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SUMMARY

A study was made to evaluate the effect of tractor traffic on yields of alfalfa and red clover. Eight basic treatments were applied by using two tractors, one with new tires and one with smooth tires.

The tests were conducted on a Paxton loam soil. Plots were seeded in August of 1959 and 1960. The following spring the first crop was harvested by hand. The traffic treatments were applied to the second growth when the plants were approximately four inches high. The area between the tractor tracks was kept cleanly mown, consequently, only those plants which had been run over by the tractor were allowed to grow.

Results show that tractor traffic does injure and kill young plants. A smooth tire does more damage than a new tire. Stem, leaf and crown damage was prevalent following all treatments.

This research was supported in part by funds from regional project NE-13. The Mechanization of Forage Crops, Harvesting, Processing, Storing and Feeding, a cooperative study, including Agricultural Experiment Stations in the Northeastern Region, of the United States Department of Agriculture.

The authors wish to express their appreciation to Richard D. Merritt and John P. Adams, University of New Hampshire photographers, for their asssitance in taking and preparing the pictures in this bulletin. The contribution of R. H. Kilpatrick, Plant Pathologist and Merle G. Wright, technical assistant, is gratefully acknowledged.

Cover Photo: Effect of increasing drawbar pull on alfalfa and red clover plants — center plants are from the control plot — degree of pull increases from center to left and right.

Legume Damage by Tractors

by

Gordon L. Byers and Robert F. Lucey*

Modern farming necessitates moving tractors and equipment over fields where plants are in various stages of growth. Incorporated in modern farming methods has been the trend towards employing more tractors with greater power at the drawbar. Increased drawbar horsepower was obtained without increasing the overall weight of the tractor.

Heavier loads are being pulled by the tractor now that tractors have the ability to do so. As a result, tractor drive wheel slippage, in the normal process of operations, has increased. Tractor tire treads have been designed to provide adequate traction along with roadability. Little or no attention has been given to the effect that weight, area of contact, or slippage may have on yields of alfalfa or other legumes.

Barger and Roberts (1) found that larger drawbar pull was obtained on green grass because of the ability of new tires to cut or shave off the grass and reach firm ground. Worn tires which had greater contact area, slipped on the grass after it had been matted down.

The studies reported in this bulletin were concerned with the extent of damage inflicted on alfalfa and red clover plants by (1) increasing drawbar pull and (2) increasing the area of contact between the tire and the ground. Increasing the drawbar pull increases the ground pressures under the rear wheels by transferring weight from the front of the tractor to the rear of the tractor. Drive wheel slippage also increases as the drawbar load increases. Increasing the area of ground contacted by the tire exposes more plants to damage. Tractor tires that are badly worn have a larger contact area than tires with new tread.

Materials and Methods

A paxton loam soil located in Northwood Ridge, Northwood, New Hampshire, was used in this study. Soil test results showed that the soil was strongly acid and low in available plant nutrients.

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Figure 1. Plots of Alfalfa and Red Clover on which 1960 trials were conducted. Picture taken May 27, 1960.

To reduce the acidity and to correct for nutrient deficiencies, lime and fertilizer were applied on the basis of soil test results. Four plots each, of Narragansett alfalfa (14 pounds per acre) and Pennscott red clover (eight pounds per acre), were seeded on July 28, 1958, and August 1, 1959. An 11 x 7 grain drill fitted with band seeding tubes was used to place the seed above the band of 8-16-16 fertilizer which was applied at the rate of 200 pounds per acre. In the spring, and after the first crop was removed, 150 pounds per acre of muriate of potash (60% K_2O) was applied. (Figure 1).

Spring growth produced by the plants which became established the preceding summer and fall was harvested on June, 1959, and June, 1960. A National sickle bar type mower was used to cut the herbage. The cut herbage was removed by manual labor. The plants were allowed to recover to a height of four inches before the basic tractor traffic treatments were applied.

Eight basic treatments were applied, using a tractor with new tires and a tractor with old, smooth tires. Four different draw-

bar loads — namely: 0 lbs., 650 lbs., 1250 lbs., 1800 lbs., with the new tires; and 0 lb., 500 lbs., 1100 lbs., 1500 lbs., with the smooth tires — effected a range of wheel slippage and weight transfer. A mower operating under average field conditions has a draft requirement ranging from 60-100 pounds per foot of width. The percent slippage of a tractor wheel was calculated by the following:

$$\text{Per cent slip} = \frac{\text{advance per wheel revolution with no pull} - \text{advance per wheel revolution with pull}}{\text{Advance per wheel revolution with no pull}}$$

Two tractors were used to obtain the drawbar load. The tractor applying the basic treatment pulled another tractor in gear, with the engine shut off. The different transmission gears — 1st, 2nd, and 3rd in the pulled tractor — provided the range of drawbar loads indicated. By drawing the pulled tractor a little to one side, it was possible to avoid running on the tracks made by the pulling tractor.

A treated plot consisted of two tractor wheel tracks. After the treatments were imposed, the area between the wheel tracks was kept mown; consequently, only those plants which had been subject to traffic were allowed to grow. (Figure 2).

When the recovery growth in the check area was in bloom, yield samples, were taken. Four samples were taken for each

Figure 2. Areas between treated plots were kept cleanly mown during the growing season. Tall row left center is a control row, the two rows to the right show retarding effect of smooth tires with 1500 lbs. drawbar load.

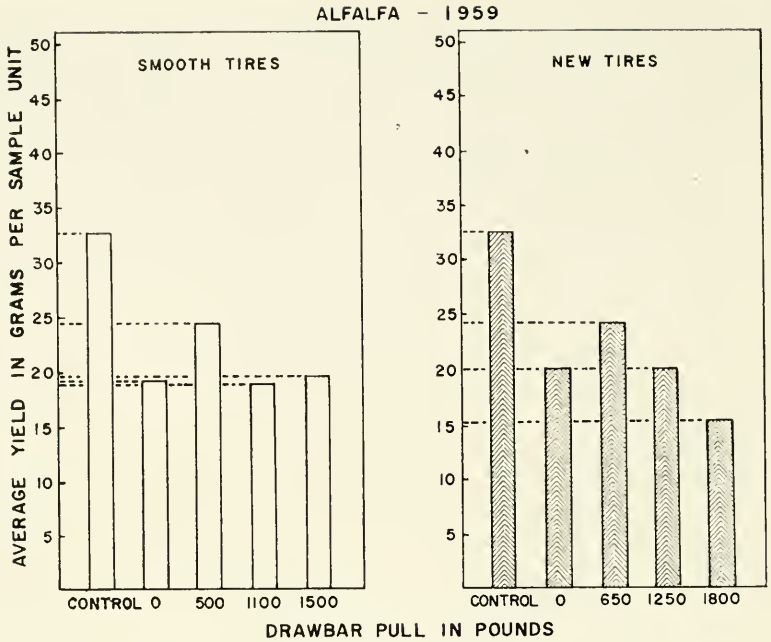

Figure 3. Effect of increasing drawbar pull with smooth tires and new tires on yields of alfalfa (1959).

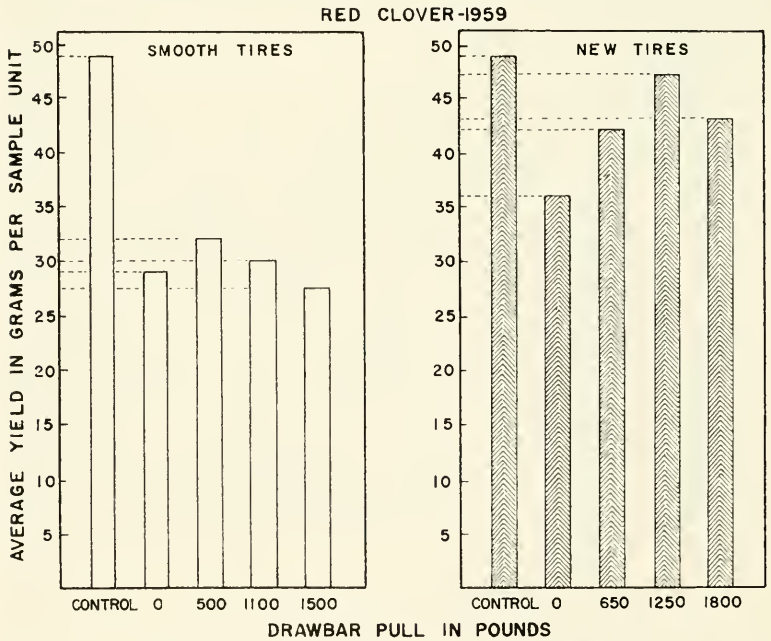

Figure 4. Effect of increasing drawbar pull with smooth tires and new tires on yields of red clover (1959).

given treatment. These samples were obtained by harvesting 14 x 14 inch areas. The seven-inch spacing of the band seeder furrow openers dictated the quadrant dimensions used. The herbage was oven-dried. The yield results are expressed as the average weight of dry herbage per sample unit. Plant counts were made after the yields were taken. The sample area was the same as that used for yield data. Representative plants were dug and taken to the laboratory for crown and root damage studies.

For evaluating plant damage, three criteria were used: (1) Plant counts (2) crop yields (3) crown damage.

Experimental Results

Results of the plant count studies showed this method to be unsatisfactory for evaluating plant damage. Regrowth from damaged plants was included in the plant counts; therefore plant counts were not indicative of the reduction in yield. However, they did indicate good stand establishment.

Results of the 1959 plant harvest yields are shown in Figures 3 and 4. Statistical analysis of the alfalfa yields showed that both new and smooth tires inflicted significant damage, when compared with the control plot. Increasing the drawbar load and

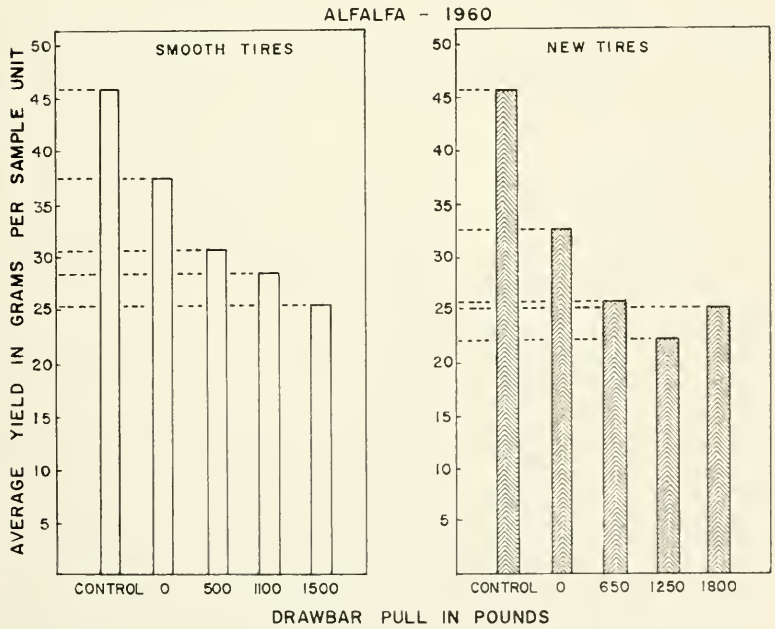

Figure 5. Effect of increasing drawbar pull with smooth tires and new tires on yields of alfalfa (1960).

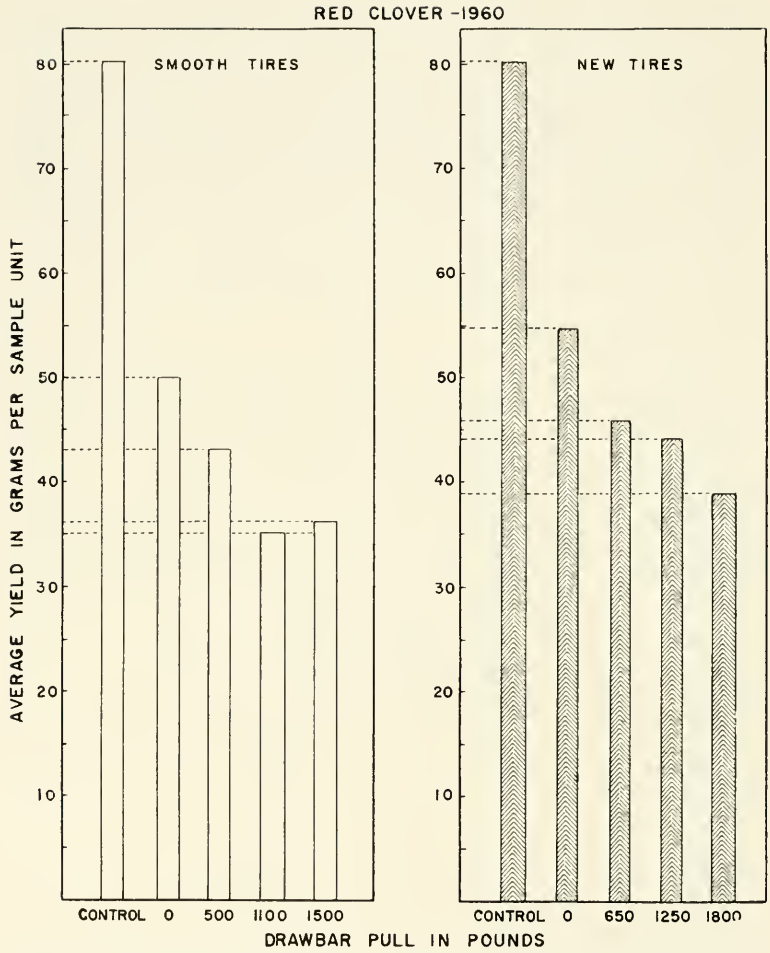

Figure 6. Effect of increasing drawbar pull with smooth tires and new tires on yields of red clover (1960).

drive wheel slippage did not result in a significant decrease in yield over that already inflicted by the effect of tractor weight alone.

Figure 4 shows the effect of traffic on red clover. Significant damage was inflicted by smooth tires, the degree of damage increasing as the drawbar load increased. With new tires, however, although some damage was inflicted, the degree of damage was not as pronounced as it was with old tires. This suggests that the greater area of contact with the smooth tires was a factor.

As a result of experience gained from the 1959 studies, better plots (Figure 1) were established and plant counting and harvesting techniques improved in 1960. Consequently the authors feel that the 1960 results are very indicative of what can be expected in the way of legume damage by tractor traffic.

Figure 7. Examples of alfalfa and red clover plant damage. Note crushed and twisted stems, bruised and lacerated leaves.

In 1960, as in 1959, both sets of tires inflicted significant damage when compared to the control plots. On both alfalfa and red clover the smooth tires inflicted more damage than the new tires. The major damage was inflicted by tractor traffic without drive wheel slippage. (Figures 1, 5, and 6). Increas-

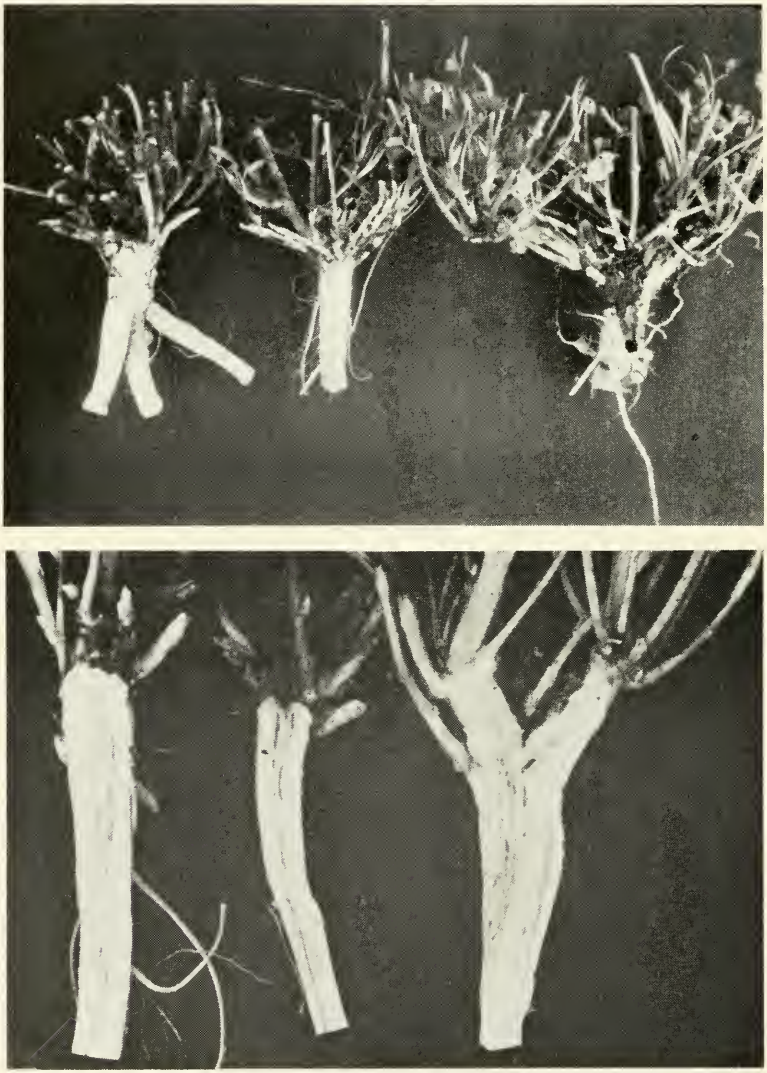

Figure 8. Alfalfa Crown Damage — showing (top) the whole crown and (bottom) the same roots sliced longitudinally left to right. Control — New tire — smooth tire.

ing the drawbar load resulted in increased plant damage. However, the difference was not statistically different when expressed in relative yield basis.

Discussion

Results of this study indicate that significant damage is inflicted on young legume plants when subjected to tractor traffic. The comparison of smooth tires and new tires demonstrates that the greater the area of contact the more severe the damage. This can be explained by the fact that more plants are contacted by a tire with a smooth surface. Increasing the drawbar pull results in an increase in plant damage.

Where the weight of the tractor alone inflicts considerable damage, the minimum ground pressure required to eliminate damage appears to be below any practical application insofar as size of tractor tire and weight of the tractor are concerned. This suggests that tires with a minimum of contact area will cause less damage despite the increased contact pressures. However, operating conditions often dictate the minimum sized tire that can be used.

Stem and Leaf Damage. Figure 7. shows several types of damage inflicted on the young plants. Broken stems, crushed stems, crushed leaves and parts of plants severed completely, were common types of damage observed. These plants, although they continued to grow, were severely retarded and by harvest time were very poorly developed and resulted in low yields.

Crown Damage. Another type of damage inflicted was crown damage. It was observed that most of the shoots present when the treatments were imposed had been killed by the action of the tractor tire. Figures 8 and 9 show examples of alfalfa and red clover roots dug up and examined in the laboratory. Most of the shoots arising from the damaged crowns at the time of harvest were new. In several instances the crowns were so severely damaged that rotting of the root had developed. (Figure 9). How long these damaged plants would continue to grow and survive winter conditions is questionable as the roots were split and apparently more susceptible to disease. It is very possible that damage inflicted by field traffic to plants may be a contributing factor to a reduction in a stand of legumes.

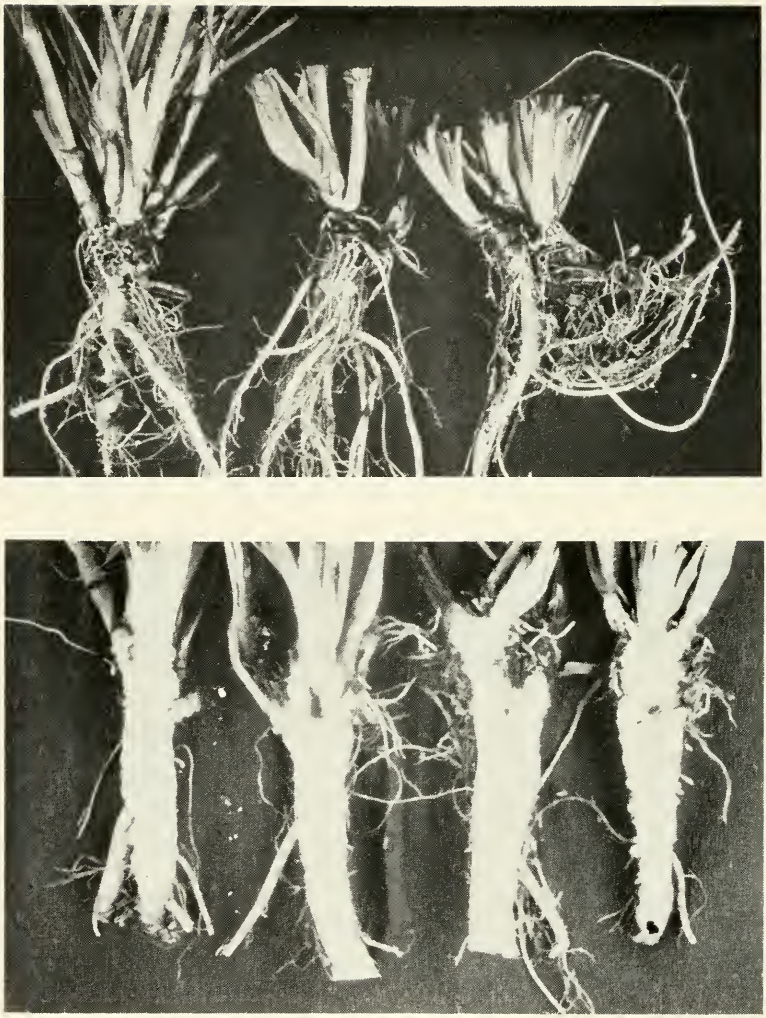

Figure 9. Red clover root crown damage. (top) whole crown and (bottom) roots sliced longitudinally. Left to right, control — new tire — smooth tire — bottom 4th root, smooth tire.

CONCLUSIONS

1. Significant damage was inflicted on alfalfa and red clover plants when they were subjected to tractor traffic.
2. Increasing the area of tire contact, increased the number of plants damaged.
3. Slippage of the drive wheel is not as important a factor as weight. The two combined, however, inflict more damage than weight alone.
4. Minimum pressures to elminate damage are well below average tractor tire contact pressures.
5. Damaged plants continue to grow, but at a slower rate and yield much lower than undamaged plants.
6. Plant crowns are severely damaged and may be more susceptible to disease.
7. Field traffic, where plants will be damaged, should be reduced to a minimum.

LITERATURE CITED

1. Barger, E. L. and J. Roberts. *Effect of Tire Wear on Tractor Performance.* Agricultural Engineering, May 1939.