Texas A&M AgriLife Extension

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Using Animal Manure and Wastewater for Crops and Pastures

Figure 1. A big gun nozzle applies effluent to a pasture.

Know and Take Credit for your N, P and K

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Effluent from animal manure and wastewater impoundments is often applied to field crops and pastures using big gun nozzles and sprinkler systems. This effluent contains nitrogen (N), phosphorus (P), potassium (K) and micronutrients essential for plant growth.

When managed properly, irrigation of crops with effluent reduces a producer's reliance on commercial fertilizers and helps protect surface and groundwater quality. To use effluent efficiently while avoiding over irrigating it on crop and pasture land, producers must know:

- The N, P and K needs of the crop, based on a realistic goal for yields.
- The N, P and K in the soil available to the plants before irrigation.
- The amounts of N, P and K in the effluent that will be irrigated.

To determine the N, P and K contents in their soils, producers should collect soil samples and have them tested. The soil test gives estimates on whether the soil contains enough N, P and K to produce the targeted yield of a crop. Producers should also have the effluent tested for concentrations of N, P and K (fertilizer value).

Sampling procedures for soil and effluent are explained in detail in Extension publication L-5175, "Managing Crop Nutrients Through Soil, Manure and Effluent Testing," which is available on the Web at http://agpublications.tamu.edu/catalog/.

Table 1 lists the number of gallons of effluent that are applied by big gun nozzles or sprinkler systems, based on various wetted areas (acres) and at depths of 1/4 inch to 2 inches.

To estimate the depth of the application, use a plastic rain gauge or a straight-sided container (a coffee can, for example) marked with gradations of 0.25, 0.50, 0.75, 1, 1.25, 1.50, 1.75 and 2 inches on the inside with a permanent marker.

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For a better estimate of irrigation depth, place several gauges equally spaced over the wetted area. Once you know the total application volume and its N, P, and K contents, you can calculate the total amounts of these nutrients applied (see example).

Knowing how much N, P and K are in the effluent will help you target your effluent applications and volumes to meet your yield goals. It will also help you avoid applying too much of the most restrictive nutrient, such as P, required by a nutrient use plan.

For diameters or areas not listed in Table 1, the volume of effluent for a given depth can be calculated using the following formulas. Some conversion factors are provided in Table 2.

Table 1. Effluent volume from discharge of big gun nozzles or a sprinkler system.

Depth (Inch)		0.25	0.5	0.75	1	1.25	1.5	1.75	2
Wetted diameter (Feet)	Area (Acre)	Total volume of effluent (Gallons)							
225	0.91	6,196	12,392	18,588	24,784	30,980	37,176	43,372	49,569
240	1.04	7,050	14,100	21,149	28,199	35,249	42,299	49,348	56,398
250	1.13	7,649	15,299	22,948	30,598	38,247	45,897	53,546	61,196
260	1.22	8,274	16,547	24,821	33,095	41,368	49,642	57,916	66,189
270	1.31	8,922	17,845	26,767	35,689	44,612	53,534	62,456	71,379
280	1.41	9,595	19,191	28,786	38,382	47,977	57,573	67,168	76,764
290	1.52	10,293	20,586	30,879	41,173	51,466	61,759	72,052	82,345
300	1.62	11,015	22,030	33,046	44,061	55,076	66,091	77,107	88,122
310	1.73	11,762	23,524	35,285	47,047	58,809	70,571	82,333	94,095
320	1.85	12,533	25,066	37,599	50,132	62,664	75,197	87,730	100,263
330	1.96	13,328	26,657	39,985	53,314	66,642	79,971	93,299	106,627
340	2.08	14,148	28,297	42,445	56,594	70,742	84,891	99,039	113,188
350	2.21	14,993	29,986	44,979	59,972	74,965	89,958	104,951	119,944
360	2.34	15,862	31,724	47,586	63,448	79,310	95,172	111,034	126,896
370	2.47	16,755	33,511	50,266	67,022	83,777	100,532	117,288	134,043
380	2.60	17,673	35,347	53,020	70,69	88,367	106,040	123,713	141,387
390	2.74	18,616	37,231	55,847	74,463	93,079	111,694	130,310	148,926
400	2.88	19,583	39,165	58,748	78,331	97,913	117,496	137,078	156,661
410	3.03	20,574	41,148	61,722	82,296	102,870	123,444	144,018	164,592
420	3.18	21,590	43,180	64,770	86,359	107,949	129,539	151,129	172,719
430	3.33	22,630	45,260	67,891	90,521	113,151	135,781	158,411	181,042
440	3.49	23,695	47,390	71,085	94,780	118,475	142,170	165,865	189,560
450	3.65	24,784	49,569	74,353	99,137	123,921	148,706	173,490	198,274
470	3.98	27,036	54,073	81,109	108,145	135,181	162,218	189,254	216,290
490	4.33	29,386	58,772	88,159	117,545	146,931	176,317	205,703	235,090
500	4.51	30,598	61,196	91,794	122,392	152,989	183,587	214,185	244,783
520	4.88	33,095	66,189	99,284	132,379	165,473	198,568	231,663	264,757
540	5.26	35,689	71,379	107,068	142,757	178,447	214,136	249,826	285,515
560	5.65	38,382	76,764	115,146	153,528	191,910	230,292	268,674	307,056
580	6.07	41,173	82,345	123,518	164,690	205,863	247,035	288,208	329,380
600	6.49	44,061	88,122	132,183	176,244	220,305	264,366	308,427	352,488

For a known diameter, $V = 0.489 \times d \times D^2$.

For a known area, $V = 27{,}152 \times A \times d$.

V = volume of effluent in gallons.

D = diameter covered by the big gun in feet.

d = depth of effluent in inches.

A = Area covered by a sprinkler system in acres.

Example

A farm uses big gun nozzles that cover a diameter of 240 feet. (Or if it were using a sprinkler system, the area covered is 1.04 acre.) The effluent is applied to a depth of 1 inch.

The laboratory test for the dairy lagoon effluent shows:

N = 0.03 percent

P = 0.01 percent

K = 0.04 percent

Use these steps to figure out how much of each nutrient was applied to the soil.

1. **Find the amount of area covered by the big gun or sprinkler system.**

   In this example, the diameter covered by a big gun is 240 feet (the area covered by the sprinkler system is 1.04 acres).

2. **Using a rain gauge or coffee can, determine the depth at which the effluent was applied.**

   In this example, the depth is 1 inch.

3. **Check Table 1 to find out the total volume applied to the area at the effluent depth.**

   Table 1 shows that at an effluent depth of 1 inch, the total volume applied at the big-gun diameter of 240 feet (or the sprinkler area of 1.04 acres) is 28,199 gallons.

4. **Have the effluent tested to find out the N, P and K percentages in the effluent.**

   The percentages for this example:

   N = 0.03 percent

   P = 0.01 percent

   K = 0.04 percent

5. **Use the formula and the percentages from the laboratory tests to calculate the total nitrogen (N), phosphorus (P) and potassium (K) in the effluent.**

   For this example:

   N (lb) = % N x volume applied x 0.0834
   Hence, N = 0.03 x 28,199 x 0.0834 = 70.6 pounds

   P (lb) = % P x volume applied x 0.0834
   Hence, P = 0.01 x 28,199 x 0.0834 = 23.5 pounds

   K (lb) = % K x volume applied x 0.0834
   Hence, K = 0.04 x 28,199 x 0.0834 = 94.1 pounds

   Where 0.0834 is a constant multiplier.

6. **Convert P (phosphorus) to P_2O_5, (phosphate), which is the form of phosphorus that is sold in commercial fertilizers.**

   The conversion formula from Table 2 shows that P_2O_5 = P x 2.29

   Therefore, in this example, P_2O_5 = 23.5 x 2.29 = 53.8 pounds

7. **Convert K (potassium) to K_2O (potash), which is the form of potassium sold in commercial fertilizers.**

   From Table 2, K_2O = 1.2 x K

   Therefore, for this example, K_2O = 1.2 x 94.1 = 112.9 pounds

   According to these calculations, the farmer in this example has applied these nutrients to the crop:

   70.6 pounds of nitrogen

   53.8 pounds of phosphate

   112.9 pounds of potash

It is estimated that nearly 75 percent of the total nitrogen is available during the crop growing season, while the other 25 percent is being mineralized and will be available for the next year's crop. Therefore, 75 percent of 70.6 (0.75 x 70.6) = 53 pounds.

Also, as much as 33 percent of this available nitrogen may be lost to the atmosphere in the form of ammonia during surface application of effluent with big gun or a sprinkler system. So, reduce the amount of nitrogen available by an additional 33 percent. The reduction from 53 pounds of available nitrogen (1 - 0.33 x 53) = 35 pounds. Hence, the plant-available nutrients in the effluent are:

N = 35 pounds

P_2O_5 = 54 pounds

K_2O = 113 pounds

Take credit

Once you know the amount of each nutrient you have applied via the effluent, you can subtract it from the amount that the soil test indicated is needed by the crop to achieve the desired yield. The amount needed minus the amount already applied is the amount of nutrients you need to apply using commercial fertilizer.

Using this procedure will prevent you from applying too much fertilizer, wasting money and harming the environment.

Table 2. Common conversion factors.

Multiply	By	To Get
Cubic Feet	7.48	gallons
Cubic Feet	62.4	pounds
Gallons	8.34	pounds
Parts per million (ppm)	0.00834	pounds/1000gallons
Percent	83.4	pounds/1000gallons
P (Phosphorus)	2.29	P_2O_5
K (potassium)	1.2	K_2O
% Nutrient	20	pounds/ton
Other conversions		
% Nutrient, wet basis = % nutrient, dry basis x (100 - % moisture)/100		
1 acre is 43,560 sq. feet		
1 inch over an acre is 27,152 gallons		

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