

How to Calculate Fertigation Injection Rates for Commercial Blueberry Production¹

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Introduction

Florida's commercial blueberry industry has increased significantly in both acreage and value, expanding from approximately 1,000 acres in 1993 to more than 5,100 acres in 2019 (USDA-NASS, 2019), and from \$39 million in 2007 to \$62 million in 2019 (USDA-NASS, 2019). Per capita consumption of blueberries has increased by 400% during the last decade (Braswell 2010). Florida produced approximately 24.2 million pounds of fresh blueberries in the 2019 season. However, Florida only contributed 4.4% of total US fresh blueberry production, which was more than 565.5 million pounds (USDA-NASS 2017). The value of blueberries destined for processing has also increased. The total US value of processed blueberries grew from \$62.3 million in 2009 to \$908.7 million in 2010 (USDA-NASS 2019).

Florida's subtropical climate allows for early blueberry production during a historically profitable marketing window. The industry is expected to continue to grow and expand. To increase nutrient and water use efficiencies and reduce nutrient leaching and environmental concerns, fertigation is recommended for commercial blueberry production. In fact, successful fertigation can enhance sustainability and maximize profitability for commercial blueberry enterprises. One of the key factors in fertigation is the correct calculation of fertilizer injection rate and time for the acreage. This publication helps blueberry growers

correctly calculate fertigation injection rates and times and provides reference tables for checking injection rates and times needed for a variety of production scenarios.

Calculation of Injection Rate and Time

Fertigation rate and time depend on the irrigation water flow rate and fertilizer application rate. To simplify the calculation, we will use nitrogen (N) fertilizer as an example. For other nutrients, such as phosphorus, potassium, and the like, the principle is the same. For most cases, 0.1% of the irrigation flow rate is a proper injection rate (Burt, O'Connor, and Ruehr 1995). Six steps are needed to calculate the injection rate and time for fertigation if a solution N fertilizer is used.

Step 1: Determine the total amount of N needed for the fertigation event. Calculate the total amount of N needed by multiplying the farm size in acres by the N rate to be applied in pounds per acre. If you know your total linear feet of bed and width of row spacing, the linear bed feet can also be used. For example, for a blueberry farm with a 4-foot bed and 8-foot row spacing, the actual linear feet of bed per acre can be calculated as follows (Equation 1):

1. This document is HS1197, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date March 2012. Revised January 2015, March 2018, and July 2021. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.
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$$\frac{43560 \text{ Square Feet}}{\text{Acre}} \div 8 \text{ Feet} = \frac{5445 \text{ Feet}}{\text{Acre}}$$

Equation 1.

In other words, the rate of N divided by the linear bed feet gives the amount of N per linear bed foot to be applied. Multiplying the total linear feet of bed and the amount of N per linear foot of bed provides the total amount of N for the fertigation event. For calculating recommended fertilizer rates in raised-bed, mulched cultural systems, see <https://edis.ifas.ufl.edu/publication/ss516>.



Figure 1. For a 4-foot irrigated bed within an 8-foot row spacing, the area that receives fertigation is half of the total, or “real estate,” area. Thus the actual bed area of the farm equals 50% of the farm area. However, all UF/IFAS recommended fertilizer rates are given on a “real estate” acre basis. The amount of fertilizer to apply is calculated based on the entire area of the blueberry farm, regardless of the width of the bed to which the fertilizer is applied.

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Step 2: Calculate the total weight of liquid fertilizer needed for fertigation. The total weight depends on both total N to be applied and the grade of the selected N fertilizer solution. For instance, UAN-32 (urea-ammonium nitrate solution, 32-0-0) contains 32% N by weight. The total weight of the fertilizer solution to apply is equal to the total N needed (from Step 1) divided by the N concentration (0.32 in this example). For example, if you need 100 pounds of N for a particular fertigation event, how much UAN-32 do you need? Divide 100 pounds by 0.32. You need 312.5 pounds of UAN-32.

Step 3: Calculate the number of gallons of liquid N fertilizer. This number is determined by the density of liquid N fertilizer. Every solution fertilizer has a density listed on the fertilizer label. For example, 1 gallon of UAN-32 weighs 11.05 pounds; thus, the density of this particular fertilizer is 11.05 pounds per gallon. The amount of fertilizer in gallons

to apply is calculated by dividing the total weight of solution fertilizer (from Step 2) by the density.

Step 4: Calculate the dilution factor. The dilution factor is determined using the N concentration of the solution N fertilizer and the target N concentration in the irrigation water (parts per million [ppm]) for the fertigation event. The fertilizer grade (e.g., 32%) should first be converted into ppm by multiplying it by 1,000,000. The fertilizer concentration in ppm (e.g., 320,000 ppm) is then divided by the target N concentration (e.g., 150 ppm). The result is the dilution factor.

Step 5: Calculate the injection rate. The injection rate is determined by dividing the irrigation water flow rate (e.g., 1,000 gallons per minute) by the dilution factor (from Step 4).

Step 6: Calculate the injection time. Injection time is determined by dividing the number of gallons of solution N fertilizer needed (from Step 3) for the fertigation event by the injection rate (from Step 5).

Practical Example

We will use UAN-32 (32% N, 11.05 pounds per gallon) to apply 5 pounds N per acre to a 5-acre blueberry field with 8-foot spacing. The irrigation flow rate is 1,000 gallons per minute and the target N concentration in the irrigation line is 150 ppm. To calculate the injection rate and time:

Step 1: Total N: 5 lb/acre N × 5 acres = 25 lb N

Step 2: Pounds of UAN-32: 25 lb N ÷ 0.32 = 78.1 lb UAN-32

Step 3: Gallons of UAN-32: 78.1 lb ÷ 11.05 lb/gal = 7.0 gal

Step 4: Dilution factor: 0.32 × 1,000,000 ppm ÷ 150 ppm = 2,133.3

Step 5: Injection rate: 1000 gal/min ÷ 2133.3 = 0.47 gal/min

Step 6: Injection time: 7.0 gal ÷ 0.47 gal/min = 15 min

Therefore, in this case, 7.0 gallons of UAN-32 are needed for the fertigation event.

For different-sized blueberry farms with 1,000 gallons per minute irrigation flow rate at target N concentration of 150 ppm N and using UAN-32 as the N source, the corresponding gallons of UAN-32 and injection time can be found in Table 1. Here, 150 ppm N is recommended because if the

N concentration is too low, the plants may not be able to get sufficient N. The fertilizer should not exceed 200 ppm in fertigation (Krewer and NeSmith 2012). This example uses UAN-32. Other soluble fertilizers can also be used in fertigation. If using double drip tape per bed, the injection time can be shortened by up to 50%.

For a 10-acre field using UAN-32 with a target N concentration of 150 ppm but with different water flow rates, the corresponding injection rate and time are shown in Table 2.

Why is it important to calculate the fertigation rate correctly? Because we need to make sure that blueberry plants receive sufficient—but not excessive—nutrients. We must avoid plant damage by not introducing too much salt at one time. We want to avoid over-applying fertilizer to save money in fertilizer cost, thus maximizing profitability. We should prevent or minimize potential nutrient contamination of nearby water resources.

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Table 1. Injection rate and time needed to apply 5 pounds of N per acre (in a 150 ppm N solution made from UAN-32 liquid fertilizer with 32% N) to a 1- to 100-acre farm with a 1,000-gallon per minute irrigation water flow rate.

| Farm size | Total N needed | UAN-32 fertilizer needed | | Dilution factor | Fertilizer injection rate | Fertilizer injection time |
|-----------|----------------|--------------------------|-------|-----------------|---------------------------|---------------------------|
| (acres) | (lb) | (lb) | (gal) | | (gal/min) | (min) |
| 1 | 5 | 15.6 | 1.4 | 2133.3 | 0.5 | 3 |
| 2 | 10 | 31.3 | 2.8 | 2133.3 | 0.5 | 6 |
| 3 | 15 | 46.9 | 4.2 | 2133.3 | 0.5 | 9 |
| 4 | 20 | 62.5 | 5.7 | 2133.3 | 0.5 | 12 |
| 5 | 25 | 78.1 | 7.1 | 2133.3 | 0.5 | 15 |

Note: To prevent any nutrient contamination of nearby water sources and maximize profitability of commercial blueberry production, fertigation time should NOT be more than 15 minutes. If you have a blueberry farm with more than 5 acres, you may need to use a pump with large capacity to perform your fertigation.

Table 2. Calculation of injection rate if applying 5 pounds of N per acre (in a 150 ppm N solution made from UAN-32 liquid fertilizer with 32% N) to a 10-acre farm with 500-, 1,000-, 1,500-, or 2,000-gallon per minute flow rate from the pump.

| Water flow rate | Total N | UAN-32 | | Dilution factor | Injection rate | Injection time |
|-----------------|-----------|--------|-------|-----------------|----------------|----------------|
| (gal/min) | (lb/acre) | (lb) | (gal) | | (gal/min) | (min) |
| 500 | 50 | 156.3 | 14.1 | 2133.3 | 0.2 | 60 |
| 1,000 | 50 | 156.3 | 14.1 | 2133.3 | 0.5 | 30 |
| 1,500 | 50 | 156.3 | 14.1 | 2133.3 | 0.7 | 20 |
| 2,000 | 50 | 156.3 | 14.1 | 2133.3 | 0.9 | 15 |