Application of Excess Manure on Alfalfa for Groundwater Protection

Stephen Herbert, Jayaram Daliparthy and Peter Veneman
Department of Plant and Soil Sciences

Manure disposal is a major problem for most of the dairy farms in northeastern United States. Manure availability normally exceeds the amounts required for current acres of corn resulting in a potential nitrate pollution source of groundwater. Manure application to forage legumes would greatly increases land area for spreading and decreases excess application to corn fields.

A Minnesota study concluded that although nitrogen availability may exceed the amount required for crops on dairy farms, efficient use of nitrogen from manures may not be compatible with economic efficiency from the farmers perspective. Our experience in Massachusetts shows that farmers are hesitant to truck manure to distant fields many of which tend to be rented. Research suggests applications of rates of manure to corn fields should be below 224 kg N ha^{-1} (200 lb $acre^{-1}$) for maximum utilization efficiency. When the long term effect of manure application is evaluated quantitatively using 'decay series', recommended rates will be much lower. Some fields are unresponsive to nitrogen additions because of previous applications of manure.

Alfalfa being a deep rooted crop can remove large amounts off nitrate from the soil despite its ability to symbiotically fix atmospheric nitrogen. Soil rich in nitrate inhibits fixation thereby reducing the total input of nitrogen into the cropping cycle and limiting the leaching of nitrates into the groundwater.

Usually manure or nitrogen fertilizers are not applied to forage legumes. Animal manure often contains viable weed seeds that may increase weed problems. It is one of the major concern for dairy farmers to spread manure on alfalfa. The spread of velvetleaf in Massachusetts corn fields has mainly been a direct result of spreading manure containing velvetleaf seed. Present research was conducted to study the impact of manure application to alfalfa on forage production, weed incidence and possible nitrate leaching into ground water.

Field Experiments: Field studies were established in 1990 on one and two-year old stands of alfalfa at the research farm in South Deerfield and at a farm in Sunderland. Five treatments were laid out in four randomized blocks in bordered plots 3m x 6m. Treatments were: check (no manure or N fertilizer), low and high manure (112 & 336 kg N ha^{-1} yr^{-1} equivalent), and low and high N fertilizer (112 & 336 kg N ha^{-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 in 1990 and 1991 immediately after the 1st cutting. Phosphorus and potash fertilizers were applied in amounts equivalent to amount of P and K in the high manure treatment. Harvest management was a 3-cut system with the first cut at full bud and the next two at 10% bloom. Sub-samples was taken to determine percent broadleaf and narrowleaf weeds.

Soil solution monitoring: Porous ceramic cup suction water samplers were installed in June 1990 in 3 replications at depths of 30, 60, 90 and 120 cm. Water samples were collected twice a week during the growing season and biweekly during the late fall; June to November, 1990 and April to November, 1991. Water samples were analyzed for nitrates by the cadmium reduction method using a Technicon auto analyzer.

Mean NO_3-N concentration in water samples: Variation in NO_3-N in leachate (June 1990 to Sept. 1991) at both experimental sites under the various treatments and sampling depths was appreciable, and the covariance was also high. Treatment differences in mean NO_3-N concentration (averaged across all sample dates) in water samples were significant (Figure 1). During 1990, mean NO_3-N at Deerfield site was less than 10 mg/L in control, low and high manure treatments, whereas NO_3-N leaching from high fertilizer plots was high. However, an increase in NO_3-N in water samples from high manure plots was observed in the second year. Water samples from low manure plots had less than 5 mg NO_3-N/L mean concentration. At the Sunderland site trends were similar to Deerfield except mean NO_3-N concentration in leachate was mostly higher. This may be due to the coarser textured soil at the Sunderland site.

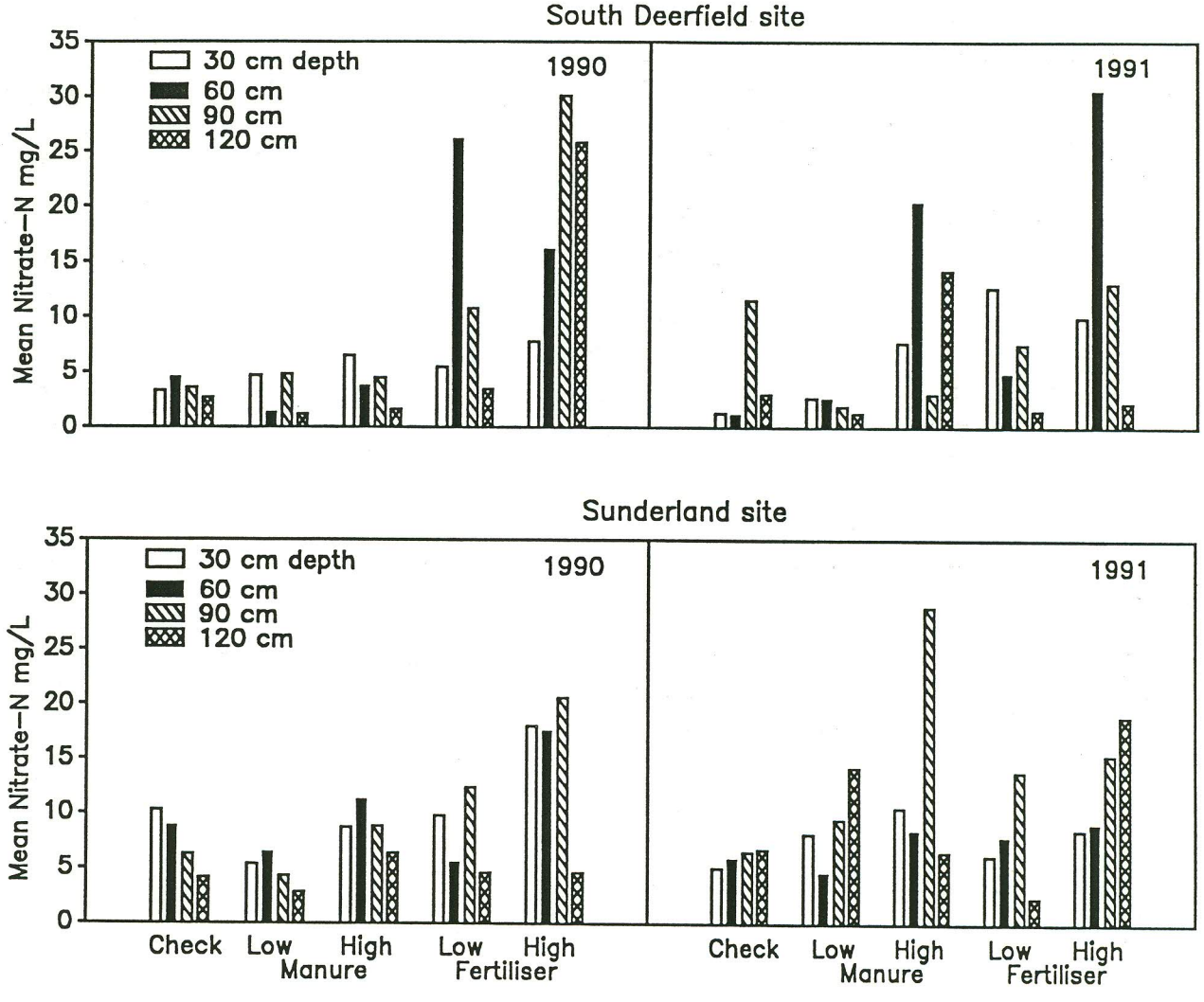

Figure 1. Mean NO_3-N concentrations in water samples (June 1990 to Sept.1991) from different depths at the South Deerfield and the Sunderland sites.

The interaction between treatments and depths was significant. NO_3-N concentrations in water samples collected from 60 and 90 cm depths were mostly higher than 30 and 120 cm depths. However, high concentrations of NO_3-N were observed even at a depth of 120 cm, especially in the high fertilizer plots at the Deerfield site in 1990 and the Sunderland site in 1991.

Forage Yield: Yield differences among the treatments during 1990-91 were not significant (Table 1) at either experimental site. However, there were significant differences in 1991-92. In that instance, the high manure treatment at the Deerfield site showed significantly lower tonnage of alfalfa compared to other treatments. This was not the case at the Sunderland site, where control and low fertilizer treatments had significantly lower yields. Forage yields were higher at the Deerfield site compared to the Sunderland site during 1991-92. This could be due to the greater moisture holding capacity of soils and younger age of the alfalfa stand at the Deerfield site. Forage yields were lower at both sites in the 1991-92 season compared to the previous year. Lower yields were due to prolonged dry weather and normal aging of alfalfa stands. Application of inorganic fertilizers or manure at low or high rates did not improve yields.

Table 1: Effects of manure and nitrogen fertilizer on alfalfa forage yield

Treatments	South Deerfield 1990-91*	South Deerfield 1991-92	Sunderland 1990-91	Sunderland 1991-92
	Mg/ha/yr			
Check	13.50	12.57	13.50	9.30
Low manure	13.80	12.62	13.83	10.36
High manure	14.20	11.04	13.80	10.24
Low fertilizer	14.30	12.81	14.61	9.60
High fertilizer	14.30	12.66	14.70	10.50
LSD at 0.05	NS	0.87	NS	0.72

* Sum of 2nd and 3rd cuttings of 1990 and 1st cutting of 1991 before second manure application.

Weed competition: Application of manure did not increase dicot or monocot weeds or any particular weed species during the first year. In the second year there was an increase in the weed population in all plots at the Sunderland site, but this alfalfa stand was in normal decline.

Conclusions: Presently available research findings indicate that the application of manure to alfalfa at the low rate neither increased concentrations of NO_3-N in leachate nor decreased forage yield compared to control plots. If the trends observed continue in succeeding years of this study, then excess dairy manure could be applied to alfalfa at lower rates depending upon soil type without an adverse effect on water quality and forage yield. Such a practice may increase land area available to spread excess manure and enable farmers to reduce overapplications of manure to corn fields.