Application of Dairy Manure on Alfalfa

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Many dairy farms in Massachusetts and the Northeast have a high ratio of livestock per acre of cropland. High density confinement of animals offers economies of scale but often results in problems for manure disposal. Often nitrogen availability exceeds the amounts required for current acres of corn. In Lancaster County, Pennsylvania, manure applications average over 40 tons acre^{-1}. Similar results have been determined for many dairy farms in Massachusetts using a computer program to quantify nutrient balance. Corn fields closest to the barn or manure storage area often receive manure applications at rates far above crop requirement. In addition, many farmers apply commercial fertilizer, further adding to the problem of nutrient excesses and potential contamination of ground and surface waters.

Only a small amount (less than 20%) of the nitrogen input into forage production leaves farms in the form of milk or meat. Since dairy farms also import nitrogen in purchased feed grains along with commercial fertilizer, there is a continual increase in nitrogen to the total system. This often results in over-application of nitrogen from manure and commercial fertilizer especially on corn fields. Some of this nitrogen is lost as nitrate to groundwater. Economic viability of some crop-livestock farms will be adversely affected if environmental regulations limit application rates to corn fields and alternative waste handling options are deemed necessary.

Manure application to perennial forages in addition to the application to corn on dairy farms would greatly increase the land area for spreading, decreasing the amount spread on any field and thus lessening the potential of nitrate leaching. Such a strategy has been found to reduce the negative impacts of agronomic and environmental limits on manure management in farm profitability. Alfalfa is often grown on the same soils as corn and is the preferred perennial forage legume by farmers. However, manure or nitrogen fertilizers are not usually applied to forage legumes. This is because well nodulated legumes fix nitrogen from the atmosphere, and the added nitrogen from manure may stimulate weed growth, intensifying weed competition with alfalfa.

This research has been designed to evaluate the impact of such applications on alfalfa yield, stand persistence and weed competition on two Massachusetts soils. This research will provide agronomic, environmental and economic information on this alternative strategy for manure utilization on dairy farms with limited land resource for manure application.

Experiments are being conducted on one-year old stands of alfalfa at the University of Massachusetts Research Farm, South Deerfield, Massachusetts, and at a farmer's field in Sunderland, Massachusetts. The soil at South Deerfield farm is a low in organic matter Hadley fine sandy loam (coarse-silty, mixed, nonacid, mesic Typic Udifluvent) while the site at Sunderland consists of an Agawam (coarse, loamy mixed, mesic Typic Dystrochrept) - Hollis (coarse, loamy, mixed mesic Lithic Dystrochrept) complex.

Five treatments were laid out in four randomized blocks with bordered plots 10 ft x 20 ft.

Treatments were as follows:

1. Check (no manure or N fertilizer)
2. Low manure (100 lb N ac^{-1} yr^{-1} equivalent)
3. High manure (300 lb N ac^{-1} yr^{-1} equivalent)
4. Low N fertilizer (100 lb N ac^{-1} yr^{-1} from NH_4NO_3)
5. High N fertilizer (300 lb N ac^{-1} yr^{-1} from NH_4NO_3)

Liquid dairy manure (0.33% total nitrogen, 0.145% ammonia nitrogen and 0.185% organic nitrogen) was applied to alfalfa immediately after the 1st cutting. Tensiometers and suction lysimeters were installed at 30, 60, 90 and 120 cm depths in the spring of 1990 for the purpose of measuring water availability and taking water samples for NO_3-N.

NO_3-N Concentration in Lysimeter Water Samples

At both experimental sites significant amounts of NO_3-N, (above the water quality standard of 10 ppm), were observed in the soil water samples (Figures 13 and 14). The variation in NO_3-N in leachate under the various treatments was appreciable. Concentrations of NO_3-N peaked 20 to 30 days after spring fertilizer or manure application, and were lower in late fall and early winter. It was observed that the NO_3-N in lysimeter water samples generally was high immediately after a rainfall event.

Treatment difference in mean NO_3-N concentration (averaged across all sample dates) in water samples was significant. The high N fertilizer rate at the University Research Farm resulted in significantly higher concentrations of mean NO_3-N compared to all other treatments. Application of N fertilizer at the low rate also showed significantly higher concentration of NO_3-N as compared to the low manure or check plots when averaged for the whole season, and was similar to the high manure treatment. The NO_3-N concentration in the samples collected from manured and check plots was low.

Similar trends were observed in the other experimental site in Sunderland. High N fertilizer showed significantly higher mean NO_3-N concentrations as compared to all

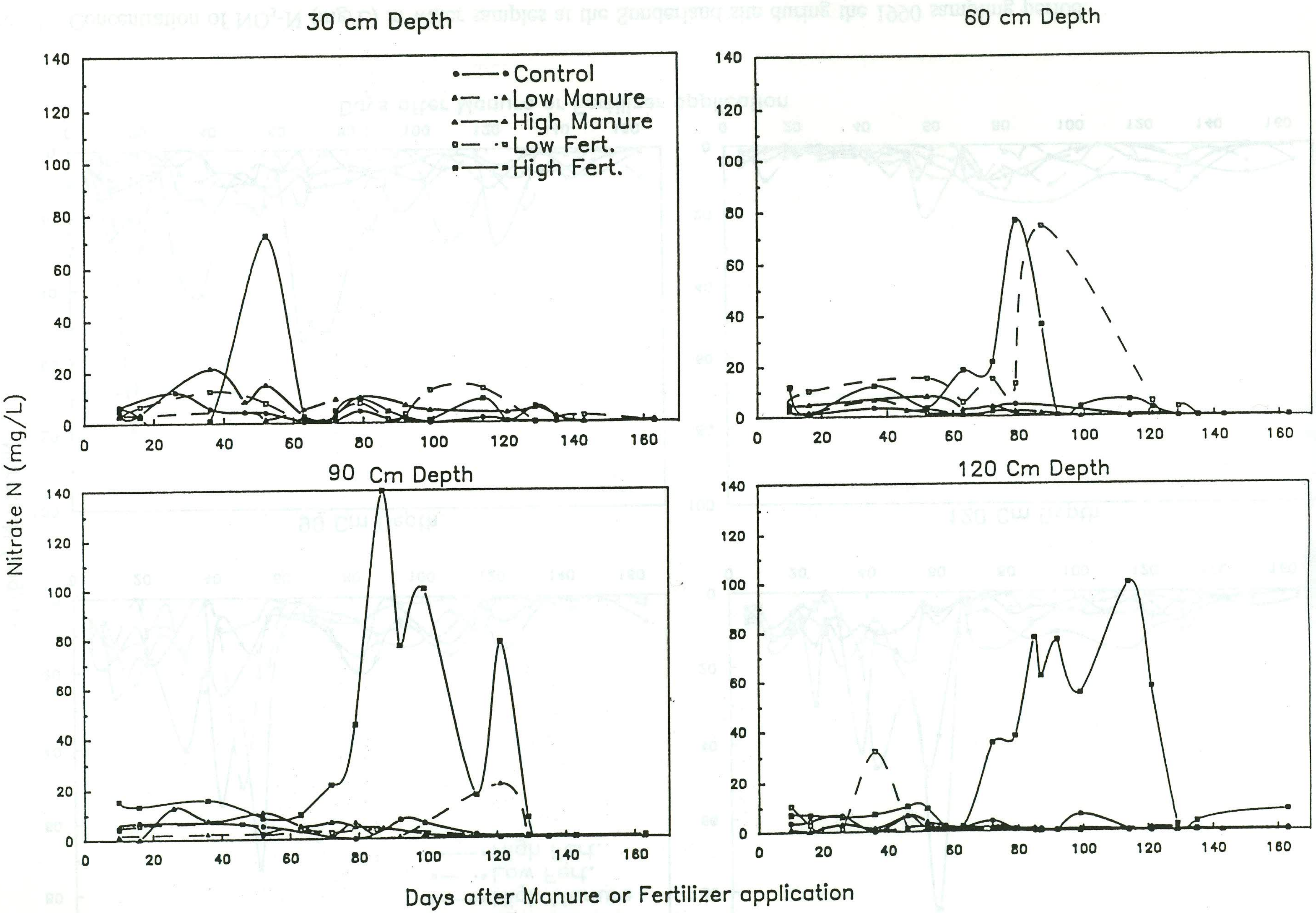

Figure 13. Concentration of NO_3-N (mg/L) in water samples at the South Deerfield site during the 1990 sampling period.

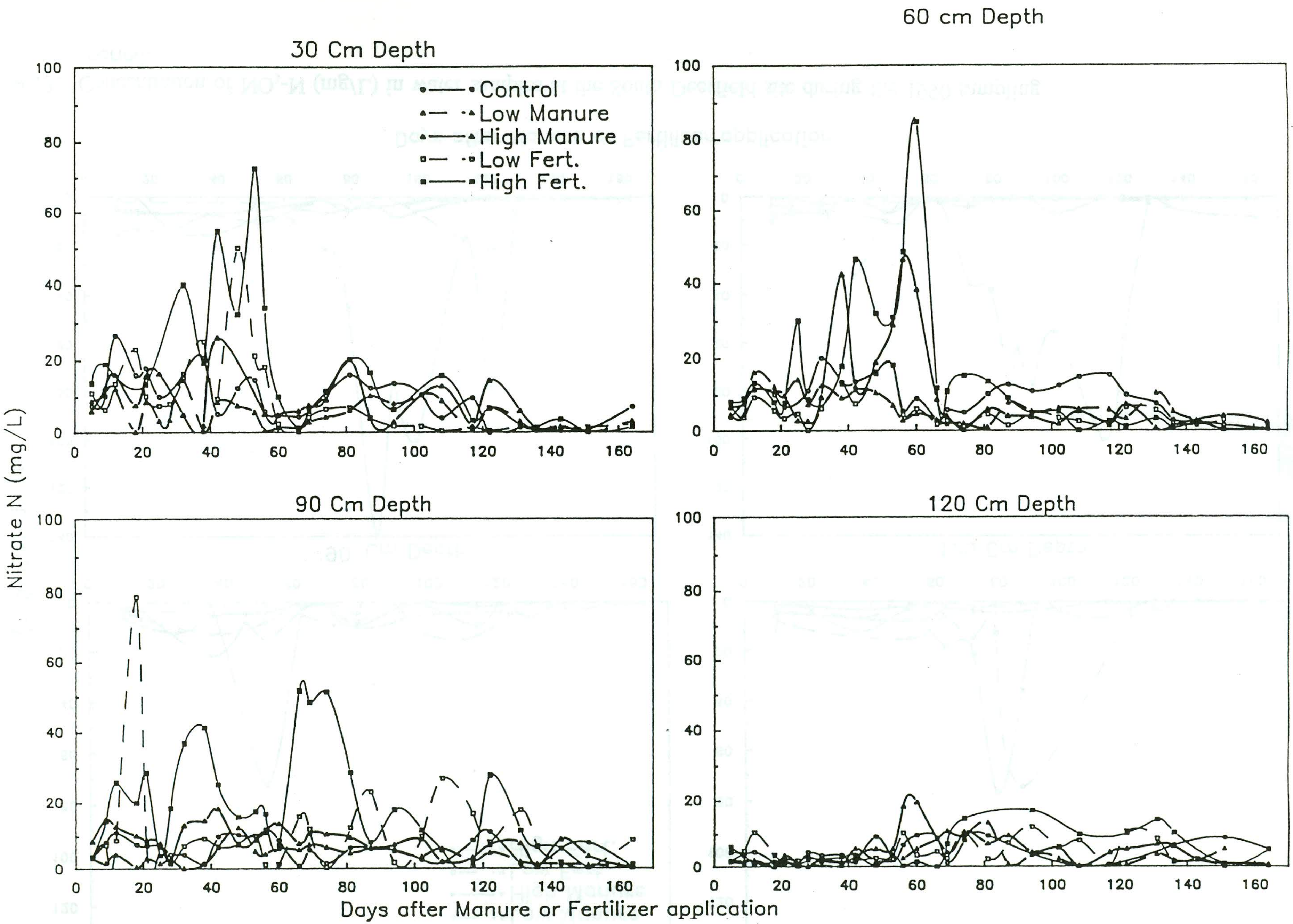

Figure 14. Concentration of NO_3-N (mg/L) in water samples at the Sunderland site during the 1990 sampling period.

other treatments. At this site high manure and low N fertilizer plots showed a higher concentration of mean NO_3-N compared to low manure plots, and NO_3-N in low manured plots was significantly lower than the concentration in check plots.

The interaction between treatments and depths was significant at both experimental sites. NO_3-N concentration in water samples collected from 60 and 90 cm depth was comparatively higher (Figures 13 and 14) and the difference among treatments was distinct. At the University Research Farm high concentrations of NO_3-N were observed even at a depth of 120 cm, especially in the high N fertilizer plots. In the Sunderland site high concentrations of NO_3-N also were observed at 30 cm depth, and the differences in concentration among treatments were large.

The variation in NO_3-N concentrations over time from the day of manure or fertilizer application was highly significant (Figures 13 & 14). At the Sunderland site, the samples collected in the first two months (July and August) after fertilizer or manure application showed higher concentrations of NO_3-N. Thereafter the concentrations are comparatively low. This may be due to the coarser soil, which may have resulted in faster percolation of rain water transporting nitrates. At the University Research Farm, higher concentrations of NO_3-N in lysimeter water samples were observed up to 4 months after fertilizer or manure application, especially in the high fertilizer treatment. Rainfall seemed to influence the wide fluctuations in NO_3-N concentrations at different times of the season.

The NO_3-N concentration in the water samples collected this spring in 1991 were low and did not show any significant differences among treatments (Figure 15 & 16).

Alfalfa Forage Yield

The yield differences among the treatments were not significant (Table 7) in both experimental sites except the 3rd cutting at the Sunderland site. In that instance high manure, low fertilizer and high fertilizer treatments showed significantly higher forage yield compared to control plots. It is interesting to observe that application of inorganic fertilizers at low or high rates did not improve yields significantly. Application of inorganic nitrogen fertilizers to alfalfa is not a regular or economic practice, but in the context of this project, comparing these fertilizer rates with dairy manure application showed appreciable differences in nitrate nitrogen concentrations in the leachate even though there were no differences in forage yield.

Weed competition

Application of manure at low or the high rate did not increase total weed population or any particular weed species during the first year. Nor was growth of existing weeds increased by additions of nitrogen fertilizer.

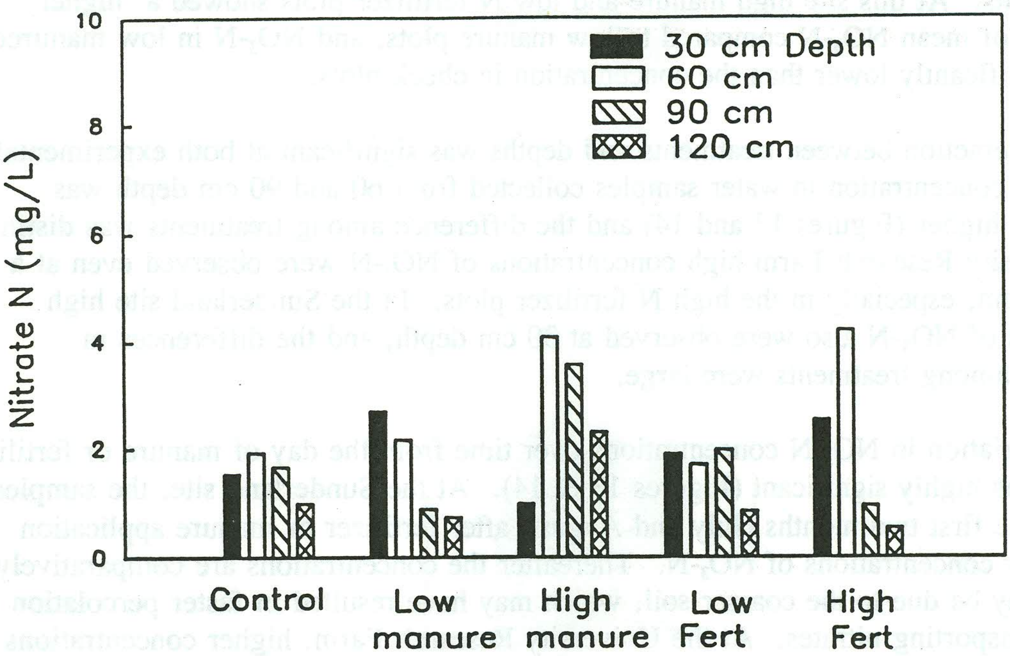

Figure 15. Concentration of NO_3-N (mg/L) in water samples at South Deerfield in the spring of 1991.

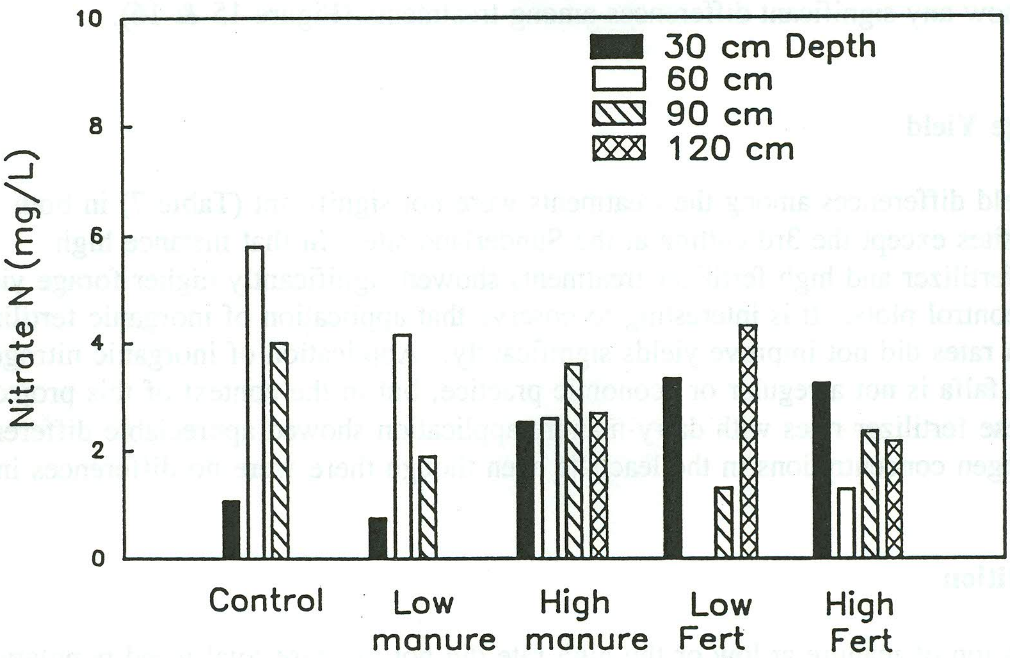

Figure 16. Concentration of NO_3-N (mg/L) in water samples at Sunderland in the spring of 1991.

Table 7. Forage yield at the South Deerfield and Sunderland sites for the second and third harvests in 1990.

Treatment	2nd Cut S. Deerfield	2nd Cut Sunderland	3rd Cut S. Deerfield	3rd Cut Sunderland
	---------------------------Mg/ha		---------------------	
Check	3.9	3.9	2.9	3.2b
Low manure	4.0	3.9	3.0	3.6ab
High manure	4.1	3.8	3.3	3.7a
Low N fertilizer	4.2	4.0	3.0	3.8a
High N fertilizer	4.2	4.0	3.1	4.0a
	n.s	n.s	n.s	

Conclusions

Preliminary findings indicate that application of manure at the low rate on alfalfa did not result in higher concentrations of NO_3-N in the suction lysimeters leachate compared to check plots. If this trend remains in succeeding years of this study then dairy manure could be applied to alfalfa at rates equivalent to 20 to 30 tons per acre without an adverse effect on water quality. Such a practice may enable farmers to reduce overapplications of manure to corn fields.