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CENTER PIVOT CHEMIGATION OR FERTIGATION INJECTION RATE WORKSHEET FOR VOLUME-BASED APPLICATIONS

Chemigation Calculation Worksheet Series

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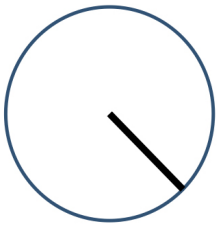
Center Pivot Chemigation or Fertigation Injection Rate Worksheet for Volume-Based Applications

This worksheet helps growers, consultants, and fieldmen to calculate the necessary **liquid fertilizer or chemical** injection rate for center pivots or linear moves when the targeted application is specified on the label in **ounces, pints, quarts, or gallons per acre**.

Required Information:

1. Distance from the pivot center to the edge of effective wetted area, in feet. (Effective wetted area is considered to be 75% of the throw radius of the outermost sprinkler or nozzle on the last span. This last sprinkler can be the end gun, but an end gun that cycles on and off requires a variable rate injection pump that is not covered here.)
2. Distance from the pivot center to the wheel track of the last tower, in feet.
3. Last tower travel distance (in feet) in a given amount of time (in minutes) while running at the application speed. (The system should be fully charged with water and operating in an existing wheel track. Do not conduct this measurement with a system operating in the "dry mode.")
4. Product application rate in ounces, pints, quarts, or gallons per acre (refer to the product label).
5. Percentage of a full circle pivot that will be used during the application.

Example: Applying a pesticide at 2 pints per acre to a half pivot (50% of a full circle) with an effective wetting radius of 1,315 feet. The end tower wheel track is 1,280 feet from the pivot center point. The application depth (pivot speed, or % setting) was chosen to comply with label requirements. At this setting, the last tower traveled a measured 52 feet in 7 minutes and 44 seconds (7:44).



AREA: Determine the size of the treatment area in acres.		
	Example	**Your System**
A. Effective Wetting Radius of Center Pivot (r) Distance from the center pivot point to the edge of the effective wetted area, in feet.	**1,315 ft**	
B. Effective Wetted Area in square feet Area = π × radius^2. (π = 3.14) (B = π × A^2)	3.14 × (1,315 ft)^2 = **5,429,766 ft^2**	
C. Convert Square Feet to Acres 1 acre = 43,560 square feet. (C = B ÷ 43,560)	5,429,766 ÷ 43,560 = **125 acre**	
D. Treatment Area in acres. Multiply Acres by % of pivot being treated ÷ 100. This example uses a half pivot (wiper) system. (D = C × % pivot ÷ 100)	124.6 acre × (50 ÷ 100) = **62.3 acre**	

APPLICATION TIME: Determine the center pivot travel speed and application time in hours.		
It is best to verify pivot travel speed as pivot panels and printed literature are often inaccurate due to gearbox wear, tire pressure, tire sizing, rolling resistance, elevation changes, tire slippage, and other factors. Travel speed is verified by measuring the travel distance (a minimum of 50 feet is recommended) of the last tower and the time required to travel that distance.		
	Example	**Your System**
E. Distance from Center to Last Wheel Track Distance from center to measurement point in feet, usually the wheel track of the last tower (often found on the sprinkler chart).	**1,280 ft**	
F. Last Wheel Track Circumference Full circle circumference in feet. Circumference = 2πr. (π = 3.14) (F = 2 × π × E)	2 × 3.14 × 1,280 ft = **8,038 ft**	
G. Last Tower Travel Distance Measured in feet.	**52 ft**	
H. Travel (Rotation) Time of Pivot Recorded travel time in minutes. Minutes + (Seconds ÷ 60)	7:44 = 7 min + (44 sec ÷ 60 sec/min) = **7.73 min**	
I. Convert Travel Time to Hours Convert minutes to hours. (I = H ÷ 60)	7.73 min ÷ 60 min/hr = **0.129 hr**	
J. End Tower Travel Speed (in feet per hour). Travel distance ÷ Time, in hours. (J = G ÷ I)	52 ft ÷ 0.129 hr= **403 ft/hr**	
K. Application Time for Full Pivot Rotation in hours. Travel distance ÷ Travel speed (K = F ÷ J)	8,038 ft ÷ 403 ft/hr = **19.9 hr**	
L. Application Time for Treatment Area Multiply time by % of pivot being treated ÷ 100. (L = K × % pivot ÷ 100)	(example for 1/2 pivot) 19.9 hr × 50 ÷ 100 = **10.0 hr**	

VOLUME TO APPLY: Determine the total volume of chemical to apply in gallons.		
	Example	**Your System**
M. Volume of chemical to be applied per acre. From chemical label.	**2 pint/acre**	
N. Total volume to be applied. Volume per acre x Total acres. (N = M × D)	2 pint/acre × 62.3 acre = **125 pint**	
O. Total Volume converted to gallons. (1 gallon = 4 quarts = 8 pints = 128 fluid ounces)	125 pint ÷ 8 = **15.6 gal**	

INJECTION RATE: Calculate the injection rate in gallons per hour.		
	Example	**Your System**
P. Injection rate in gallons per hour. (gal/hr) Total volume ÷ Application time. (P = O ÷ L)	15.6 gal ÷ 10.0 hr = **1.56 gal/hr**	

Note: Although some can, many agricultural chemigation pumps cannot accurately inject at very low injection rates such as this. In this case, water is added to the chemical (diluted) to increase the total injected volume to a more convenient total volume. In this example, water is added to the calculated 15.6 gallons of chemical to increase the total volume (including the chemical) to 150 gallons. This volume is then used to calculate the new injection rate:

150 gal ÷ 10.0 hr = **15.0 gal/hr**.

Additional Useful Information:

Some helpful conversions for calibration testing:

Multiply:	By:	To Get:
gallons/hour	2.13	ounces/minute
gallons/hour	63.09	milliliters/minute

Many pivots only have a percentage timer as a speed setting. Application depth, or the run time at other percentage settings can be calculated if the application depth or run time at one percentage setting is known. For both of these a constant must be calculated or measured which is the equivalent to the application depth or full rotation time at the 100% setting.

Center Pivot Percentage Timer Settings for Application Depth

$$C_d = d \times \%$$

where:

C_d = Application depth at 100% (inches). *Constant*
d = Application depth at % setting (inches)
$\%$ = Pivot % setting (as a decimal, or % setting divided by 100)

Once C_d is known, the application depth at other % settings can be calculated by:

$$d = \frac{C_d}{\%}$$

Center Pivot Percentage Timer Settings for Full Rotation Time

$$C_t = H \times \%$$

where:

C_t = Full rotation time at 100% (hours)
H = Full rotation time at % setting (hours)
$\%$ = Pivot % setting (as a decimal, or % setting divided by 100)

Once C_t is known, the full rotation times at other % settings can be calculated by:

$$H = \frac{C_t}{\%}$$

Additional Resources

Burt, C., K. O'Conner, and T. Ruehr. 1998. Fertigation. San Luis Obispo: California Polytechnic State University.

Carpenter, J., and W.S. Johnson. 1997. Pesticide Chemigation through Pumped Irrigation Systems. *University of Nevada Cooperative Extension Publication* FS-97-37. University of Nevada.

DeValerio, J., D. Nistler, R. Hochmuth, and E. Simonne. 2015. Fertigation for Vegetables: A Practical Guide for Small Fields. *University of Florida IFAS Extension Publication* HS1206. University of Florida.

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Kranz, W., C. Burr, J. Hay, J. Schild, and D. Yonts. 2016. Using Chemigation Safely and Effectively: Training Manual. University of Nebraska Extension.

Liu, G., and G. McAvoy. 2015. How to Reduce Clogging Problems in Fertigation. *University of Florida IFAS Extension Publication* HS1202. University of Florida.

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Use pesticides with care. Apply them only to plants, animals, or sites as listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

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