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

Chemigation Worksheet Series

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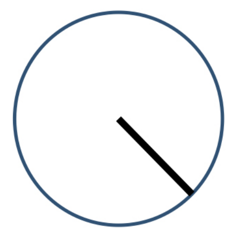
Center Pivot Chemigation or Fertigation Injection Rate Worksheet for Weight-Based Applications

This worksheet helps growers, consultants, and fieldmen to calculate the necessary **liquid fertilizer or chemical** injection rate for center pivots or linear move irrigation systems when the targeted application is specified in **pounds of product per acre**.

Required Information:

1. Distance from the pivot point to the edge of the effective wetted area, in feet. (Effective wetted area is considered to be 75% of the wetted 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 point 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 preset 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. Targeted product application rate in pounds per acre.
5. Product concentration in pounds of active ingredient per gallon.
6. Percentage of a full circle center pivot that will be used during the application. A 3/4 pivot would be 75%, a half pivot would be 50%, and so on.

Example: In this example, apply Urea Ammonia Nitrate (UAN) 32 (32-0-0; 3.54 pounds of nitrogen per gallon) at 25 pounds per acre to a full circle center pivot with an effective wetting radius of 1,315 feet. The end tower wheel track is 1,280 feet from the center point. The last tower traveled a measured 52 feet in 21 minutes and 42 seconds (21:42). The system panel setting (% speed) was selected to apply 0.50 inch.



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 effective wetted area, in feet.	**1,315 ft**	
B. Effective Wetted Area in square feet Area = $\pi \times$ radius^2. ($\pi = 3.14$) ($B = \pi \times A^2$)	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 ÷ 100. This example assumes a full pivot, or 100%, revolution. (D = C × % pivot ÷ 100)	125 acre × 100 ÷ 100 = **125 acre**	

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, changing field slopes, 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. Measurements taken over greater distances or for longer times will improve the calibration accuracy. On an irregular field (due to soil surface conditions or topography), multiple speed measures are recommended. Use the same reference point on the tower for both the start and end time period. If the percentage timer is set at less than 100% when determining pivot speed, take the beginning and end time measurements at the same point in the move-stop cycle of the pivot. Note: Considerable calibration inaccuracy can result in a measurement error of only a few feet or a few minutes.

APPLICATION TIME: Determine the center pivot travel speed and application time in hours.		
	Example	**Your System**
E. Distance to Last Wheel Track (r) Distance from center to measurement point in feet, usually the wheel track of the last tower. This is often found on the sprinkler chart.	**1,280 ft**	
F. Last Wheel Track Circumference (length) Full circle circumference in feet. Circumference = 2 × π × r. (π = 3.14) (F = 2 × π × E)	2 × 3.14 × 1,280 ft = **8,038 ft**	
G. Last Tower Travel Distance Physical measurement (measuring tape) in feet.	**52 ft**	
H. Travel (Rotation) Time of Pivot Recorded (stopwatch) travel time in minutes. Minutes = Minutes + (Seconds ÷ 60)	21:42 = 21 min + (42 sec ÷ 60 sec/min) = **21.7 min**	
I. Convert Travel Time to Hours Convert minutes to hours. Minutes ÷ 60 minutes per hour	21.7 min÷ 60 min/hr = **0.362 hr**	
J. End Tower Travel Speed Calculate end tower travel speed in feet per hour Travel distance ÷ Time. (J = G ÷ I)	52 ft ÷ 0.362 hr= **143.6 ft/hr**	
K. Application Time for Full Pivot Rotation Calculate full revolution for circle pivot in hours. Travel distance ÷ Travel speed (K = F ÷ J)	8,038 ft ÷ 143.6 ft/hr = **56.0 hr**	
L. Application Time for Treatment Area Multiply hours by % of full pivot treated ÷ 100. Use appropriate percentage for less than full circle pivot applications. This example assumes a full pivot, or 100%, revolution.	56.0 hr × 100÷100 = **56.0 hr**	

VOLUME TO APPLY: Determine the total volume of chemical to apply in gallons.		
	Example	**Your System**
M. Application Rate (weight) of chemical to be applied per acre. (Pounds per acre)	**25 lb N/acre N**	
N. Product Active Ingredient Concentration of the injected chemical solution from the label. Pounds per Gallon.	**3.54 lb N/gal UAN**	
O. Product Volume per Acre Pounds per acre ÷ Concentration per gallon. (O = M ÷ N)	25 lb/acre ÷ 3.54 lb/gal = **7.1 gal/acre UAN**	
P. Total Volume of Chemical Needed Volume of chemical to be applied Volume per acre x Total acres. (P = O × D)	7.1 gal/acre × 125 acre = **885 gal**	

INJECTION RATE: Calculate the injection rate in gallons per hour.		
	Example	**Your System**
Q. Pump Injection Rate Calculate injection rate in gallons per hour. Total Volume ÷ Application Time. (Q = P ÷ L)	885 gal ÷ 56.0 hr = **15.8 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

Some pivots only have a percentage timer. Application depths or run times 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 equivalent to the application depth for a 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) *Constant*
H = Full rotation time at the given % 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

R.T. Peters, T. Hoffmann, and W.H. Neibling. 2011. Calculating Chemigation Injection Rates. *Washington State University Extension Publication* FS035E. Washington State University.

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

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.

Haman, D. Z., and F. Zazueta. 2014. Chemigation Injection Methods for Irrigation. *University of Florida IFAS Extension Publication* CIR864. University of Florida.

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.

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

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

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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