(Revised and Reprinted from 1974 Proceedings)

THE INFLUENCE OF WHEEL TRAFFIC ON YIELD AND STAND LONGEVITY IN ALFALFA

W. R. Sheesley, D. W. Grimes, W. D. McClellan, C. G. Summers, V. Marble

---

These experiments indicate wheel traffic in alfalfa hay fields is responsible for severe reduction in yield and stand life. Wheel traffic on sandy or medium texture soils also limits the development of alfalfa roots by compaction. Mechanical damage to crowns and regrowth shoots in treatments simulating baler, cuber or bale wagon traffic is responsible for reduced plant vigor and loss of stand.

Equipment wheels cover up to 70% of alfalfa hay fields during each harvest. Most haying implements have four wheels, few of which trail one behind another. This extensive traffic results in most alfalfa plants being run over one or more times each harvest, and up to 20 times during a season.

Experiments conducted from 1972 to 1974 at the San Joaquin Valley Research and Extension Center in Parlier measured the effects of wheel traffic on alfalfa plants and soil. These treatments, simulated harvest (swather), post harvest (bale wagon), and harvest plus post-harvest traffic were applied to the varieties Moapa, Lahontan, and Team at each cutting. An area receiving no traffic was used as a control. A seven-day interval separated swather and bale wagon traffic.

The study analyzed the effects of wheel traffic on stand life, forage productivity, root development, physical injury and relationship to diseases in alfalfa. Soil compaction within the top two feet of the soil profile was measured with a penetrometer. Wheel traffic was confined to narrow paths by using a tractor with trailing wheels.

Plant Survival and Damage

No significant reduction in plant population resulted from wheel traffic during normal cutting time, When regrowth buds are short (Table 1). Survival of plants exposed to wheel traffic seven days after harvest was about half that of plants in the control plots. Mechanical damage was common on crowns and longer regrowth shoots which were more subject to crushing and pinching when run over by a wheel.

Disease development in plant crowns was secondary to the mechanical damage. *Fusarium* spp., *Alternaria* spp., and *Cephalosporium* spp. were isolated from plants in both wheel traffic and control areas, but played a minimal role in stand losses and in reduced vigor of plants in these experiments.

Hay Yields

Yield was reduced in the immediate area of the wheel tracks, where traffic was applied seven days after harvest. Since traffic was confined to narrow lanes in these experiments, there was a "border effect" growth adjacent to the wheel path. This border effect sparks hope for minimal forage losses if traffic can be confined to specific narrow lanes within alfalfa fields.

Yields from the swather traffic lanes were not significantly different from the control plot yields, as shown in Table 2. Fewer and weaker alfalfa plants survived in the treatments involving traffic seven days after harvest. These post-harvest traffic treatments also produced less forage than the control plots (Table 2).

Table 1

Alfalfa Plant Populations

Traffic Treatments	1/ Planted 2/17/72 Plants/sq. ft. 7/72	4/16/73	% check	2/ Planted 4/4/73 Plants/sq. ft. 7/73	4/15/74	% check
1. No traffic (check)	30.1	13.8	100	38.2	19.3	100
2. Swather	25.0	11.6	84	24.4	15.8	82
3. Bale Wagon (7 days after cutting)	26.2	7.1	51	33.3	10.4	54
4. Swather & Bale Wagon	21.6	4.6	33	39.9	14.0 3/	73

1/ 5 harvests in 1st year. 2/ 4 harvests in 1st year. 3/ The majority of plants of this treatment were in a 1" depression which gave protection from wheel traffic pressure to plant regrowth and crowns.

Table 2

Relative Yields from Traffic Areas
(3rd cutting of 2nd year)

Treatment	% check	1/ Dry grams/ 2 sq. ft.
1. No traffic (check)	100	98.8 a
2. Swather	90	88.8 a
3. Bale Wagon (7 days after cutting)	45	44.1 b
4. Swather & Bale Wagon	27	26.4 b

1/ Average of nine plots per treatment. Yields not followed by the same letter differ at a 1% probability level.

Table 3

Alfalfa Root Density (cm/cm^3)
(1973 Planting)

Soil Depth (inches)	Traffic Treatments Control	Swather	Bale Wagon	Swather & Bale Wagon	Means*
0- 6	3.41	3.12	1.74	1.80	2.52 a
6-12	1.90	1.85	0.86	0.86	1.37 b
12-18	1.62	0.96	0.74	0.97	1.07 b
18-24	1.40	1.05	0.32	0.44	0.80 b
Means*	2.08a	1.75ab	0.92b	1.02b	

*Treatment means not followed by same letter differ at a 5% probability level using Duncan's multiple range test.

Soil Strength & Root Development

Penetrometer soil strength measurements were made after each season's wheel traffic treatments. A uniform irrigation was applied and time was allowed for water to be uniformly distributed through the two-foot deep measured zone before strength measurements were taken. This procedure was necessary because soil strength is infulenced by soil water content. Soil moisture samples verified that soil water content was uniform.

Soil samples were collected by six-inch increments to two feet on all treatments and replications. At approximately the same time, strength measurements were made and root length per unit volume of soil (root density: cm/cm^3) was determined. Table 3 shows the influence of various wheel traffic treatments on root densities compared to the control (no traffic) treatment. A 37% reduction in root density of the 6-12 inch zone was observed for the traffic plots. Some of the roots in this zone likely came from lateral roots of plants growing adjacent to the traffic lanes.

Penetrometer soil strength values, shown in Figure 1, illustrate the degrading influences of wheel traffic compared with a no-traffic strength profile. The zone of maximum increased strength in the 6-12 inch zone corresponds with a high reduction in root density. That the increased strength from compaction extends to a depth of about 14-18 inches agrees with our previous results.

The restriction imposed by increased soil strength on alfalfa root extension is shown in Figure 2. Ech 100 pounds per square inch increase in soil strength gave a 15-20% reduction in root density for a given depth increment. Rooting densities at each depth were appreciably higher in the spring of 1974 than in the fall of 1973. However, the relative effects of treatments did not change during the winter and early spring.

Timing First Harvest

Much of the stand loss shown by the data in Table 1 occurred as a result of wheel traffic during the first and second harvests. Most of the root-restricting soil compaction illustrated in Figure 1 occurred during the first three passes of wheel traffic over the soil. This emphasizes the importance of having a large, healthy root system prior to the first harvest of a new alfalfa planting.

In fine sandy loam soil, the alfalfa tap root should be down 14-18 inches before the first harvest. This will permit additional root growth below the compacted soil area. Root-stored carbohydrates are needed for shoot growth following harvest. If regrowth shoots are damaged by wheel traffic, additional root reserves will be required for shoot growth and plant survival. Plants growing on light textured soil with small root systems at the time of first harvest will be generally weakened, and many will not survive the double blow of root-inhibiting soil compaction and mechanical damage to regrowth. Fall planting will give more time for proper root development before the summer harvest season begins.

Minimizing Traffic Damage

Extending the stand life of alfalfa plantings in California one year beyond the present three-year or four-year averages could mean savings of $16 million per year to alfalfa producers. An additional $87 million per year savings could result to California hay growers from minimizing traffic effects on alfalfa regrowth shoots in post-harvest operations. This study demonstrates the significant effects of wheel traffic, and makes imperative the further development of techniques to minimize traffic damage. Possible ways of reducing traffic effects and extending the production life of a stand include standardizing wheel traffic patterns, establishing designated traffic lanes in the alfalfa field, corrugation or rill planting, and bed plantings with shallow furrows to be used as lanes for standardized wheel traffic. In designing alfalfa seed beds, a grower needs to consider soil type, irrigation system, and weed populations, in addition to standardizing wheel traffic patterns.

W. R. Sheesley is Farm Advisor, U. C. Cooperative Extension, Fresno; D. W. Grimes is Associate Water Scientist, U. C. Davis; W. D. McClellan was Tulare County Farm Advisor; C. G. Summers is Associate Entomologist, U. C. Berkeley; V. Marble is Cooperative Extension Agronomist, U. C. Davis.

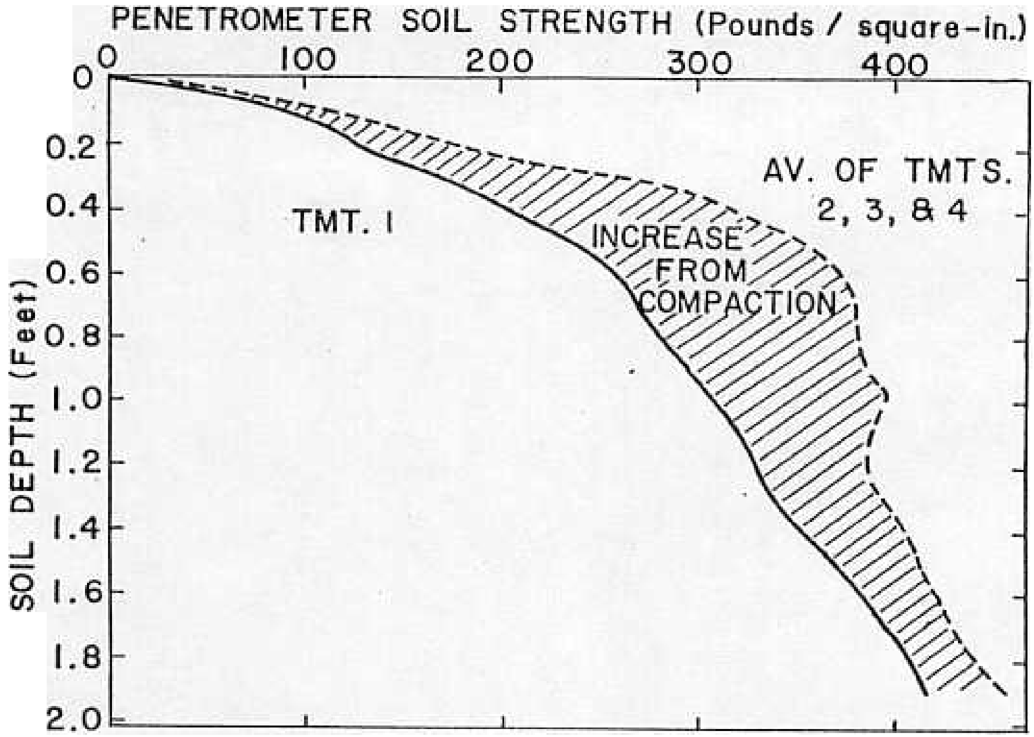


Figure 1 - Increase in penetrometer soil strength from wheel traffic compaction.

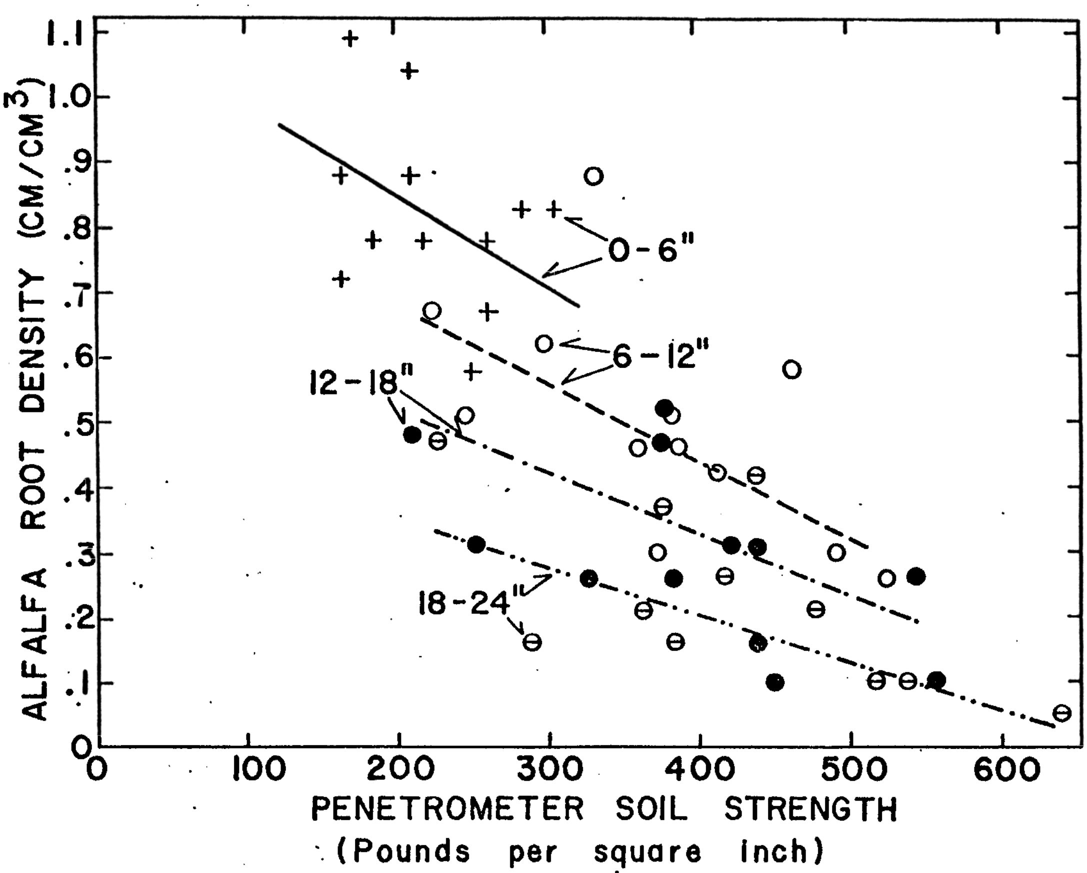
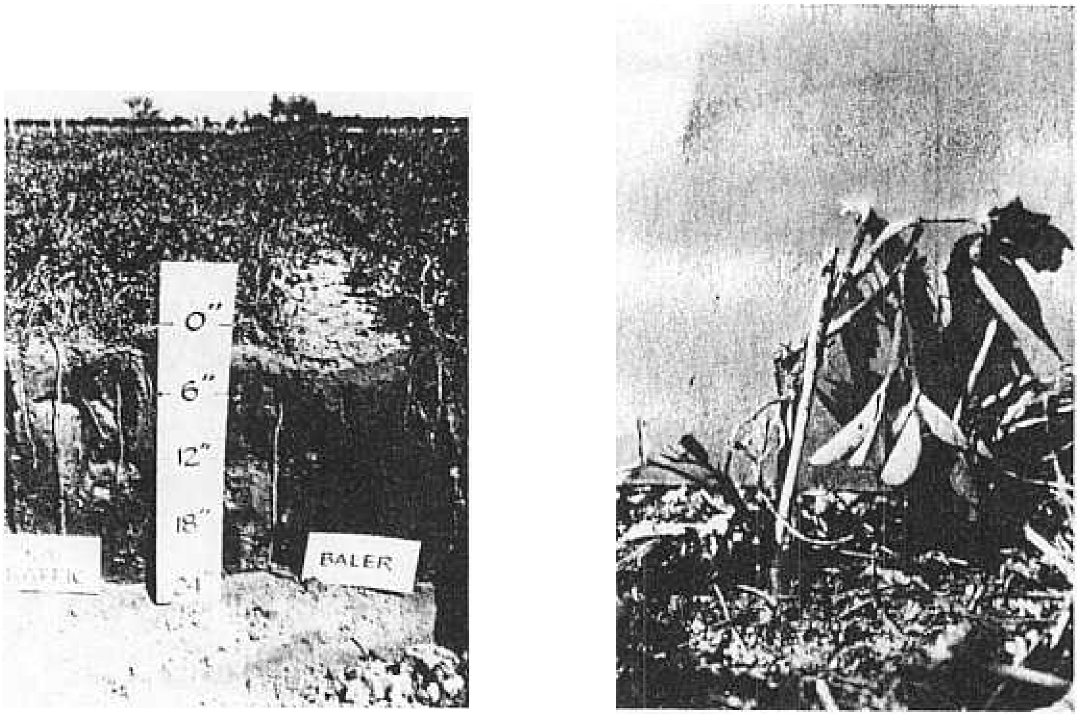
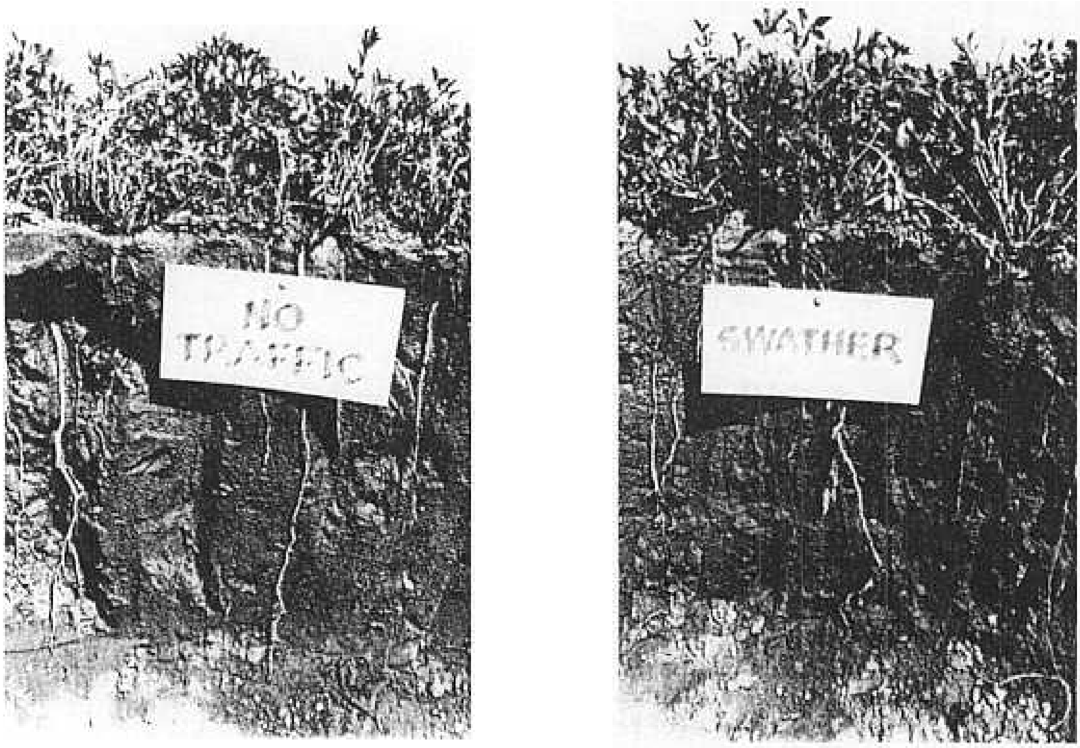


Figure 2 - Effect of soil strength and depth on alfalfa root density.



Severe damage to plant crowns and regrowth shoots is caused by post-harvest equipment traffic and results in reduced yields and shorter stand life.



No significant reduction in plant populations resulted from wheel traffic at normal harvest time, when most regrowth buds are short.