Evaluation of the Survivability of Fecal Coliform in Soil after Winter Application of Dairy Slurry on a Transitional-organic, Grazing Based Dairy.

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ABSTRACT. *The lifespan of soil bacteria can affect the potential of bacterial transport to surface waters and therefore influence policy decisions for land application of manure. The persistence of fecal coliform and Escherichia coli in the top 3.8 cm of soil was evaluated after spreading dairy slurry during winter months on a transitional-organic, grazing based dairy in southwestern Washington. Two applications of dairy slurry were applied, once in December 2003 and again in January 2004, by broadcast manure applicator to pastureland in an area approximately 3 to 4 times greater than routine farm practice. Soil cores were taken from plots in a setback zone or slurry application area using a 6 cm diameter soil probe at a depth of 3.8 cm and included surface material. Background soil samples were taken prior to slurry applications to establish baseline levels of fecal coliform and E. coli. Soil samples for determination of fecal bacteria were taken daily for 7 and 4 d, respectively, after the December and January slurry applications and on a weekly basis until bacteria levels were near background concentrations. Bacteria counts increased in the soil with slurry application and a subsequent increase in fecal coliform numbers occurred two to three days after slurry application. Fecal coliform numbers declined over 3 log(10) CFU per 100 g of soil within 52 days after the December slurry application and 42 days after the January slurry application. Fecal coliform bacteria had a relatively short lifespan after application on grassland during the winter months.*

Keywords. *Fecal coliform, Escherichia coli, dairy slurry, soil.*

INTRODUCTION

Application of dairy slurry to pastureland increases the concentration of fecal coliform bacteria present on the soil. The presence of fecal bacteria on soil and/or plant material increases the risk of transport of fecal bacteria to surface water (Nunez-Delgado et al., 2002). In addition, some fecal bacteria can be hazardous to human or animal health if the bacteria are ingested (Jones, 1999).

Developing an understanding of the length of time fecal coliform and *Escherichia coli* can survive in soil environments is an important factor in evaluating the risks associated with application of dairy slurry. Previous reports on the persistence of fecal coliform and *E. coli* on soils have been variable. Avery et al. (2004) reported that *E. coli* survived up to 162 days and Stoddard et al. (1998) found that fecal bacteria declined to non-detectable levels in 60 days after manure application.

The objective of this study was to evaluate the persistence of fecal coliform and *E. coli* bacteria on soil after application of dairy slurry on a native pasture in a grazing-based dairy operation.

MATERIALS AND METHODS

Dairy slurry was surface applied in December 2003 and January 2004, without incorporation, to a native pasture used for management intensive rotational grazing of dairy cattle. Background soil samples were taken on 8 Dec. 2003. Dairy slurry was surface applied to a 1.16 ha area of pasture on 12 Dec. 2003 using a splash-plate manure applicator. Slurry was applied at a rate of 0.036 kg $(m^2)^{-1}$, covering an area four to five times greater than normal daily slurry applications for this dairy. After the December application, three soil plots (148.6 m^2), located 30.5 m from each other, were designated for soil sampling. Two of the soil plots (X and Y) were located in the slurry application area and one plot (Z) was located in a setback zone between the application area and a grassed waterway. Soil samples were taken on a daily basis from 13 to 19 Dec. and on a weekly basis from 21 Dec. 2003 to 26 Jan. 2004.

Dairy slurry was surface applied on 27 Jan. 2004 to a 0.49 ha area at a rate of 0.039 kg $(m^2)^{-1}$, which covered an area two to three times greater than a normal daily slurry application for this dairy. Soil samples were taken on a daily basis from 28 Jan. to 31 Jan. 2004 and on a weekly basis from 2 Feb. to 9 Mar. 2004. Samples were collected from three 37.2 m^2 plots located 12.2 m apart. Plots M and N were in the slurry application area, whereas Plot O was in a grass setback zone.

Sample Collection

Soil samples were taken using a 6-cm diameter soil probe at a depth of 3.8 cm. Three soil cores were taken from each plot and included grass and surface material. Each core was divided into 2 parts and placed into separate sterile sample bags. One set of cores was used for microbiological analyses and the other set was frozen. The soil probe was cleaned and sterilized between plots with a 90% isopropyl alcohol solution.

Laboratory Analyses

Soil and slurry samples were analyzed for fecal coliform and *Escherichia coli* within 6 h of sample collection. Soil samples were diluted in a 1:1 ratio of milliliters sterile buffer water to grams of wet soil. The soil and buffer solution mixture were placed into a stomacher for 1 minute at 200 rpm. Samples were allowed to settle for approximately 15 min, after which 5 ml of solution was pipetted from the top of the sample. Samples containing soil particulates were pre-filtered using a 2.5 µm filter. After pre-filtering, soil samples were membrane filtered and incubated according to Clesceri et al., 1998.

Results and Discussion

Soil fecal coliform concentrations increased after application of dairy slurry in both December and January (Figures 1 and 2). The concentrations of fecal coliform in the dairy slurry were 5.02 log(10) CFU g^{-1} and 4.51 log(10) CFU g^{-1} in the December and January slurry applications, respectively. After the slurry applications, there were subsequent increases in the concentrations of fecal coliform bacteria in the soil. However, the multiplication of bacteria was a short-lived occurrence, with declines in fecal coliform concentrations seen less than 1 week after the slurry applications. The cause of the increases in fecal bacteria concentrations detected during the first week after application was not known, but may have been due to environmental changes.

After the January slurry application, there was some movement of fecal bacteria into the plot O (Figure 2), which was located in the setback zone, after 5.6 cm of rainfall (in the first 72 hours after application) led to direct runoff of the slurry from the application area. Similarly, Nunez-Delgado et al. (2002) reported that fecal bacteria were transported to buffer strips with rainfall events. Fecal coliform levels in Plot O declined to background levels in less than 17 days after the large rainfall event.

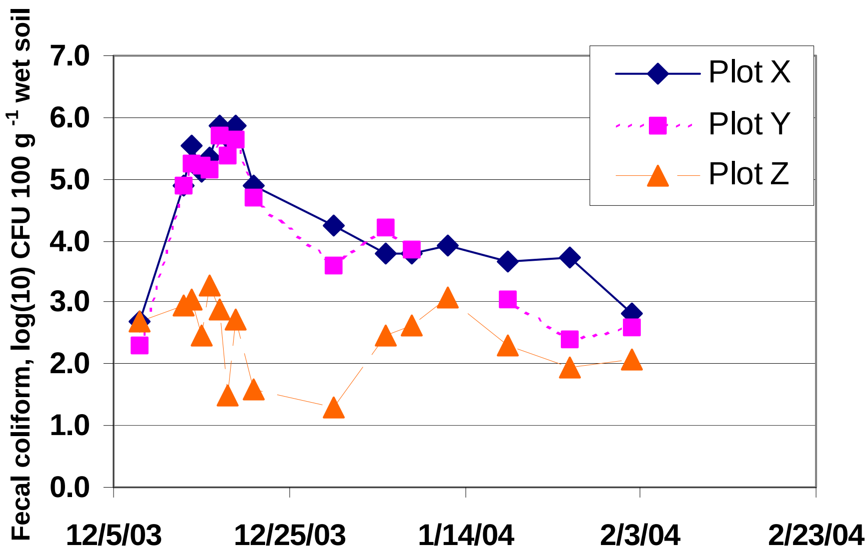

Figure 1. Fecal coliform bacteria concentrations in soil from plots X, Y, and Z before and after application of dairy slurry on December 12, 2003. Plots X and Y were located in the slurry application area and plot Z was located in a grass setback zone between the area applied with dairy slurry and a grassed waterway.

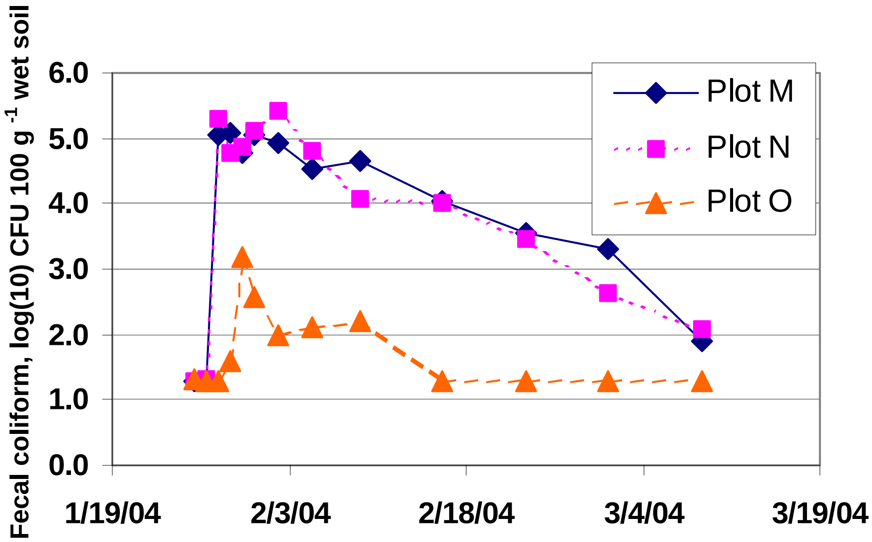

Figure 2. Fecal coliform bacteria concentrations in soil from plots M, N, and O before and after application of dairy slurry on January 27, 2004. Plots M and N were located in the slurry application area and plot O was located in a grass setback zone between the area applied with dairy slurry and a grassed waterway.

On average, soil fecal coliform concentrations in our study declined 0.043 log(10) cfu 100 g^{-1} per day after the December application and 0.078 log(10) cfu 100 g^{-1} per day after the January application. The concentrations of fecal bacteria reached background levels 52 and 42 days after the December and January slurry applications, respectively. In comparison, Stoddard et al. (1998) reported that fecal coliform levels had returned to background concentrations in less then 60 days, whereas Avery et al. (2004) found that E. coli survived for up to 162 days. Lenehan et al. (2004) found that fecal coliform levels in a pasture area used to feed cattle returned to background levels in less then 3 months.

CONCLUSION

Direct runoff of slurry led to some movement of fecal coliform bacteria into the setback zone. Soil fecal coliform concentrations returned to background levels in less than 52 days after application of dairy slurry to a native pasture.

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