FORAGE-LIVESTOCK
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EFFECTS OF LAND-APPLIED POULTRY LAGOON EFFLUENT ON THE ENVIRONMENT. 2. NUTRIENT UPTAKE BY FORAGE GRASSES

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Background. Hen effluent consisting of manure flushed from channels beneath caged birds in intensive egg production houses is a source of soluble plant nutrients. Concentrations of nitrogen from six poultry lagoons in Texas ranged from 400 to 1650 ppm. Phosphorus ranged from 20 to 170 ppm and potassium ranged from 540 to 1150 ppm in a survey conducted in 1994. Consider the high end of each of these nutrient concentration ranges. Irrigating a soil with one acre inch of effluent at these concentrations provides 374 lb of nitrogen, 39 lb of phosphorus, and 260 lb of potassium per acre. At these nutrient rates, sufficient nitrogen to maximize yields of ryegrass and hybrid bermudagrass could be applied with 1.3 acre-inches of irrigated effluent each year, based on research we have conducted. This rate would provide 50 lb of P (116 lb P_2O_5) and 339 lb of K (410 lb K_2O) per acre. A lagoon that covers 9 surface acres with effluent that averages 12 feet deep with these nutrient concentrations could annually supply the plant nutrients needed by a ryegrass–hybrid bermudagrass forage production system on approximately 1,000 acres. We conducted research using effluent generated by laying-hen-house operations to irrigate nutrients onto Coastal bermudagrass and Coastal bermudagrass– TAM 90 annual ryegrass forage systems at two locations. These studies produced plant uptake data for nitrogen (N), phosphorus (P), and potassium (K). Grass samples collected for yield estimates were oven dried, ground to pass a 20-mesh screen, chemically digested and analyzed for N, P, K using standard laboratory methods.

Research Findings. Nitrogen uptake was increased in grasses in both forage systems on Ships clay at College Station and on Bowie fine sandy loam at Overton by increasing the effluent application rate (Table 1). Uptake of P and K was significantly increased in the grasses by the low rate of effluent. Doubling the effluent application rate increased P uptake only in the bermudagrass–ryegrass forage system on the Ships clay. Nutrient uptake efficiencies for N, P, and K were low at all rates in both forage systems on the Bowie soil (Table 2). Doubling the effluent application rate lowered nutrient uptake efficiencies. The forage system based only on bermudagrass had the lowest nutrient uptake efficiency. Nutrient uptake efficiencies were improved by inclusion of ryegrass in the forage production system.

Application. Multiple, split-applications of nutrients in manure wastes were not effective in improving nutrient use efficiency by bermudagrass. Including ryegrass as a cool-season forage in the system greatly improved nutrient uptake efficiency. Even in the double cropping forage system, nutrient uptake efficiency was less than 50% of applied. Nutrients that were applied but not taken into the vegetation could be stored in soils or lost in runoff. Excess N could also be volatilized as NH_3, denitrified to N_2O gas, or leached deeper into the soil as NO_3.

Table 1. Nutrient application and uptake by forage grasses on Ships clay and Bowie fine sandy loam.

Soil type	Appl. rate	Nitrogen		Phosphorus		Potassium	
		Applied	Uptake	Applied	Uptake	Applied	Uptake
		----------lb/acre/year----------					
Ships clay	C†-0X‡	0	78 d§	0	7 c	0	95 d
	C-1X	480	203 c	63	38 b	928	274 c
	C-2X	960	289 b	127	40 b	1853	377 ab
	CR-0X	0	76 d	0	16 c	0	99 d
	CR-1X	480	229 c	63	41 b	928	304 bc
	CR-2X	960	355 a	127	52 a	1853	422 ab
Bowie fsl	C-0X	0	122 e	0	29 d	0	177 d
	C-1X	480	256 d	52	35 cd	1047	360 c
	C-2X	960	334 c	101	41 c	2088	443 b
	CR-0X	0	247 d	0	53 b	0	291 c
	CR-1X	480	490 b	52	75 a	1047	657 a
	CR-2X	960	574 a	101	78 a	2088	677 a

†Cropping system: C = Coastal bermudagrass; CR = Coastal bermudagrass/ryegrass.
‡Application rate: 0X = no N; 1X = 480 lb N/ac/yr; 2X = 960 lb N/ac/yr.
§Average of three replicationPs. 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.

Table 2. Uptake efficiencies for nitrogen, phosphorus, and potassium on the Bowie soil based on the amount of nutrients applied.

Vegetation-application rate	N uptake % of applied	P uptake % of applied	K uptake % of applied
C†-1X‡	27.9	10.3	17.5
C-2X	22.0	11.5	12.8
CR-1X	50.6	43.1	35.0
CR-2X	34.0	24.8	18.5

†C = Coastal bermudagrass; CR - Coastal bermudagrass/ryegrass.
‡Application rate based on N: 1X = 480 lb N/ac/yr; 2X - 960 lb N/ac/yr.