Relationship of Soil Nutrient Content from Poultry Litter and Dairy Manure on Microbial Survival in Fescue Soils.

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Introduction

➢**Nutrient accumulation from manure application**

- Poultry litter is high in P and some micronutrients in relationship to the quantities required by plants (Sistani et al., 2004).
- Application of higher litter rates resulted in accumulations of P, K, Cu, and Zn in the top 5 cm of soil (Adeli et al., 2008).
- Broiler litter applied to meet N requirements can give 8x as much P as needed (Franzluebbers et al., 2002)
- In a 5 year bermudagrass study using poultry litter, Zn concentrations were found to be 2.1 times higher in soils with poultry litter application in comparison to inorganic fertilization (Franzluebbers et al., 2004).

➢**Microbial Survival after manure application**

- Most of the previous research on pathogen/microbial survival has been in vegetable crop production.
- In a study by Natvig et al.(2002), it was found that *Salmonella enterica* and *Escherichia coli* survival was influenced most by temperature, moisture and length of time in the environment.
- *Escherichia coli* and *Salmonella enterica* were reduced by 99% after 1 hour in 55-65 ^{0}C laboratory conditions (Wilkinson et al., 2011). As would be anticipated, moisture (65% vs. 30%) made these pathogens survive for a longer time in the laboratory, up to 21 days.
- High soil moisture coupled with low temperatures was found in most studies to favor enteric pathogens persistence in soil (Entry et al., 2000)
- Other factors that seem to also correlate with soil moisture and survival are season, presence of plant root systems, and decaying materials all increase soil microbial populations (Dowe et al. 1997).
- Poultry litter compost that was windrowed, led to increased E. coli densities when incubated in a lab for up to 21 days (Wilkinson et al, 2011).

Objective

➢ To determine if select microbes survival is influenced by fertilizer source in tall fescue soils and on tall fescue grass blades.

Materials and Methods

➢**General Study Information**

➢**Sample Site**: WKU Agricultural Research and Education Complex, Bowling Green, KY
➢**Fertilizer application**: May 17, 2011
➢**Fescue harvest and soil nutrient analysis dates**: June 21, Aug. 9, and Oct. 6, 2011.
➢**Microbial sampling**: May 17, 18, 19, 21, 24, June 2, 8, 22, 29, July 13, Aug. 9 and Oct. 6, 2011.
➢**Soil samples**: Fifteen random soil cores were taken from each plot before fertilizer and at each harvest.
➢**Soil type**: Crider silt loam (Typic Paleudalf)
➢**Soil slope:** 0-2%
➢**Statistical Design**: split plot
➢main plot variable=tillage
➢ subplot variable= fertilizer source

➢**Table 1. Fertility treatments** (total amount on a dry weight basis)

Year	DM	PL		I	C
	------------Mg ha^{-1}	PL----------------		------------------kg ha^{-1}----------------	
2011	5.5	16.3	N	225	0
			P_2O_5	45	0
			K_2O	180	0

➢**Microbial Sampling Protocol**

➢25 g of manure or soil placed in 100 ml Buffered Peptone Water (BPW), shaken 10 mins at 200 rpm.
➢500 µl of BPW mix place in 4.5 ml of 0.1 XPBS for plating.
➢5 ml of BPW mix added to Bolton and UVM Broth for selective enrichment.
➢1 ml of BPW mix saved for molecular analysis and duplication.
➢After removal of the above aliquots, the remaining BPW was incubated at 37^{0}C for 24 hours for broth inoculations.
➢5 organisms were targeted for detection: *Enterococci*, *E. coli*, *Campylobacter*, *Listeria*, and *Salmonella* on their respective media and by molecular analysis.

Results and Discussion

➢**Comparison of Soil Measurements by Fertilizer Source and Tillage (Tables 2 & 3)**

–After a 2 factor repeated measure ANOVA showed no differences in fertilizer x time, tillage x time, fertilizer x tillage, and fertilizer x tillage x time interactions, data were averaged across the three harvests for statistical analysis (p<=0.05).
–pH were similar by tillage and fertility treatment (p<=0.05).
–P and K were equal by tillage treatment. P and K were equal in all fertility treatments except C which was lower than DM (p<0.05).
– No differences between tillage or fertility treatments were detected in regards to Cu accumulations (p<=0.05).
–Zn concentrations were higher in no-till compared to tilled fields. DM and PL had the highest Zn levels. PL, I, and C were all similar in Zn levels (p<=0.05).

➢**Initial Indicator Organisms in Manures** (Data not shown)

–Total cell counts were 1.98x10^{10} (+/- 5.6x10^9) cells g^{-1} of poultry litter and 1.10X10^7 (+/- 7.4x10^6) cells g^{-1} in dairy manure.
–*Enterococci* cell counts were 1.22x10^9 (+/- 3.33x10^8) cells g^{-1} of poultry litter and 1.53x10^6 (+/- 5.72x10^5) cells g^{-1} dairy manure.

➢**Microbial Survival in Soils (Table 4)**

–Statistical analysis was a two factor repeated measures ANOVA design.
–Fertilizer source (C vs. DM vs. PL) was significant over time with the *Enterococci* population (p<=0.05)(Figure 1).
–DM and C treatments did not change *Enterococci* populations over time. Populations in these treatments were similar to day 0 levels.
–*Enterococci* populations spiked day 1 to 15 with the PL treatment with day 4 being highest. (Figure 1)
–Over time, both tillage treatments showed similar changes in regards to *Enterococci* populations (p<0.05). Both had peak *Enterococci* populations by day 4 and diminished from there (Figure 2).

Table 2. Selected soil properties based upon fertility treatment.

Soil Measure	Fertility Treatment Control (C)	Dairy Manure (DM)	Poultry litter (PL)	Inorganic Fertilizer (I)
pH	6.6 (±0.20)^a	6.7 (±0.15)^a	6.3 (±0.12)^a	6.3 (±0.24)^a
	-------------------------mg kg^{-1}	-------------------------		
P	41.91 (±11.51)^b	69.55 (±44.41)^a	55.62 (±9.87)^{ab}	46.03 (±11.99)^{ab}
K	88.32 (±17.53)^b	203.58 (±24.94)^a	165.64 (±15.78)^{ab}	1126.83 (±20.62)^{ab}
Cu	4.18 (±0.63)^a	8.73 (±2.26)^a	4.57 (±0.55)^a	3.84 (±0.34)^a
Zn	4.27 (±0.76)^b	6.72 (±4.05)^a	5.44 (±1.06)^{ab}	4.06 (±0.45)^b

p<=0.05

Table 3. Select soil properties based on tillage treatment.

Soil Measurement	Tillage Treatment Till	No till
pH	6.4 (±0.18)^a	6.5 (±0.29)^a
	-----------------mg kg^{-1}	---------------------
P	58.00 (±25.50)^a	48.60 (±25.31)^a
K	162.35 (±47.00)^a	122.84 (±43.89)^a
Cu	6.48 (±0.86)^a	4.18 (±0.92)^a
Zn	5.69 (±2.81)^b	4.55 (±1.53)^a

p<=0.05

Table 4. Average Enterococci populations over 148 day period from application.

	Days after application D0	D1	D2	D4	D7	D15	D21	D35	D42	D57	D84	D148
	----------------------	----------------------	Cell no. g^{-1} soil	----------------------								
Fertility Treatment												
C	6 ^{a}	37 ^{a}	156^a	637^a	481^a	1843^a	975^a	162^a	6212^a	68^a	1556^a	137^a
+/- SD	*17*	*69*	*351*	*1685*	*821*	*4288*	*1853*	*360*	*7875*	*133*	*1896*	*109*
DM	62 ^{a}	125 ^{a}	46875^a	62^a	14881^a	837^a	931^a	793^a	3643^a	75^a	7706^a	531^a
+/- SD	*62*	*220*	*130566*	*138*	*2446*	*914*	*2554*	*1829*	*2802*	*125*	*11763*	*669*
PL	25 ^{a}	140125^b	542812^b	5362500^b	1894275^a	239375^b	40687^b	1156^a	17481^a	1912^b	14706^a	718^a
+/- SD	*6*	*73606*	*520956*	*4314655*	*3154278*	*169798*	*24065*	*1742*	*37615*	*2110*	*17951*	*1102*
Tillage Treatment												
NT	41^a	45729^a	293458^a	1971295^a	1770^a	59379^a	12533^a	708^a	3587a	362^a	9516^a	650^a
+/- SD	*11*	*88075*	*480804*	*3945197*	*3727*	*92159*	*25552*	*1509*	*3524*	*621*	*15325*	*973*
CT	8^a	47795^a	99770^a	1604170^a	1271320^a	101991^a	15862^a	700^a	14637^a	1008^a	6462^a	275^a
S+/- D	*19*	*72091*	*251916*	*3185794*	*2679267*	*190651*	*21940*	*1493*	*30734*	*1970*	*10882*	*412*

p<=0.05

Figure 1. Average *Enterococci* population change over time as influenced by fertilizer source

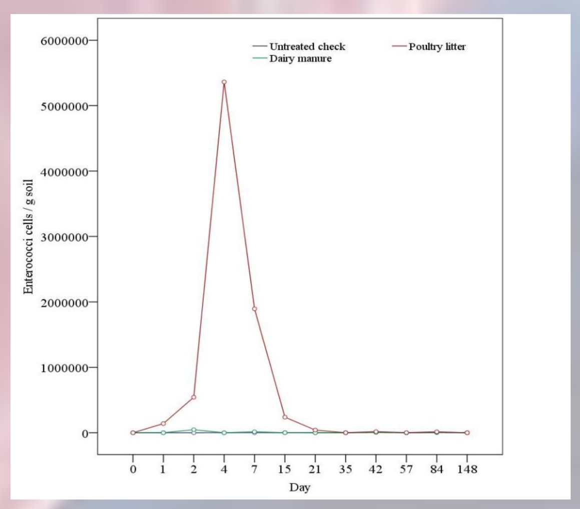
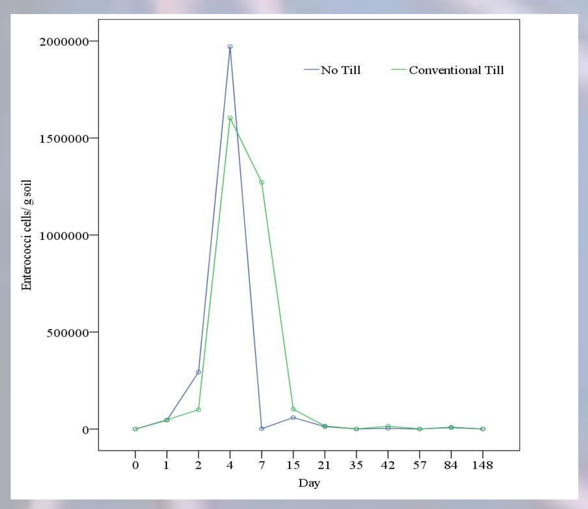


Figure 2. Average Enterococci population change over time influenced by tillage



Summary

➢P and K concentrations were similar in all fertility treatments except C.
➢Zn concentrations were higher in no-till compared to tilled fields. DM and PL had the highest Zn levels.
➢DM and C treatments did not change *Enterococci* populations over time with similar populations to day 0.
➢*Enterococci* populations spiked day 1 through 15 with the PL treatment with day 4 being highest.

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