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EFFECTS OF LAND-APPLIED POULTRY LAGOON EFFLUENT ON THE ENVIRONMENT. 3. SOIL NUTRIENT LEVELS

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Background. Disposal of poultry lagoon effluent is an environmental concern for operators of large poultry farms and the public. Repeated applications of lagoon effluent can cause high levels of nitrogen (N), phosphorus (P), potassium (K), and other plant nutrient elements in the soil and vegetation. Often, effluent is applied on land at rates that provide nutrients in excess of vegetation needs. Concerns with excess loading rates can increase when there is insufficient rain or irrigation water to ensure optimum crop growth. Excess concentrations of nitrates (NO_3) and soluble salts in the soil can lead to nutrient leaching into the groundwater and contamination of drinking water. Excessive nutrients and salts in the soil can cause health problems for grazing animals. Historically, nitrate-N (NO_3-N) is the element of concern when considering the nutrients leaching into the groundwater. High NO_3 concentrations in drinking water are associated with methemoglobinemia in infants. For this reason, the U.S. Environmental Protection Agency has set a maximum contaminant level of 44.3-ppm NO_3 in drinking water. Sodium (Na), a significant portion of salts, can accumulate in soil. The dispersion of soil clay with the resultant sealing of the soil to water and air is a problem associated with high salts of sodium in the soil. Nutrient imbalances from excessive K can cause grass tetany by negatively affecting magnesium (Mg) uptake. In our studies using poultry lagoon effluent for forage grass production, we evaluated the increased soil nutrient loads that resulted from effluent treatments. Average nutrient concentrations in the effluent applied to Ships/Bowie soils, respectively, were N – 581/1480 ppm, P – 76/155 ppm, K – 1121/3217 ppm, Ca – 85/114 ppm, Mg – 36/13 ppm, Na – 327/908 ppm, EC – 843/1458 mS/M, and pH – 7.85/8.07. Effluent was applied to 4- x 8-ft plots at per-acre-equivalent rates of none (0X), 480 lb of N/acre (1X), and 960 lb of N/acre (2X) for Coastal bermudagrass or Coastal bermudagrass/TAM 90 ryegrass forage systems. Soil samples were collected before the initial application and after completion of the study. Selected nutrients were analyzed to determine concentrations resulting from effluent.

Research Findings. Soil pH and EC of the alkaline Ships clay were not increased by effluent application. Surface 6-inch depth pH of the Bowie soil was increased from 6.0 to 6.5 by the 2X effluent rate. The EC of the Bowie soil was significantly increased by the 2X rate of application to a depth of 6 to 12 inches. Concentrations of P in both soils were not affected by effluent application. Soil NO_3-N was increased in the Ships clay by the 2X rate of effluent applied to the bermudagrass/ryegrass forage system (Table 1) and in the Bowie soil by the 2X rate applied to each forage system (Table 2). Soil K was increased by the 2X rate of application in all depths sampled below the bermudagrass/ryegrass forage system in the Bowie soil.

Application. The increase in NO_3-N in both soils that received the 2X rate of effluent indicates that the forages were not able to use all the applied N. Effluent applied at a rate to deliver 480 lb of N/acre appears to be adequate for the bermudagrass/ryegrass forage production system.

Table 1. Soil nitrate nitrogen (NO_3-N) in the Ships clay as a function of soil depth and sampling date. (See report 2, Table 2 for application rates.)

Vegetation and Application rates	0-6 inches		6-12 inches		12-18 inches		18 to 24 inches	
	4/95	4/96	4/95	4/96	4/95	4/96	4/95	4/96
	ppm							
C†-0X‡	2.0 a§	10.3 b	1.7	8.96	1.0	5.9 b	1.0	6.0 b
C-1X	2.0 a	6.2 b	1.7	2.86	1.0	3.9 b	1.0	2.7 b
C-2X	1.7 a	18.2 b	1.3	13.3 ab	1.0	2.5 b	1.0	4.0 b
CR-0X	2.3 a	11.6 b	1.3	5.3 b	1.0	3.8 b	1.0	2.9 b
CR-1X	1.7 a	16.5 b	1.0	5.5 b	1.0	1.7 b	1.0	1.1 b
CR-2X	2.0 a	38.4 a	1.0	24.2 a	1.0	16.8 a	1.0	10.9 a

Table 2. Soil nitrate-nitrogen (NO_3-N) and potassium (K) in the Bowie fine sandy loam as a function of soil depth and sampling date.

Vegetation and application rate	0-6 inches		6-12 inches		12-24 inches		24-36 inches	
	2/95	3/96	2/95	3/96	2/95	3/96	2/95	3/96
	NO_3-N, ppm							
C†-0X‡	1.3 a	3.1 b	0.6 a	2.6 b	0.8 a	1.7 b	1.1 a	1.5 b
C-1X	8.7 a	4.8 b	0.7 a	2.4 b	1.0 a	2.7 b	1.7 a	3.1 ab
C-2X	1.4 a	10.9 a	1.1 a	8.3 a	1.1 a	7.9 a	1.7 a	7.9 a
CR-0X	5.2 a	3.2 b	0.7 a	1.5 b	1.0 a	1.0 b	0.9 a	1.0 b
CR-1X	1.4 a	3.8 b	10.6 a	3.0 b	5.5 a	2.2 b	3.6 a	2.1 ab
CR-2X	7.2 a	10.2 a	3.6 a	7.0 a	2.5 a	5.5 ab	2.8 a	7.5 a
	K, ppm							
C-0X	8 a	97 b	5 a	17 a	0 a	7 c	0 c	48 b
C-1X	10 a	145 ab	0 a	33 ab	4 a	16 c	22 bc	49 b
C-2X	11 a	141 ab	5 a	65 ab	9 a	42 a	83 a	97 ab
CR-0X	10 a	23 b	0 a	6 b	0 a	9 c	15 c	62 b
CR-1X	5 a	129 ab	0 a	11 b	0 a	9 c	12 c	58 b
CR-2X	10 a	229 a	0 a	79 a	6 a	31 b	48 b	128 a

†C = Coastal bermudagrass; CR = Coastal bermudagrass/ryegrass.
‡Application rate: 0X = no N; 1X = 480 lb N/ac/yr; 2X = 960 lb N/ac/yr.
§Averages of three replications. Within a column, numbers followed by the same letter are not statistically different using the Student-Newman-Keuls test with an alpha of 0.10.