Response of Alfalfa to Three Levels of Spring Tillage

While alfalfa stand densities were significantly reduced by increased tillage, yields were not affected as much as anticipated because of crown and root size compensation.

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Introduction

Tillage of alfalfa *(Medicago sativa* L.) is practiced in many areas of Montana to control weeds and stimulate alfalfa growth. The value of this practice has often been questioned. Experiments conducted in the West and Midwest have shown varied results ranging from little effect of tillage on weed control or alfalfa growth (4) to marked reduction in cheatgrass (*Bromus tectorum* L.) populations (3), or even increased alfalfa stand densities (1).

Montana Agricultural Experiment Station (MAES) researchers at Kalispell and Bozeman conducted alfalfa tillage experiments on older alfalfa stands from 1981 through 1983 (2). They compared three tillage methods:

- deep, one-pass tillage (4 inches deep with a field cultivator containing multiple spring loaded shanks (points);
- shallow, one-pass tillage (2 inches deep) and
- one-pass tillage with a tandem disk (3 inches deep).

Generally, deep tillage in one or two consecutive years stimulated alfalfa growth and vigor. Perennial rhizomatous grasses were also stimulated by a single deep tillage, but two consecutive years of deep tillage decreased grass yields. Shallow cultivator tillage and disk tillage did not greatly affect forage yield or botanical composition of the sward. Alfalfa crowns were damaged more by shallow cultivator and disk tillage than by deep cultivator tillage. Shallow tillage detached alfalfa crowns, whereas deep tillage allowed shanks to slip around alfalfa crowns.

This study was conducted in a young, highly-productive, weed-free alfalfa stand to ascertain direct tillage effects on alfalfa. Specific objectives of this study were to:

- determine the effects of three tillage levels on alfalfa yield and stand density,
- examine the relationship between yield and stand density in a young alfalfa stand and
- determine the amount of plant injury caused by tillage.

Materials and Methods

This study was conducted at the Northwestern Agricultural Research Center at Kalispell from 1982 through 1984 on a Creston silt loam soil. 'Thor' alfalfa was established in May, 1981 at a seeding rate of 12 lbs/a. Prior to seeding, phosphorus (180 lbs/a P_2O_5) was disked into the soil.

The experiment was designed as a randomized complete block with six replications and four tillage treatments in 1982. The four levels of Vibra-Shank tillage were; 1) no tillage (control), 2) tilled once, 3) tilled twice (opposite directions) and 4) tilled three times (at right angles). The Vibra-Shank was set at a depth of four inches for all tillage operations.

In 1983, every other block (replication) was again tilled as described above. The experimental design was a split plot in 3 blocks with years of tillage (1982 and 1983) as main plots and levels of tillage as subplots. Analyses of variance were computed for all parameters and mean squares were tested at the $P=0.05$ level of significance. Treatment main effect and interaction means were separated with the LSD.

Tillage treatments were applied in March of 1982 and 1983 when alfalfa had about two inches of new growth. Plots were irrigated in each year to prevent moisture stress. Generally, plots were harvested twice at 10 percent bloom and in late September. In 1983 and 1984, a representative

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sample from each plot at all harvests was hand separated into alfalfa and dandelions (*Taraxacum officinale* Weber) to determine tillage effects on dandelion control.

In September 1982, plots were sampled to determine stand densities. Alfalfa plants in each sample were counted and scored for crown and root size. Plants were assigned a value from 1 to 3 (1 = smallest and 3 = largest size class). The number of plants showing scar tissue or injury in the upper four inches of root area were tabulated for each sample.

Tissue samples were collected biweekly until late July. Dried tissue samples (100 °F, 48 hours) were analyzed for total N by micro—Kjeldahl process, and P on a plasma spectrophotometer (Perkin-Elmer Model 5500 ICP).

Results and Discussion

First harvest alfalfa yields were not affected by tillage in 1982 (Table 1), but the three-pass tillage treatment reduced second harvest alfalfa yields as compared to the control (no tillage). Total season yields of one-pass and three-pass tillages were 12 percent and 11 percent lower than alfalfa yields in the control plot. Two-pass tillage did not affect total alfalfa yields.

Tillage operations in 1982 affected alfalfa yields in 1983, but did not control dandelion (Figure 1). Total alfalfa yields of two-pass tillage were greater than one-pass tillage, but no other significant treatment effects were found.

Spring tillage in two consecutive years (1982 and 1983) influenced alfalfa and dandelion yields (Figure 1). Total alfalfa yields for two-pass tillage were the lowest. It appears that a single spring two-pass tillage will not affect alfalfa yields, but two successive years of this practice will decrease alfalfa yields. Dandelion control was increased as tillage level increased. Tillage operations in 1982 and two consecutive tillage operations (1982 and 1983) did not affect forage, alfalfa or dandelion yields in 1984. At least half the stand was infected with Verticillium wilt (*Verticillium albo-atrum* Reinke and Berth). Tillage operations did not seem to increase the incidence of this disease as all plots were affected similarly.

Alfalfa stand densities (plants/ft²) in fall of 1982 were reduced by all tillage treatments (Figure 2). As tillage intensity increased, stand density decreased. However, the most extensively tilled plots (two-pass and three-pass tillage) contained a higher percentage of large alfalfa plants (rated 2 or 3) than the control or one-pass tillage plots (Figure 3), suggesting that alfalfa crown and root size increased rapidly as space became available. This component compensation explains why alfalfa yields for two-pass tillage were similar to the control. Although plant size was increased by three-pass tillage, this did not fully compensate for plant losses which resulted in reduced yields. A single spring tillage (one-pass) did not remove

TABLE 1
Effect of tillage level on alfalfa forage yield at Kalispell in 1982

Tillage Level	First Harvest	Second Harvest	Total Yield
	tons dry matter per acre		
0 (control)	2.67	1.11	3.78
1 (one-pass)	2.32	1.01	3.33
2 (two-pass)	2.46	1.07	3.53
3 (three-pass)	2.39	0.98	3.37
LSD (0.05)	N.S.	0.11	0.31

FIGURE 1
Effect of tillage level in 1982 and 1983 on alfalfa and dandelion season total yields in 1983 at Kalispell, MT.

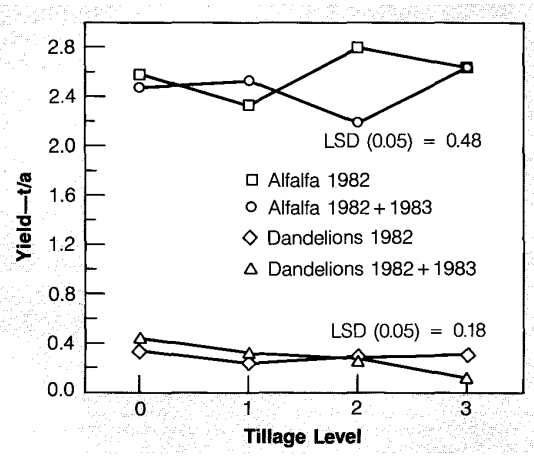


FIGURE 2
Effect of tillage level on alfalfa stand density and root injury at Kalispell in 1982

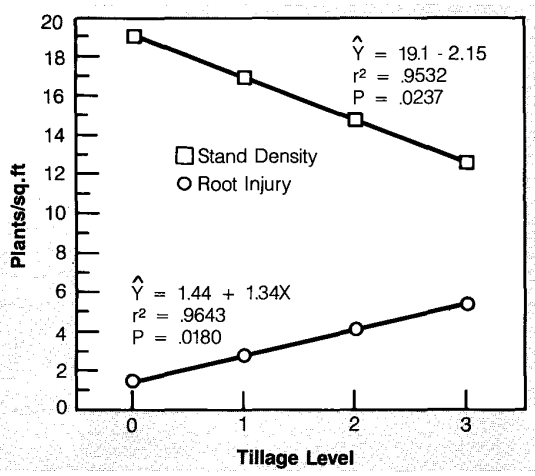


FIGURE 3
Effect of tillage level on alfalfa crown and root size at Kalispell in 1982. Scored on a 1-3 scale for increasing crown and root size.

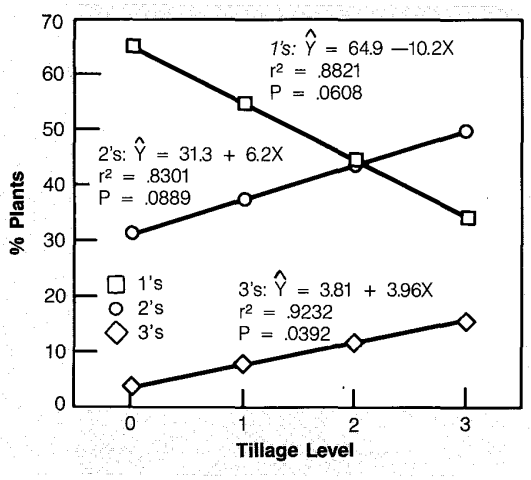
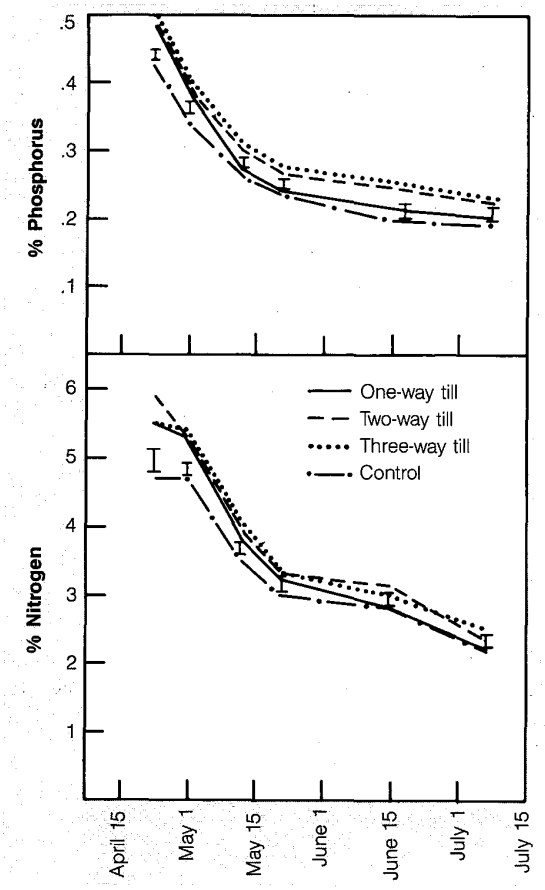


FIGURE 4
Effect of tillage level on P and N percentage of alfalfa at Kalispell, in 1982. Vertical bars denote least significant differences (P = 0.05)



enough plants to allow increased growth of remaining alfalfa plants.

Lesions were observed on alfalfa roots (top 4 inches) from all treatments (including control), indicating that tillage was not the only cause of root injury. However, the number of alfalfa plants injured by tillage increased as level of tillage intensity increased (Figure 2).

Tillage increased the percentage of N and P in alfalfa plant tissue, particularly early in the season (Figure 4). Increased nutrient uptake was probably due to higher soil temperatures in the tilled plots.

Plants were not scored for disease severity because necrosis of roots and crowns was not evident in most alfalfa plants. Spring tillage in 1982 did not appear to increase the incidence of crown and root rot by the fall of 1982. Lateral or vertical spread of necrosis from the injured tissue was not observed.

Conclusions

Results from previous studies showed that alfalfa suffering from weed competition could be stimulated by tillage with a shank implement. This study was designed to ascertain the effect of multiple (up to three) tillages on stands and yields of alfalfa. While alfalfa stand densities were significantly reduced by increased tillage, yields were not affected as much as anticipated because of crown and root size compensation. As plant numbers were decreased, crown and root size increased. Alfalfa yields from a single two-pass tillage were greater than a single three-pass tillage, but were not different than the control (no tillage). Two consecutive yearly spring tillages (1982 and 1983) decreased alfalfa yields as compared to no tillage. Under no circumstances did tillage (1, 2 or 3-pass) of a young vigorous stand significantly increase alfalfa yields as compared to the control (no tillage). Tillage increased N and P concentrations in alfalfa, particularly in early spring.

Acknowledgement

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