non-traffic systems as affected by preplant compaction.



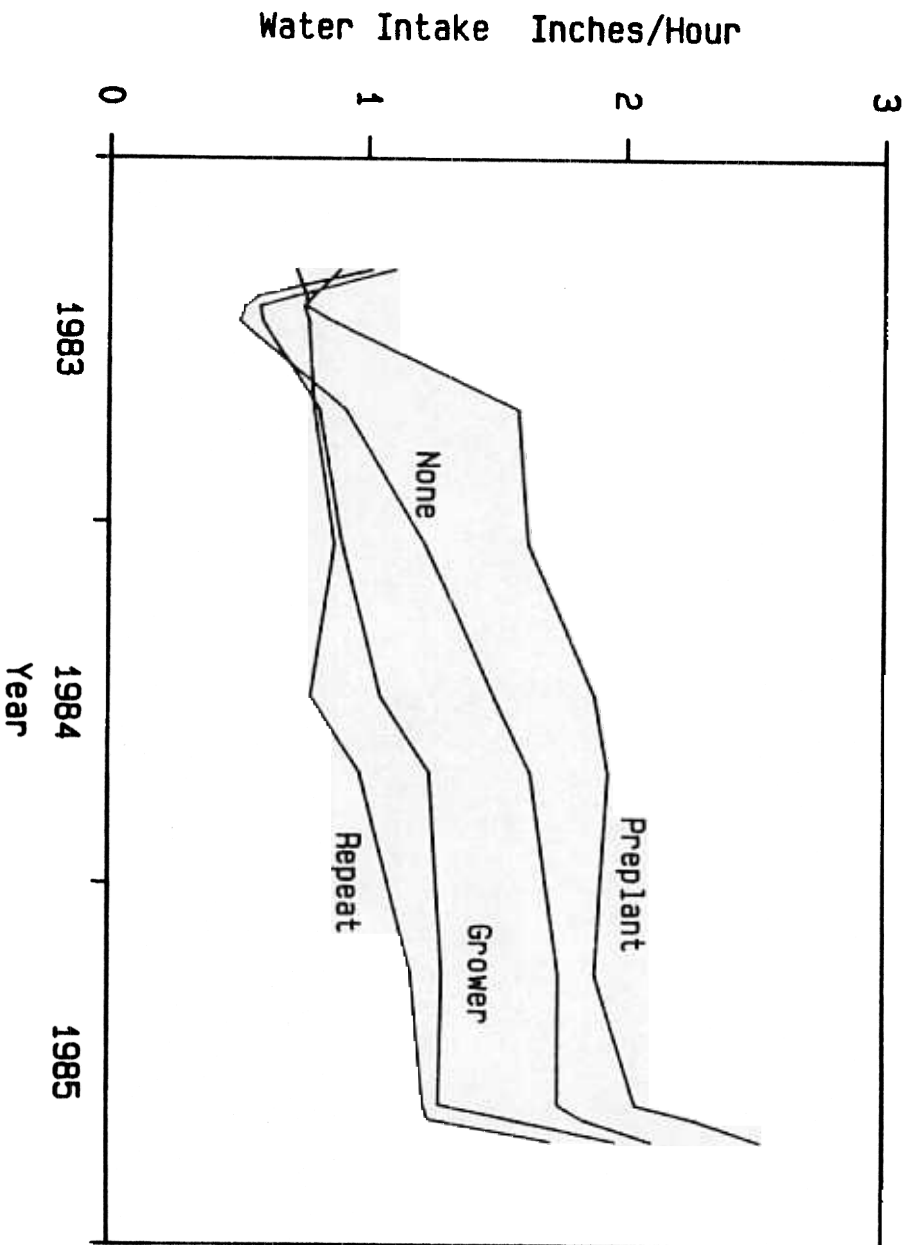


Figure 4. Water intake rates for alfalfa as affected by different systems of traffic.