Calibrating Traveling Guns for Slurry Irrigation

► Waste storage ponds are used on many dairy, swine, and poultry layer farms. Storage pond slurry can be an effective part of the waste management plan. Learn the proper procedure for calibrating traveling guns for slurry irrigation.

Waste storage ponds are used on many dairy, swine, and poultry layer farms in Alabama as part of the waste management system. These ponds collect and hold animal waste generated at these operations. Most waste storage ponds are designed to fill up and be emptied at least twice and in some cases three times a year. If waste storage ponds fill up and overflow, they will pollute water sources. On the other hand, if storage pond slurry is applied to cropland, it can be an effective part of the waste management plan.

Land application of storage pond slurry with sprinkler irrigation equipment is becoming more common in Alabama. This is a good management practice for two reasons: it allows recycling of on-farm nutrients, and it reduces the pollution of the surrounding environment.

Land application should match the fertilizer content of slurry to the crop requirements and soil characteristics. Fertilizer concentrations in animal waste slurry are quite high, ranging from more than 500 pounds of total nitrogen per acre inch for dairy slurry to more than 800 pounds of total nitrogen per acre inch for swine slurry. Poultry layer slurry may contain twice these levels of total nitrogen per acre inch. When irrigation-applied, less than half of the total nitrogen is plant available. Controlling the application depth of animal waste slurry irrigation is essential to manage off-farm pollution and receive maximum available benefits from fertilizer in the slurry.

To control the amount of slurry and nutrients being applied to a field, the operator must properly calibrate slurry irrigation equipment. Calibrating fertilizer application equipment is not new to farmers, but calibrating irrigation equipment may be a relatively new procedure for those unfamiliar with irrigation. Traveling irrigation guns are commonly used for waste slurry application and are the most difficult type of irrigation system to calibrate.

Table 1. Typical Nozzle Flow Rates and Diameters of Throw for 2-Inch Taper Bore Nozzle with 24° Trajectory

PSI	Nozzle 0.7"		Nozzle 0.8"		Nozzle 0.9"		Nozzle 1.0"		Nozzle 1.1"		Nozzle 1.2"		Nozzle 1.3"	
	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA
50	100	250'	130	270'	165	290'	205	310'	255	330'	300	345'	350	360'
60	110	265'	143	285'	182	305'	225	325'	275	345'	330	365'	385	380'
70	120	280'	155	300'	197	320'	245	340'	295	360'	355	380'	415	395'
80	128	290'	165	310'	210	335'	260	355'	315	375'	380	395'	445	410'
90	135	300'	175	320'	223	345'	275	365'	335	390'	405	410'	475	425'
100	143	310'	185	330'	235	355'	290	375'	355	400'	425	420'	500	440'
110	150	320'	195	340'	247	365'	305	385'	370	410'	445	430'	525	450'
120	157	330'	204	350'	258	375'	320	395'	385	420'	465	440'	545	460'

Calibration Procedure

The following example illustrates the calibration procedure for traveling guns. It applies to both waste slurry and wastewater irrigation using traveling guns.

(1) Choose nutrient application rate based on the crop grown, soil characteristics, and the existing nutrient level.

Example: 150 lb. N/acre
Your numbers: _____ lb. N/acre

(2) Determine waste slurry application rate in gallons per acre (gal./acre). Divide the nutrient application rate from Step 1 by the pounds of plant-available nutrient per thousand gallons of slurry (determined by actual test or by site or operation-type history); then, multiply by 1,000.

Example: 150 lb. N/acre ÷ 17 lb. N/1,000 gal. × 1,000 = 8,823 gal./acre
Your numbers: _____ lb. N/acre ÷ ____ lb. N/1,000 gal. × 1,000 = ______ gal./acre

(3) Determine in./acre of slurry to apply. Divide gal./acre from Step 2 by 27,154 gal./acre-in.

Example: 8,823 gal./acre ÷ 27,154 gal./acre-in. = .32 in.
Your numbers: ______ gal./acre ÷ 27,154 gal./acre-in. = ____ in.

(4) From table 1, select diameter of throw for existing nozzle size, expected psi, and **GPM.***
Multiply by 0.7 for correct **travel lane spacing.****

Example: 1.0 -in. nozzle at 60 psi, 225 GPM,
Lane spacing = 0.7 × 325 -ft. diameter of throw = 227 ft.
Your numbers: ____-in. nozzle at ____ psi, ____ GPM,
Lane spacing = 0.7 × _____-ft. diameter of throw = ____ ft.

(5) Calculate **travel speed***** (ft./min.) required. Multiply 1.6 times GPM. Divide by lane spacing (ft.); then divide by inches applied.

Example: Travel speed = 1.6 × 225 GPM ÷ 227 -ft. lane spacing ÷ 0.32 in. = 4.95 ft./min.
Your numbers: Travel speed = 1.6 × _____ GPM ÷ _____-ft. lane spacing ÷ _____ in. = _____ ft./min.

*Gallons per minute flow rate **(GPM)** from any particular nozzle can easily be determined by pressure at the nozzle. Most traveling guns are equipped by the manufacturer with a ¼-inch nipple tap located on the gun body. A pressure gauge can easily be attached at this location and used to check gun nozzle operating pressure. Table 1 gives typical flow rates and expected diameters of throw (24° gun trajectory angle) for various size taper bore nozzles used in traveling guns. This chart can be used to determine traveling gun flow rate at actual operating pressure if a manufacturer's chart is not available.

****Travel lane spacing** should be 70 percent (0.7) of the nozzle throw diameter for uniform wastewater application. See Figure 1 for a typical traveling gun layout.

*****Travel speed** of the gun cart is the most complicated of the traveling gun application rate factors to calculate. Travel speed can be calculated from mathematical formula, from information in Table 2, or from manufacturer's data on particular travel guns.

Table 2. Wastewater Applied by Traveling Gun Sprinklers*									
Sprinkler Flow Rate (GPM)	Travel Lane Spacing (ft.)**	Travel Speed (ft./min.)							
		0.4	0.5	1	2	4	6	8	10
		Wastewater Applied (in.)							
100	150	2.7	2.1	1.1	0.5	0.3	0.2	0.1	0.1
	200	2.0	1.6	0.8	0.4	0.2	0.1	0.1	0.1
	250	1.6	1.3	0.6	0.3	0.2	0.1	0.1	0.1
	300	1.3	1.1	0.5	0.3	0.1	0.1	0.1	0.1
200	150	5.4	4.3	2.1	1.1	0.5	0.4	0.3	0.2
	200	4.0	3.2	1.6	0.8	0.4	0.3	0.2	0.2
	250	3.2	2.6	1.3	0.6	0.3	0.2	0.2	0.1
	300	2.7	2.1	1.1	0.5	0.3	0.2	0.1	0.1
300	200	6.0	4.8	2.4	1.2	0.6	0.4	0.3	0.2
	250	4.8	3.9	1.9	1.0	0.5	0.3	0.2	0.2
	300	4.0	3.2	1.6	0.8	0.4	0.3	0.2	0.2
	350	3.4	2.8	1.4	0.7	0.3	0.2	0.2	0.1
400	200	8.0	6.4	3.2	1.6	0.8	0.5	0.4	0.3
	250	6.4	5.1	2.6	1.3	0.6	0.4	0.3	0.3
	300	5.4	4.3	2.1	1.1	0.5	0.4	0.3	0.2
	350	4.6	3.7	1.8	0.9	0.5	0.3	0.2	0.2
500	250	8.0	6.4	3.2	1.6	0.8	0.5	0.4	0.3
	300	6.7	5.4	2.7	1.3	0.7	0.4	0.3	0.3
	350	5.7	4.6	2.3	1.1	0.6	0.4	0.3	0.2
	400	5.0	4.0	2.0	1.0	0.5	0.3	0.3	0.2
600	250	9.6	7.7	3.9	1.9	1.0	0.6	0.5	0.4
	300	8.0	6.4	3.2	1.6	0.8	0.5	0.4	0.3
	350	6.9	5.5	2.8	1.4	0.7	0.5	0.3	0.3
	400	6.0	4.8	2.4	1.2	0.6	0.4	0.3	0.2
700	300	9.4	7.5	3.7	1.9	0.9	0.6	0.5	0.4
	350	8.0	6.4	3.2	1.6	0.8	0.5	0.4	0.3
	400	7.0	5.6	2.8	1.4	0.7	0.5	0.4	0.3
	450	6.2	5.0	2.5	1.2	0.6	0.4	0.3	0.2

*If your exact numbers are not in the table, use the formula below to calculate the application rate. The mathematical operations should be done in order from left to right.
Wastewater applied (in.) = 1.6 × sprinkler flow rate (GPM) ÷ lane spacing (ft.) ÷ speed (ft./min.)

**The travel lane spacing should be approximately 70 percent of the sprinkler's coverage diameter. The coverage diameter can be determined from the manufacturer's literature or by measurement. Refer to Figure 1 for a diagram of a traveling gun layout.

Checking Gun Cart Speed

Checking actual traveling gun cart speed is a simple matter. You'll need two flags, a 100-foot tape, and a wristwatch with a minute and second indicator. Set up the gun, and extend the hose. Then:

(1) Measure off a 100-foot distance along the gun cart travel path and mark with the flags.

(2) Use a marker, ribbon, or string to mark a point on the retracting hose or cable that is pulling the gun cart.

(3) During traveling gun irrigation operation, measure and record the time in minutes and seconds required by the ribbon to travel the measured 100-foot distance.

(4) Convert travel time in minutes and seconds to minutes and partial minutes

(minutes and seconds = whole minutes + $\frac{\text{seconds}}{60}$).

Example: 1 minute, 27 seconds = 1 + $\frac{27}{60}$ = 1 + 0.45 = 1.45 minutes

(5) Divide the travel distance (100 feet) by the travel time in minutes to get travel speed in feet per minute. After determining the travel speed, adjust the speed control as necessary to get the desired travel speed.

Adjusting Gun Cart Speed

After determining travel speed required, either from the chart or by mathematical calculation, adjust gun cart speed in the field to this desired speed. Since travel speed is so critical for slurry and wastewater irrigation, **use only those traveling guns with easily adjustable speed control and speed compensation.** Traveling guns with knob adjustments for a dial readout and with mechanical linkage speed compensation seem to be the most reliable.

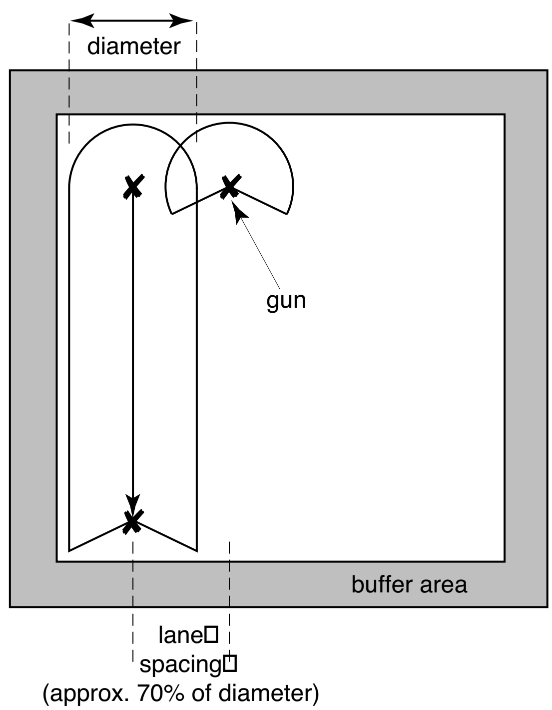

Figure 1. Traveling gun layout

Ted W. Tyson, *Extension Biosystems Engineer*, Professor, Biosystems Engineering, Auburn University, and **Perry L. Oakes**, State Conservation Engineer, Natural Resources Conservation Service

Adapted from: Karl VanDevender, Phil Tacker, and John Langston, *Extension Agricultural Engineers*; and Angela Rieck, Assistant Specialist Waste Management. "Calibrating Traveling Big Gun Sprinklers For Manure Applications," FSA 1022-4M-93-S459. University of Arkansas Cooperative Extension Service, Little Rock, AK.

Printed by the Alabama Cooperative Extension System in cooperation with the Alabama Department of Environmental Management and the Environmental Protection Agency with Clean Water Act Section 319 Demonstration Funds.

For more information, contact your county Extension office.
Visit www.aces.edu/directory.

Revised Dec 2011, **ANR-0925**