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Texas A&M AgriLife Extension

Easy Gardening

WATERING YOUR VEGETABLES • WATERING YOUR VEG

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A critical part of growing vegetables is determining the right amount of water to give them. If you irrigate properly, you can minimize water runoff, decrease the amount of labor needed, and produce a more bountiful, high-quality crop. Reducing runoff will also help cut down on soil erosion and fertilizer needs.

To water vegetables efficiently, you need to calculate:

1. The amount of water that your plants need (irrigation requirement) under the current weather conditions of the growing season
2. The amount of time to run your irrigation system to apply the water needed

Step 1: Assess your garden's water needs

To calculate the irrigation requirement, you'll need four measurements: effective rainfall, crop evapotranspiration, irrigation efficiency, and the crop coefficient.

Effective rainfall is the total amount of rainfall that a site receives during a specific period (usually the previous week) minus the amount lost to runoff or deep percolation from the site in that period.

You can find the total rainfall for your area on the Texas ET Network website

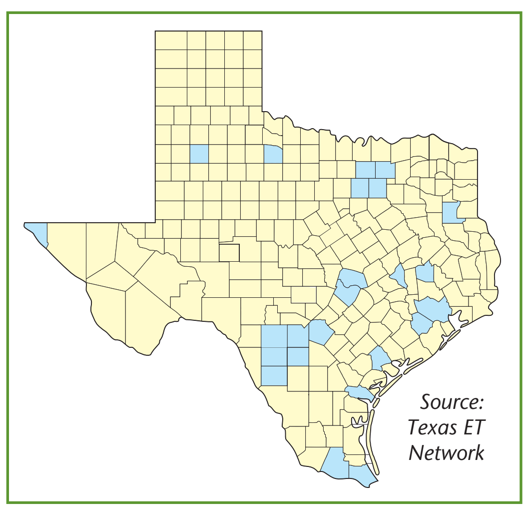

Figure 1. **Texas counties with weather station data.**

TABLE 1. Correction factors for various rainfall amounts in inches per week

Rainfall (in.)	Correction factor
0.0–0.2	0.1
0.2–0.4	0.3
0.4–0.6	0.4
0.6–0.9	0.5
0.9–1.6	0.6
1.6–2.5	0.7

Figure 2. Drip irrigation is a very efficient way to irrigate your garden.

(*texaset.tamu.edu*). The network bases its calculations on data from weather stations across Texas (Fig. 1). Use the data from the station nearest your garden along with local information such as the amount of rain that has fallen in your specific area.

The amount of water lost to runoff or deep percolation depends on the amount of rainfall received. When little rain falls, most of the water is lost through evaporation. When much rain falls, most of the water is lost through surface runoff. Effective rainfall is calculated using the correction factors listed in Table 1. Multiply the correction factor by the amount of rainfall for that period.

For example, a gardener determines that the total rainfall received in the past week amounts to 0.5 inch. Using the correction factor in Table 1, the effective rainfall is $0.5 \times 0.4 = 0.2$ inch instead of 0.5 inch.

Crop evapotranspiration (ET_O) is the amount of water lost from the soil to evaporation and transpiration, which is the water that travels from the soil through the plant and out of its pores, or stomata. The current ETo values from weather stations across the state are also listed on the Texas ET Network.

Irrigation efficiency (IE) is the percentage of the water applied that can actually be used by the plants. Some of the water applied by an irrigation system evaporates before it can reach the plant roots (Fig. 2); some water runs off the site; and some will fall on soil away from the plants. The IE calculation takes into account these losses as well as the type of irrigation system you are using.

TABLE 2. Sample crop coefficients (Kc) for the early, midseason, and harvest stages of a growing season

Crop	Kc early	Kc mid-season	Kc end
Small vegetables *(herbs, salad greens)*	0.7	1.05	0.95
Solanum family *(eggplants, peppers, tomatoes)*	0.6	1.15	0.8
Cucurbit family *(cucumbers, melons, pumpkins, squash)*	0.5	1.0	0.8
Roots and tubers *(beets, carrots, onions, potatoes)*	0.5	1.1	0.95
Legumes *(beans, lentils, peanuts, peas)*	0.4	1.15	0.55
Average	**0.6**	**1.1**	**0.81**

Example 1: Chris's garden

Chris has a tomato patch in Brazos County and wants to calculate how much and how long to water it. The first step is to determine how much water it needs.

- The tomatoes are growing in a row that is 100 feet long and 5 feet wide.
- It is midseason for a fall tomato crop.
- Last week was September 9 to 13, 2012. The garden is watered with a drip irrigation system that was manufactured to deliver 0.45 gallons per minute.
- According to the Texas ET website at texaset.tamu.edu (Fig. 3), the closest weather station to Chris's garden is the Texas A&M University golf course.
- The Texas ET website lists the reference evapotranspiration at the golf course (shown as ETo in Fig. 3) as 1.37 inches.
- The website lists the total rainfall as 0.11 inch (listed as rain in Fig. 3).
- Chris determines that the effective rainfall is 0.11 x 0.1 or 0.011 inch.

TAMU Golf Course Weather Station
***Station Sponsored by :* Texas AgriLife Extension**

Date	ETo PET (in)	Tmax (F)	Tmin (F)	RHmin (%)	Solar (MJm2)	Rain (in)	Wind 4am (mph)	Wind 4pm (mph)
2012-09-07	0.25	99	75	28	23.85	0.00	1.79	4.25
2012-09-08	0.20	87	76	39	22.02	0.00	2.89	3.63
2012-09-09	0.19	91	63	16	25.22	0.00	0.33	3.53
2012-09-10	0.19	91	64	21	24.55	0.00	0.00	3.30
2012-09-11	0.21	91	62	31	24.15	0.00	0.34	4.06
2012-09-12	0.21	94	71	33	19.84	0.00	0.28	3.40
2012-09-13	0.12	87	72	53	10.74	0.11	3.03	6.34
7 Day Summary	1.37	91	69	32	21.48	0.11	1.24	4.07

Note: Reported are the average hourly values, not the absolute highs and lows.

Figure 3. **Data from the Texas A&M University golf course weather station for September 7 through September 13, 2012.**

- According to Table 1, the crop coefficient for tomatoes at midseason is 1.15.

Using the equation:

$$IR = \frac{(ETo \times Kc) - ER}{IE}$$

And the information above, the irrigation requirement for Chris's tomato crop this week is:

$$IR = \frac{(1.37 \text{ inches} \times 1.15) - 0.011 \text{ inch}}{0.9} = 1.74 \text{ inches}$$

Answer: Chris's garden needs 1.74 inches of water to replace what was lost or used in the previous weeek.

The crop coefficient (Kc) is based on the type of vegetables being grown and the current point of their growing cycle. Table 2 lists the coefficients for several types of vegetables at three stages of development—early, midseason, and harvest.

Use those four measurements and the following equation to determine the irrigation requirement for a specific crop and date (Example 1).

$$IR \text{ (inches)} = \frac{(ETo \text{ (inches)} \times Kc) - ER \text{ (inches)}}{IE}$$

Where:

IR = Irrigation requirement
ETo = Reference evapotranspiration
Kc = Crop coefficient
ER = Effective rainfall = Total rainfall x correction factor
IE = Irrigation efficiency

Note: If the garden received more effective rainfall than its total water requirement from the previous week, IR would equal 0 and no irrigation would be needed that week.

Step 2: How long to run your irrigation system

To determine the amount of time it will take to water your garden, you'll first need to:

- Convert the garden dimensions from feet to square feet (length × width), and square feet to acres.
- Convert the water needs determined previously from inches to gallons.
- Determine the run time needed to apply the number of gallons of water.

Convert the garden area from feet to acres

Most people measure their gardens in square feet. Use this equation to convert the garden area into acres:

$$\text{Acres} = \frac{\text{Length (feet)} \times \text{Width (feet)}}{43{,}560}$$

Note: You can also use an online unit converter (such as the one at http://www.unitconverters.net/) to convert the garden dimensions in feet to square feet and from square feet to acres.

Convert water needs from inches to gallons

Rainfall is measured in inches, but irrigation system output is measured in gallons per minute. One inch of rain falling on 1 acre of land is equal to 27,154 gallons of water.

Use this equation to convert the amount of water that your garden needs from inches to gallons:

$$\text{Gallons} = 27{,}154 \text{ (gallons per acre-inch)} \times \text{Garden area (acres)} \times \text{Irrigation requirement (inches)}$$

Example 2: Chris's garden conversions

In Example 1, we learned that Chris's garden is measured in feet. Now Chris needs to convert feet to acres.

Using this equation:

$$\text{Acres} = \frac{\text{Length (feet)} \times \text{Width (feet)}}{43{,}560}$$

and the dimensions of the garden, Chris can convert the area of the garden from feet to acres. The number of acres is:

$$\text{Acres} = \frac{100 \text{ feet} \times 5 \text{ feet}}{43{,}560} = 0.0115 \text{ acre}$$

Answer: Chris's garden size is 0.0115 acre.

Chris also needs to convert irrigation needs from inches to gallons.

Using this equation:

$$\text{Gallons} = 27{,}154 \text{ (gallons per acre-inch)} \times \text{area irrigated (acre)} \times \text{Irrigation requirement (inches)}$$

and the information from Example 1, Chris can calculate the number of gallons of water that the tomatoes need this week:

$$\text{Gallons} = 27{,}154 \text{ (gallons per acre-inch)} \times 0.0115 \text{ (acre)} \times 1.74 \text{ (inches)} = 543 \text{ gallons}$$

Answer: Chris needs to apply 543 gallons for his 100 ft by 5ft garden.

Determine how long to run your irrigation system

An irrigation system delivers a specific number of gallons per minute (gpm), which is called its output rating. Each irrigation system has an output rating that is specified by the manufacturer; it is an important factor to consider when choosing an irrigation system.

To find your system's output rating, check the manufacturer's website or product information. You can also determine it by measuring the volume of water collected in a bucket of water in 30 minutes. If you are using a hose with built-in emit-

Example 3: Chris's irrigation run time

Using this equation:

$$\text{Run time (minutes)} = \frac{\text{Irrigation requirement (gallons)}}{\text{Irrigation system output rating (gallons per minute)}}$$

and the output rating of Chris's drip irrigation system (from Example 1) and the amount of water the tomatoes need (from Example 2), the run time should be:

$$\text{Run time (minutes)} = \frac{\text{543 (gallons)}}{\text{0.45 (gallons per minute)}} = \text{1,206 minutes}$$

Answer: Chris needs to run the irrigation system 1,206 minutes, or 20 hours and 7 minutes, to meet the irrigation requirements of his tomatoes for the week of September 9 to 13, 2012, in Brazos County.

ters, you will also need to know how many emitters are used to collect the water volume in 30 minutes. Then you can calculate the output per emitter.

Use this equation to calculate the number of gallons of water needed:

$$\text{Run time (minutes)} = \frac{\text{Irrigation requirement (gallons)}}{\text{Irrigation system output rating (gallons per minute)}}$$

Using the above equations can help you determine the water needs for a given crop.

Having the right amount of water available to the crop will increase plant health and vegetable yield and quality. This information can also help you determine the best crop to grow based on water availability and the best type of irrigation system.

Summary

More information on the different irrigation systems and how to choose the right system can be found in the *Vegetable Growers Handbook* on the Texas A&M AgriLife Extension website at http://aggie-horticulture.tamu.edu/vegetable/texas-vegetable-growers-handbook/chapter-v-irrigation/.

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