H. Applying Irrigation Water

Irrigation Water Units

The application of irrigation water is often referred to in many different units. The most universal unit is inches of water depth. It is referred to as universal since rainfall and ETo as well as the calculated irrigation volumes values use the same term. This convention allows easy manipulation of the values in making scheduling decisions. Once the scheduling decision is made, the unit "inches" must be converted to volume since emitters and water meters use "gallons" of water volume. The convention is to standardize on an area of one acre. The depth of one inch of water on an acre of land area is equal to 27154 gallons. Those familiar with their irrigation system may often use gallons per vine. It is important to note that if vineyards with a different number of vines per acre were irrigated with the same gallons per vine, the volume applied per acre would be different by the ratio of vine numbers. For a 12 × 7 versus 10 × 7 foot vine spacing, the ratio would be 1.2 for a 20% difference in water applied.

In this publication, the determination of how much water to apply to the vineyard is in inches of water depth for a given time period. The conversion should be first to gallons per acre. If using a water meter, multiplying the required gallons per acre by the acres irrigated provides a useful number. If using emitter discharge in gallons per hour per vine, divide the gallons per acre desired by the vines per acre to determine the irrigation volume per vine. Finally the volume of water per vine can be converted to system operation on time by dividing the gallons per vine required by the gallons per hour emitter discharge.

Water Volume Conversions

1 acre inch	=	27,154 gallons per acre
1 acre foot	=	325,000 gallons per acre
1 cubic foot	=	7.48 gallons

Often growers use gallons per vine-applied water to compare applications to fields of different vine spacing resulting in error. Additionally, the net application rate is an average over the entire vineyard without any accounting for how uniformly the water is distributed across the vineyard or without regard to irrigation efficiency. The following section describes in detail how to: 1) Determine the gross application rate and application uniformity of the drip system, and 2) Determine the number of hours to irrigate.

Determining the Irrigation Amount

Step 1:	Determine the net amount of water you want to apply to the vineyard.
Step 2:	Determine the actual application rate and application uniformity of the drip system.
Step 3:	Determine the number of hours to irrigate.

Step 1: Determine the vineyard's water use:

- Determine vineyard weekly net water application in inches as described in Section F. Assume for this example vineyard water use is 0.75 inch per week.

- Convert inches to gallons per acre for use with water meter

  gallons/week/acre = net water application (in/wk) × 27,154 gal/ac in.

  Example:

  gallons per week per acre = 0.75 in/wk × 27,154 = 20,366

- Convert inches to gallons per vine/week for use with emitter discharge

  gallons/wk/vine = net water application (in/wk) × vine spacing (sq. ft) × 0.623

  Example:

  Assume: Water application = 0.75 in/wk

  7 ft × 11 ft vine spacing

  gal per vine /wk = 0.75 in/wk × (7 ft × 11 ft) × 0.623

  = 36 gal/wk or use Table H-1.

  The Net Irrigation Amount is 36 gallons per vine per week.

- Convert gallons applied to inches

  $$\text{net water application inches/wk} = \frac{\text{gallons/vine/wk}}{\text{spacing (sq ft)} \times 0.623}$$

  Example:

  Assume: Water application = 36 gallons/vine/wk

  7 ft× 11 ft vine spacing

  $$\text{inches per week} = \frac{36 \text{ gallons/wk}}{(7' \text{ x } 11') \times 0.623}$$

  The Net Irrigation Amount is 0.75 inches.

Step 2: Determine the average application rate and application uniformity of the drip system.

- Drip emitter discharge may vary with the pressure, manufacturing variation and clogging in the drip system. For example, a 0.5 gallon per hour (gph) dripper may not actually be discharging at 0.5 gph.

- If there are multiple irrigation blocks, each block should be evaluated separately since they may be operating at different pressures.

- Sample drip emitters at the following locations. See attached forms:

Head of the system	**- 4 near the head of the lateral**
	- 4 near the middle of the lateral
	- 4 near the end of the lateral
Middle of the system	**- 4 near the head of the lateral**
	- 4 near the middle of the lateral
	- 4 near the end of the lateral
Tail end of the system	**- 4 near the head of the lateral**
	- 4 near the middle of the lateral
	- 4 near the end of the lateral

In addition, you might sample at any other spots where you suspect there could be a difference in the pressure and discharge rate. For example, low or high elevation spots in the vineyard. More emitters than suggested above should be sampled on large irrigation blocks (greater than 20 acres).

- Collect water for 30 seconds in a 100 ml graduated cylinder (see *Table H-2*) or in a 35 mm film canister (see *Table H-3*). Use either table to convert the amount of water collected from each sampled emitter to the discharge rate for that emitter.
- The following *Example* is summarized on the attached **Sample Data Sheet**.

A. Determine the Average Application Rate:

- For each irrigation block, average all your discharge rate measurements. This is the average emitter discharge rate (gph) of your emitters.

Example: If you measured the output from 36 drip emitters, find the average discharge rate (gph) of the 36 emitters. (See **Sample Data Sheet**.*)*

Average discharge rate of all emitters = 0.48 gph

Example cont.: There are 2 drip emitters per vine

application rate per vine (gph)	=	*0.48 gph per dripper*	×	*2 drippers per vine*	=	***0.96 gph/vine***

Average Application Rate is 0.96 gph/vine:

B. Determine the Emission Uniformity:

Each drip emitter in the vineyard will be discharging water at a different rate. This discharge variability is due to manufacturing variation between emitters, pressure differences in the system, and any emitter clogging which may be occurring. We need to compensate for the variability when we determine how much to irrigate (gross irrigation application).

The drip system's application uniformity is quantified using a measurement called the Emission Uniformity (sometimes referred to as the Distribution Uniformity). The Emission Uniformity (EU) is defined as:

$$\text{Emission Uniformity (\%)} = \frac{\text{Avg. discharge rate of the low 25\% sampled emitters}}{\text{Avg. discharge rate of all the sampled emitters}} \times 100$$

To determine the average discharge rate of the low 25% of sampled emitters, the discharge rate (gph) of each of the sampled emitters should be ranked from lowest to highest and the 25% of the emitters with the lowest discharge rate should be averaged together. For example, if 36 emitters were monitored, the average of the 9 emitters with the lowest discharge rates would be determined.

Example cont.: Average discharge rate of all sampled emitters = 0.48 gph

Average discharge rate of the low 25% sampled emitters = 0.44 gph

$$\text{Emission Uniformity (\%)} = \frac{0.44 \text{ gph}}{0.48 \text{ gph}} \times 100 = 92\%$$

Average Emission Uniformity is 92% (This is quite good)

Step 3: Determine the number of hours to irrigate:

The gross irrigation amount (the amount you actually apply) should include the net water you wish to apply plus some additional water to account for the inefficiencies of the irrigation system. The gross irrigation amount is determined as:

$$\text{Gross irrigation amount} = \frac{\text{Net irrigation amount}}{\text{Irrigation efficiency (\%)}} \times 100$$

Irrigation efficiency is difficult to quantify. However, when using micro irrigation techniques, if the drainage below the root zone and the runoff from irrigation is minimal, then the irrigation efficiency can be approximated using the emission uniformity. The above equation becomes:

$$\text{Gross irrigation amount} = \frac{\text{Net irrigation amount}}{\text{Emission uniformity (\%)}} \times 100$$

Example cont.: Net irrigation amount = 36 gal per vine/wk (see Step 1)
Avg. application rate per vine = 0.96 gph (Step 2A)
Emission uniformity = 92% (see Step 2B)

$$\text{Gross irrigation amount} = \frac{36\ \text{gal/wk}}{92} \times 100 = 39\ \text{gal/wk}$$

$$\textit{irrigation time per week (hrs)} = \frac{\textit{gross irrigation amount (gal/wk)}}{\textit{avg. application rate per vine (gph)}}$$

$$\frac{\textit{39 gallons/wk}}{\textit{0.96 gph}} = \textit{41 hrs}$$

Number of hours to irrigate is 41 hours/week.

Table H-1. Converting vineyard water use from inches/week to vine water use in gallons per vine / week for various vine spacings.

		Vineyard water use (inches/week)										
		0.40	**0.50**	**0.60**	**0.70**	**0.75**	**0.80**	**0.90**	**1.00**	**1.10**	**1.20**	**1.30**
Vine Spacing	**4' × 7'**	7.0	8.7	10.5	12.2	13.1	14.0	15.7	17.5	19.2	20.9	22.7
	5' × 8'	10.0	12.5	15.0	17.5	18.7	19.9	22.4	24.9	27.4	29.9	32.4
	5' × 10'	12.5	15.6	18.7	21.8	23.4	24.9	28.1	31.2	34.3	37.4	40.5
	6' × 8'	12.0	15.0	18.0	20.9	22.4	23.9	26.9	29.9	32.9	35.9	38.9
	6' × 10'	15.0	18.7	22.4	26.2	28.1	29.9	33.7	37.4	41.1	44.9	48.6
	7' × 10'	17.5	21.8	26.2	30.5	32.7	34.9	39.3	43.6	48.0	52.4	56.7
	7' × 11'	19.2	24.0	28.8	33.6	36.0	38.4	43.2	48.0	52.8	57.6	62.4
	8' × 10'	19.9	24.9	29.9	34.9	37.4	39.9	44.9	49.9	54.9	59.8	64.8
	8' × 12'	23.9	29.9	35.9	41.9	44.9	47.9	53.9	59.8	65.8	71.8	77.8

Table H-2. Drip emitter discharge rate (gallons per hour- gph using a graduated cylinder.

ml of water collected in 30 seconds	Drip emitter discharge rate (gph)	ml of water collected in 30 seconds	Drip emitter discharge rate (gph)
10	0.32	26	0.82
12	0.38	28	0.89
14	0.44	30	0.95
16	0.51	32	1.01
18	0.57	34	1.08
20	0.63	36	1.14
22	0.70	38	1.20
24	0.76	40	1.27

Drip emitter discharge rate (gal/hr) = Water (ml) collected in 30 seconds x 0.0317

Table H-3. Drip emitter discharge rate (gallons per hour - gph) using a 35 mm film canister			
Seconds to fill 35 mm film canister	Drip emitter discharge rate (gal/hr)	Seconds to fill 35 mm film canister	Drip emitter discharge rate (gal/hr)
26	1.28	50	0.67
28	1.19	52	0.64
30	1.11	54	0.62
32	1.04	56	0.59
34	0.98	58	0.57
36	0.92	60	0.55
38	0.88	62	0.54
40	0.83	64	0.52
42	0.79	66	0.50
44	0.76	68	0.49
46	0.72	70	0.48
48	0.69		

$$\text{Drip emitter discharge rate (gal/hr)} = 33.29 \div \text{Time to fill 35 mm film canister (seconds)}$$