Irrigation for Home Gardens:
Part Two, Drip Irrigation Basics

By Art Scott

Photo by fdp.com.pk

DRIP IRRIGATION:

- *If you want a system that will allow you to take a vacation and not worry about your garden, drip irrigation is worth a close look.*
- *If you want a system that reduces potential for fungal infections, consider drip irrigation.*
- *If you want a system that does not splash soil borne microbes onto your plants, read on.*
- *If you want a system that will reduce factors causing root rot and plant death, you will find this article useful.*
- *If you want a system that encourages deep roots for healthy, productive, disease resistant plants, drip irrigation is the answer.*

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ADVANTAGES OF DRIP IRRIGATION OVER OTHER FORMS

Drip irrigation delivers water to your plant's root zone. The water slowly penetrates deep into the soil encouraging the developing roots to follow. The water isn't sprayed on the foliage, which might cause fungal disease. Excess water doesn't accumulate around plants, predisposing them to root rot and eventual death. There is no run-off from excess water. And you aren't irrigating areas of soil where plants aren't present.

The most efficient method of delivering water to your plants is drip Irrigation. Plants are healthiest when their roots run deep. Most plants thrive with a soil moisture level between 20 and 60 percent. Too little and there is a problem with nutrient absorption. Too much moisture can result in fungal problems and a lack of oxygen uptake.

DETERMINING HOW LONG AND HOW OFTEN TO IRRIGATE

Allow the top 2 – 4 inches of soil to become dry. Using a ruler, see which of your fingers is within this range. Stick that finger into the soil for a quick estimate of the depth of the dry soil. Run your system for 15 – 30 minutes. Wait 15 minutes for the water to penetrate, and then see how deep the soil is moistened. You will need a garden trowel to check for the 6 – 8-inch moisture extension. Turn on the system a little longer if needed. Keep track of the additional time. When the water has reached the desired depth, that will be how long to run your system for each session.

Check daily and when the top 2 – 4 inches again become dry you will know how often to set your timer to come on – once a day or once every 2 or 3 days. This method will keep the deeper roots in moist soil where nutrients are easily absorbed. These developing deep roots also provide structural support for the developing plant.

Every few months, check for dryness of the top few inches to be sure that the change in daylight hours and the change in daily temperatures hasn't resulted in a need to modify your timer settings.

EXCEPTION: When starting from seeds, keep the soil moist but not super saturated. The radicle (primitive root) absorbs water causing the seed to soften and swell, followed by complete germination. If the soil remains dry for a few days when the radicle first emerges and fails to find moisture, the seed will not develop. You could apply the water with a spray bottle each day to ensure adequate moisture around developing seeds and seedlings. Another method is to lightly cover the seeded area with vermiculite. It holds water but will allow any excess to drain away, keeping the soil lightly moist. Too much water can encourage fungal diseases, resulting in your seedlings damping off. A third method is to start the seeds indoors. Charts are available online listing the ideal soil temperature for germination. Check RESOURCES on the last page.

Using timers and drip irrigation enable you to provide the ideal duration and frequency for water penetration of the soil to stimulate deep-running roots. It is best to set the timer for the morning, providing water during the hotter, middle of the day when water utilization is highest.

OBTAINING A DEEP RUNNING, EXTENSIVE ROOT SYSTEM

You can expect these results in your garden from an automated, drip irrigation system. This single, transplanted eggplant demonstrates a healthy root system. It was placed in a container six months ago. A drip irrigation system with a battery-operated timer turned on every other morning at 5:00 a.m. and turned off in 40 minutes.

Roots of this eggplant have extended to the bottom of the container (13 inches) where the soil is always moist. The plant was placed in mid-April and this photo was taken in mid-October, six months later. It is a swallow eggplant, an Asian variety. A single layer of lava rocks on the bottom of the container kept the ¾ inch drain holes open.

Most of the soil has been shaken from the roots and into the container. The soil is close to the original height as the plant utilizes the applied nutrients. There is minimal break down of the organic contents.

Eggplant is a summer crop. Its removal from the container makes way for a cool season plant. You only need to replace a small amount of potting soil or compost.

The weight of the plant and fruit plus the falling rain has compacted the soil over the six months it thrived in this container.

Soil has been loosened in this container after the plant was removed. Only a minimal amount of potting soil or compost was needed to refill the container to the initial height. You can see the many fine roots that broke off as the dirt was removed. Much finer root hairs that are not visible in the photo are the primary way that plants take up nutrients and water.

Loosened soil has many small spaces for oxygen and nutrients that are always available to the plant when ideal moisture is present. Ideal garden soil consists of 25% air, which is the spaces in the loosened soil. The roots will easily penetrate this soil and grow in length, number, and diameter. They are attracted by the ever-present moisture.

MATURE GARDENS WITH AUTOMATED IRRIGATION SYSTEMS

The first four beds all have drip irrigation in three different irrigation zones. A zone is one or more gardens supplied by an irrigation system controlled by the settings on a single timer. The timer opens and closes an irrigation valve at the time and for the duration that you select.

The irrigation designs for most of the mature gardens pictured are difficult to photograph once the foliage is dense and healthy.

GARDENS 1 AND 2: I planted the garden in the foreground with thyme, oregano, lemon balm, basil, and yellow squash. The rear garden has eggplants and tomatoes. The irrigation system is difficult to see because of the healthy, dense vegetation. Both gardens are on the same irrigation zone. I installed irrigation in the garden in the front in 2008. The rear garden was established several years later.

GARDEN 3: A River Birch tree provides part-shade for this garden. I drove a T-post into the ground next to the hanging baskets' support and joined them with thick electrical ties. Four basket brackets are on the support and when all are in use, support from the T-post prevents tipping. Micro-tubing for irrigation is held against the post with small-plastic electric ties. Water flows through the quarter-inch micro-tubing from the larger, half-inch supply line at ground level. I used drippers on stakes in the hanging baskets. For the plants at ground level, I used soaker driplines combined with some other emitters.

GARDEN 4: Heavy plant cover conceals the irrigation system for this garden. I used a half-inch supply line, quarter-inch feeder lines, quarter-inch soaker driplines and various emitters. Pictured from left are encore azaleas, Philippine violets, fire bush, elderberry, fire spike, pineapple sage, African blue basil, and a Chinese fringe tree. Those red flowers above the six-foot tall Philippine violets are pineapple sage reaching for the sun. I didn't know they would grow that tall.

GARDEN 5: Impatiens are resistant to fungal infections caused by moisture on the leaves and flowers enabling the use of mini-jet spray emitters on stakes between the low growing flowers and caladiums. This was one of Judy Wood's gardens in Lacombe before she moved to Arizona. This is not a true drip irrigation system because of the higher volume spray emitters

ESSENTIAL PARTS FROM FAUCET TO VARI-FLOW VALVES

I set up this system to water four gardens. Three gardens are on the bottom timer. A leader hose goes to a PVC pipe that runs underground to first garden, then underground to the second and third gardens. These three gardens are considered one zone because they are controlled by one timer that has a single irrigation valve that will open and close as programed.

The leader hose for the upper timer connects directly to the supply line for the single garden to the right in the photo. The single garden is also considered a zone.

The main parts of a drip irrigation system are shown in the photo. I have arranged the parts in the recommended order. The filter placement depends on the source of your water supply, municipal water vs. unfiltered water from a well or a pond. I needed a filter to prevent the debris from the unfiltered well water from clogging the timer. I also needed one that functions under constant pressure. Some filters are rated to operate under constant pressure while others are not. You will find more details under “FILTERS”.

The reason for the two timers is that initially, I needed only one timer. As I added gardens, the total gallons per hour required was well above the recommended limit of 240 GPH (gallons per hour) for the half-inch supply line. Rather than buy a multi-zone timer, I bought a second, single zone timer, which required the purchase of a second pressure regulator to control the system in the new zone.

Determining the flow rate of water at your faucet

Here is an easy way to determine if the flow rate of the outdoor faucet you are using is adequate. You'll need a bucket and a watch that counts off seconds. Measure the capacity of your bucket. A larger one is preferable because a second or two will result in a larger error if you only use a one-gallon container. Measure the capacity. Five gallons indicated on the bottom of your plastic pail may be just to the fill line. You want the volume all the way to the rim.

Bucket size, divided by seconds to fill, equals the gallons per second flowing out of that faucet. Then you convert the seconds to hours. The formula is below.

Turn on the faucet all the way. Put the bucket under the faucet and determine the number of seconds it takes to fill.

Divide the bucket volume (5.5 gallons in this instance) by the number of seconds to fill (38 seconds for this faucet) equals 0.1447 seconds.

Multiply this by the number of seconds in an hour (3,600 seconds) to arrive at the flow rate out of your faucet. Here's the formula:

$$\frac{5.5 \text{ gal (container size)}}{38 \text{ (seconds to fill)}} = 0.1447 \text{ gallons per second X } 3{,}600 \text{ sec per hr.} = 520.92 \text{ gallons per hour (GPH)}$$

The pressure at this faucet at my home in Folsom is 60.2 PSI (pounds per square inch) which is much too high for an irrigation system. I needed a pressure regulator. Pressure regulators are discussed below, after **"Vacuum breaker – backflow preventer"**. The water pressure for the faucet supplying the Master Gardener Herb Garden at the St. Tammany Parish Library in Slidell was 50 PSI.

If you just must know, a water-pressure gauge is available at Big Box Stores for about $14. You don't need a gauge. The gallons per hour is the more critical measurement.

Y – splitter

You can begin your irrigation system directly from an outdoor faucet. This will dedicate the faucet to the drip system 100% of the time.

If you use a splitter, you can also attach a handheld hose which will then open the faucet for other uses.

In the system shown in the previous photo, attaching the half-inch supply line directly to the two pressure regulators would put a lot of weight on the faucet. Using a leader hose from each pressure regulator reduces the stress.

Filters

Filters prevent dirt and debris from clogging your emitters. They are available in many designs. This is the one I use.

The screen can be removed while the filter is still attached to the water line once the water has been turned off. The barrel is unscrewed, and the filter is lifted out. A sand film is covering the screen in this photo. The screen was removed and hosed off. The O-rings are replaceable.

Use a screen mesh of 155 microns. If **misters** are used, go to a 200-micron mesh.

On the left is a quarter-inch feeder line that contains debris which has resulted in a blocked connector (left) and an emitter shown on the right.

Debris in the cleanable emitter (top removed) has clogged the openings and prevented water flow. This was a system being supplied by well water and operating prior to a filter being installed. If this happens to you, once the filter is attached, take the pressure regulator off line, remove or open all the emitters and run clean water throughout the entire system and check that the debris has been eliminated. If the debris content is too great, the supply and feeder lines, as well as the emitters, may all need to be replaced.

A filter for a system supplied from a well or pond that doesn't have a filter must be installed before the timer and be rated to function under constant pressure. It is placed upstream (closer to the faucet) from the timer. The small screen in the timer inlet will clog very quickly if your water supply is not clean and free of debris (from a well or pond). It is much easier to unscrew and remove and clean the screen in a larger filter than take your timer offline and clean the small one on your timer.

A variety of filters are available in different sizes and alignments. Some are designed to function under constant pressure, but many are not. The one pictured above has a filter that is easy to open and clean. The large barrel portion ending in the orange valve just screws off. The filter is removed and hosed off, reinserted, and then screwed back on.

Timers

A timer irrigates a garden by opening and closing an irrigation valve. A single timer can control from one to 12 or more zones. On some timers, zones can be programed to come on at different times for different durations plus other options including rain delays and the ability to manually bypass the system and turn the water on.

A timer's valve is closed when not irrigating, preventing the timer from being under constant pressure while also protecting the other attachments that are downstream. The faucet supplying your system should be left on. When irrigation time arrives, the timer valve will open, and water will flow.

Timers can be manually turned on, battery operated or hard wired to the electrical system in your home.

Manual timers must be set by hand every time you want to turn the system on. Advantage of a system with a power source is that it automatically turns on and then off at your predetermied intervals . Your presence isn't required.

The tip of the screened pre-filter is just visible in the brass inlet on top. It is present on most timers. If the water supply is not free of debris, it will easily clog. A larger filter should be installed upstream from the timer (closer to the faucet). There are two outlets on the bottom of this battery-operated timer to control two separate zones (systems). The batteries last about 2 years depending on the frequency and duration of irrigation periods. This design is also available with a single outlet on the bottom that controls only one zone.

This timer can handle four separate zones set to come on at different times. Only two irrigation valves are set up here. I didn't install any valves to the two zones on the right. You can see the water supply for each has been shut off. Additional valves can be bought separately. This timer is powered by double A batteries.

This timer can be hardwired to your home's electrical system and can be programed for up to 12 zones.

Vacuum breaker (backflow preventer)

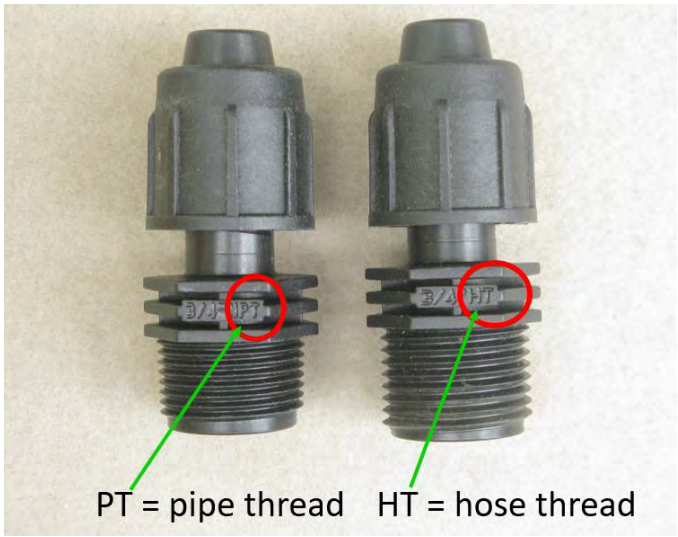
Louisiana law requires that any home irrigation system connected to a water supply must be protected by a vacuum breaker. It's been in effect for years, but the state has only begun to enforce it for the last few years.

When the water supply to your home is interrupted and the pressure forcing the water to your house stops, water will flow backward into the main supply line. This can result in water being sucked from the pipes in your home and from your irrigation system into the main water supply line. This irrigation water can contain various microorganisms and other contaminants that will then be forced into your home's water pipes when the water pressure is restored. A vacuum breaker will prevent this from happening.

Once you have it attached, tighten the set screw so it will not back off and lose the seal. It should be placed upstream from (before) the line(s) to the irrigation zones.

Most are not rated for use under constant pressure, so place them downstream from the timer.

You will want FHT x MHT – Female hose thread on top. Male hose thread is visible on the bottom. There is an arrow indicating the flow of water through this backflow preventer.



These are male hose end fittings for your irrigation system. The tubing from the half-inch supply line slips over the top end and the plastic nut is screwed down to hold it in place. A garden hose is attached to the threaded end so you can flush your line. Both hose and fitting must have the same thread, i.e., hose. An end cap screws on to prevent debris and garden dwellers from entering.

If one is hose thread and the other is pipe thread, the connection will leak.

These threads are slightly different and are not compatible. If mixed, a leak occurs. If you plan to extend your irrigation system underground, pay attention to the difference when you are buying attachments for PVC pipe. Hose thread attachments are available for the plastic PVC attachments. Most threaded fittings for irrigation are identified and are ordered with either pipe or hose thread.

Pressure regulator

Commonly available in 12, 20 and 30 PSI (pounds per square inch) models with a flow rate of up to 480 GPH.

Flow rate is imprinted on this regulator as ½ -8 GPM i.e., per **MINUTE**. This regulator is 30 PSI with hose-to-hose thread on both ends. 8 X 60 minutes = 480 GPH

Most home irrigation systems work best under a pressure of 30 PSI. Your outdoor faucet's pressure will depend on your water company. At my home in Folsom, it is 60.2 PSI. If a pressure regulator is not used, the emitters can be blown out of the tubing at pressures this high. It is also out of the recommended range of most emitters. If they are not blown out of the tubing, they will deliver a much higher flow rate than listed.

Most homes have a water pressure between 40 and 80 pounds per square inch. If below 30 PSI, devices in your home that use water will give poor performance.

Many driplines and emitters are rated at a maximum pressure that is lower than the pressure at your outside faucet.

Most pressure regulators are not rated for use under constant pressure and may be damaged if used upstream from a timer.

Be sure your regulator has the correct thread for your system. If not, adapters from pipe thread to hose thread and hose to pipe are available.

Fittings for half-inch supply line tubing

Clockwise from the upper left: elbow fitting, coupler fitting (a must have on hand for repairing a supply line that has been accidentally cut, or if you want to extend an existing half-inch supply line). Lower right is end cap for threads on the male hose end fitting, male hose end fitting, figure 8 end in center (a cheaper alternative for the male hose end fitting), female hose beginning fitting on lower left.

The slight swelling where the half-inch supply line slips over the fitting is visible on the hose fittings. The nut then screws down to firmly hold the supply line tubing in place. Also available is a tee (three-way) fitting.

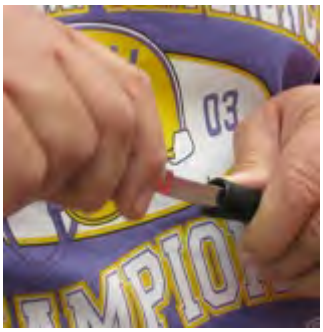
Half-inch supply line tubing precautions

A-Thick wall versus thinner wall

A Big Box store in Covington had both 100-foot coils next to each other. It is easy to make a mistake as they are both black plastic rolls of tubing in the irrigation section and close to the same size.

Always consult with a salesperson who understands irrigating home gardens as well as lawn systems so you can avoid this problem.

The thicker walled tubing above cannot be made to slip over the attachments made for the thinner walled tubing……



……not with a knife …

……not with boiling water….

…….not with a propane torch.

This thicker wall problem is also present with quarter-inch risers that hold mini-jet spray emitters. More on them later.

You can force the proper tubing over the fittings just using your fingers and hand pressure. If it's really cold, you might need some warm water.

B-Half-inch supply tubing has a memory it needs to forget

This 100-foot roll of half-inch supply line tubing ships tightly coiled. When the green bindings are removed it will remain in loose coils. It will refuse to lay straight.

If you wait until a warm, sunny day, the warmth will relax its memory, making it quite easy to put in a straight line with minimal use of wire hold-downs.

Half-inch supply line tubing attached to water supply

The green leader garden hose from the pressure regulator attaches to the female hose beginning fitting. You can then connect it to the beginning of the half-inch supply line by slipping the line over the slight swelling on the fitting and tightening the nut to secure it in place. The garden is to the immediate right of the photo.

Half-inch tubing fittings at the end of supply line

The cap on this male hose end fitting can be unscrewed, and a garden hose attached to flush out the half-inch supply line.

A figure 8 half-inch hose end results in a deep crimp that prevents water from flowing out the end.

It is cheaper than a half-inch hose end. You can add the attachment later if you find the need to flush your line.

The rusty hold-down has evidently been in place for a while.

Pressure compensating (PC) emitters

Many emitters are designed to function up to a given pressure or within a pressure range (15 – 45 PSI is one example, another is 10 – 50 PSI). If they are PC (pressure compensating) they will deliver the rated amount of water at any pressure within this range.

A non-PC emitter is pressure dependent and will release more or less water depending on the water pressure. Most emitters work best at or below 30 PSI. Incoming pressure at the faucet is usually well above this. You can control it with a pressure regulator.

Half-inch pressure compensating (PC) emitter tubing (supply line)

Embedded emitter in supply line. Bottom of the tubing has been removed. Direction of flow can be from either end of the line.

A PC (pressure compensating) emitter is factory installed inside the tubing. Water drips from the hole shown above. Emitter spacing is either 9, 12, 18, 24 or 36 inches. Rolls are 50, 100, 250 or 500 feet. Their functional range is from 10 – 50 PSI. Flow from emitters can be ordered for one-half GPH (gallon per hour) or 1 GPH. Spacing and flow rate for each emitter in the entire roll is the same. (Commercial growers can increase the recommended supply line flow rate from 240 GPH by using a ¾ inch or a one-inch supply line. A half-inch supply line is recommended for home gardens.)

The built-in emitters in a half-inch supply line can present a problem unless you will never adjust the placement of your plants. If you do decide to alter the location of some plants, they may be too far away from the embedded emitters to receive adequate water, necessitating the use of a quarter-inch feeder line connecting to another emitter. If you make a major design change, you may be using an unnecessarily high volume of water flowing from the embedded emitters that are no longer near your plants. This can result in run-off flooding plants and the surrounding lawn every time the system comes on.

Quarter-inch plain feeder line without inserted emitters

This is a 100-foot roll of polyethylene quarter-inch feeder line tubing.

It is also available in vinyl.

Caution: The vinyl is softer and more flexible but must not be used at a high flow rate (30 GPH max) and not at a high pressure (30 PSI max). Being softer, it is easier to install connectors and emitters, but it is easier for high pressure to blow them out especially in hot weather.

You can attach an emitter directly to the end of the feeder line to reach a plant. This plain feeder line can be used as a bridge from the half-inch supply line, over areas where there are no plants, or up the sides of containers, to connect with a quarter-inch soaker dripline. A plain line avoids watering soil between the supply and drip line where there aren't any plants.

Quarter-inch soaker dripline – the inserted emitters are not PC

This is a 100-foot roll of quarter-inch soaker dripline. Small round openings in each emitter will drip water at 0.8 – 0.4 GPH (gallon per hour) depending on the pressure (they are not pressure compensating), and spacing.

Approximate flow rate per emitter with a pressure regulator of 30 PSI and corresponding emitter spacing:

6 inches	9 inches	12 inches
0.8 GPH	0.54 GPH	0.4 GPH

The line is ordered with emitters spaced every 6, 9 or 12 inches.

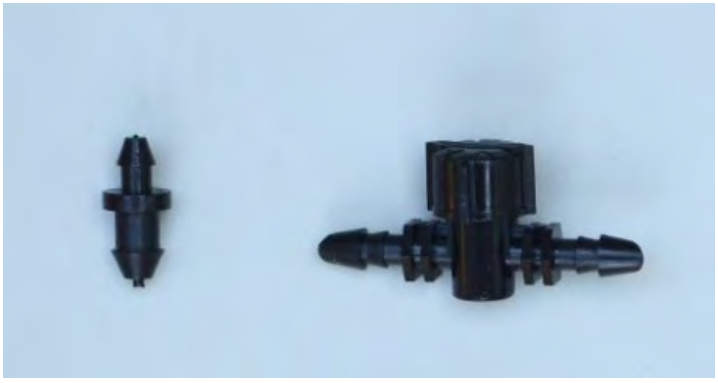
The quarter-inch tubing is available without emitters.

Attachments for quarter-inch lines

This is a quarter-inch punch with a built-in socket for installing a threaded mini-jet sprayer. A sprayer has been inserted into the socket.

On the left of the punch is an emitter with a 180-degree spray pattern.

A 360-degree pattern is produced by the emitter on the right. Look closely and you'll notice that you can see all the way through the 360-degree emitter but not the one with a 180-degree pattern.



A goof plug is on the left followed by a vari-flow valve.

The valve can complete shut off water to an emitter or feeder line.

It can also control the flow through the valve reducing the output of an emitter.

These four items are the various forms of transfer barbed connectors that you can order: an elbow, a tee, a cross and the one you'll use most often, a straight transfer barb. All of these attachments are demonstrated in the photos of the various arrangements in the "**CONSIDERATIONS FOR EMITTER PLACEMENT AND ARRANGEMENTS"** section below.

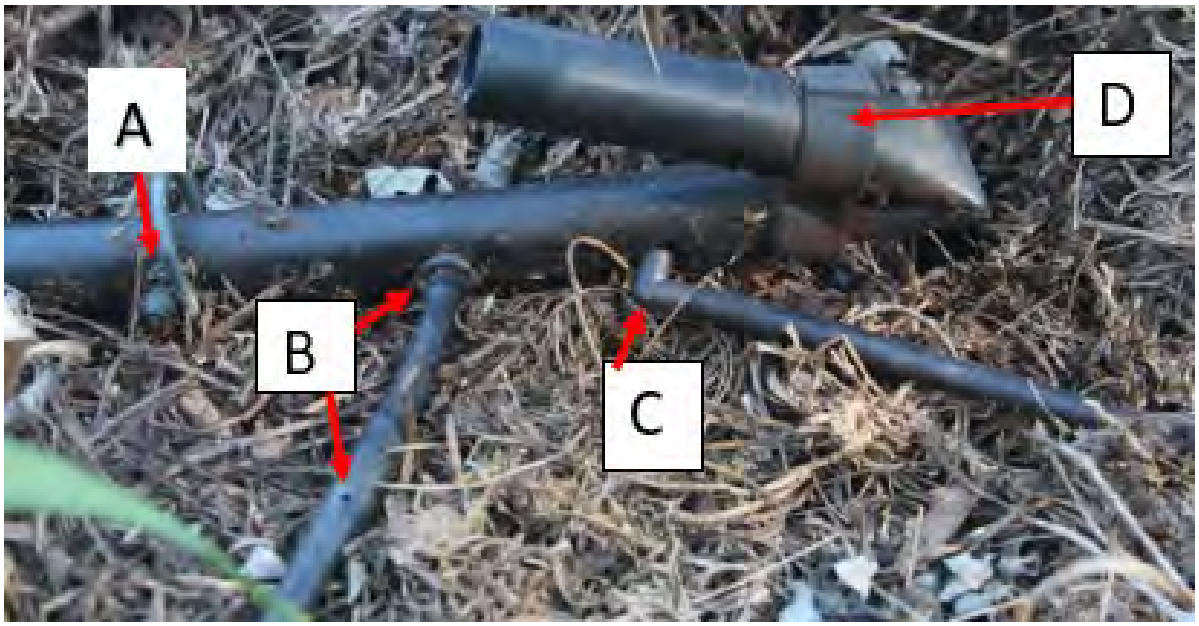
One end of the goof plug is larger than the other. There isn't a hole in it because it serves as a plug when a broken transfer barb needs to be removed or you want to plug the end of a feeder line or a soaker dripline. The half-inch tubing may be torn, and the larger end will be needed to prevent a leak.

A vari-flow valve allows you to control the water flow to emitters. You can also cut off the water completely if you a) want to change the emitter or b) because the plant(s) have been removed.

Attaching quarter-inch feeder lines, soaker driplines and emitters to the half-inch supply line

The blue arm punches a hole in the half-inch supply line by closing the blue handle. You'll find insertion will be easier if you place the quarter-inch tubing on the quarter-inch transfer barb before inserting it into the half-inch supply line.

1. There are several things to notice in the next photo. Micro-fittings at A, B and C have been inserted into holes in the half-inch supply line made with the blue and white punch. All the transfer barbs just happen to be on one side of the supply line. They could have been inserted on top or on the opposite side.
   A. A goof plug is on the far left with the larger end sticking out.
   B. The straight transfer barb is used to connect a soaker dripline. The opening in the dripline is facing up to minimize the intake of dirt if a back-suction occurs when the water is turned off.
   C. An elbow transfer barb is used for the line going to the right. If a straight transfer barb had been used, you would notice a bend in the quarter-inch tubing as it headed to the right. It could result in severe crimp that could reduce or completely cut off the water flow.
   D. Last is a figure-8 end that is cheaper than a half-inch male hose end fitting. It won't leak.



Emitters

Emitters are the attachments that deliver water to your plants. They will drip, mist, spray, or sprinkle in varying patterns, delivering amounts of water measured in gallons per hour (GPH).

The flow rate for the individual emitters I most often use can vary from ½ GPH to over 8 GPH. A vari-flow valve allows me to reduce the flow to well below 8 GPH. For most home gardens with a drip system, you will be selecting ones that vary from half a gallon to only a few gallons per hour. For smaller gardens with special demands, you can use higher flow rated emitters. More under "**Considerations for high volume emitters".**

When you are designing a zone (area controlled by one timer, can be one or more gardens) all the emitters will be on for the same amount of time to deliver water to a soil depth of 6 – 8 inches. The objective is to design a system that will achieve this goal at approximately the same time to avoid wasting water and delivering excessive amounts to a particular part of your garden. You can accomplish this goal by selecting emitters with different flow rates, increasing or decreasing the number of emitters, and the use of micro-valves that allow you to reduce the water flow to selected emitters.

You will eventually favor just a few designs. They can be purchased in small packs for just a few dollars, or in packs of 50 to 100 if you're going to go huge.

Vari-flow valve

A quarter-inch line with a vari-flow valve controlling water flow to a hanging basket. The valve is only partially open. When the arrow is in line with the tubing, the valve is fully open. It is closed when perpendicular to the quarter-inch tubing.

Use a vari-flow valve:

- To shut off the water to any emitter so you can change it.
- To completely shut the water off and leave the non-functioning emitter in place if a plant has been removed and you don't want to remove the feeder line and emitter.
- To reduce the flow rate to any emitter so you don't have to change to one with a lower flow rate.
- To significantly reduce the flow rate to an emitter allowing you to convert a high-volume emitter to a drip emitter.

CONSIDERATIONS FOR TUBING LOCATION AND EMITTER PLACEMENT

I took this photo in 2013. The garden was doing great. You can see a different view of it just after the introduction, under **"MATURE GARDENS WITH AUTOMATED IRRIGATION SYSTEMS".** This is Garden 2.

Over the years, the maple tree to the right and just out of the picture, grew extending its roots into the garden. It became necessary for me to remove the mass of roots and completely rework the bed before re-planting. Initially, every few years, then every other year and now every year. I decided to use containers in a limited capacity for the summer of 2020. The results were so positive I expanded from 9 containers to 24 for my fall-winter garden.

The trellis was supporting several blackberry plants. This garden extends south from the trellis.

This is the first winter for my 37 X 8-foot container garden for 2020-2021. The 5-foot horse panel prevents deer from enjoying the salad bar offerings. The rope across the top discourages fence jumping and has been working. I only had containers on the right as a trial during the summer. The containers now range from 3 to 45 gallons, plus the hay bale planters attached to the fence. They all have quarter-inch feeder lines extending up to them. The PVC pipes are to support my crop covers when we have a hard freeze. This was the garden with a root problem from the maple tree shown in the previous photo.

The irrigation tubing and emitters in some of the newly planted containers (mini gardens), demonstrate different layouts. Beginning plant growth allows a clearer view of the tubing and connectors.

The half-inch supply line, visible to the left of center, extends under the front fence in the above photo and runs on top of the soil near the base of the containers. I used quarter-inch plain feeder lines to reach up, into the containers, each with a vari-flow valve.

A few quarter-inch feeder lines, attachments, and emitters in place

The Master Gardener Slidell Library Herb Garden with a couple of two-GPH emitters. Feeder lines are buried. The black top may be unscrewed for cleaning. They have been inserted into the end of a quarter-inch feeder line. They could also be placed horizontally by lifting the feeder line a little more and keeping the tip above and out of the mulch with a support stake.

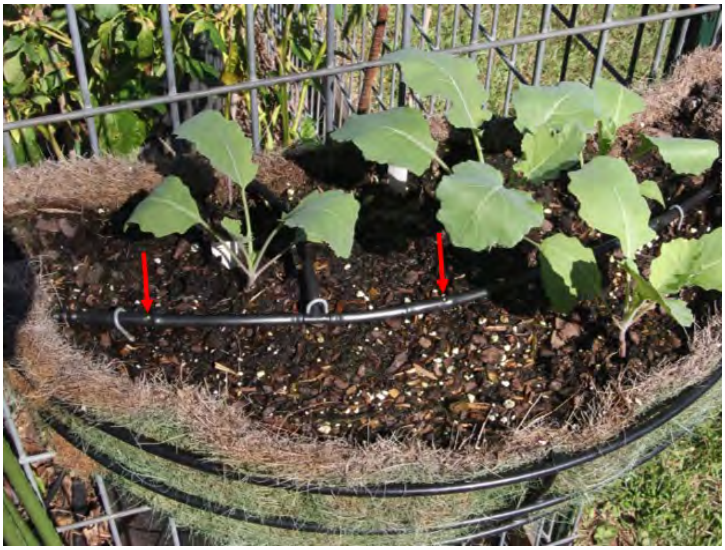
Enlarged image of one of the circled emitters in the above photo. The green base indicates that the flow rate is 2 GPH (gallons per hour).

Since I began using the vari-flow valves to reduce the flow rate to my emitters, I only reorder these with a flow rate of 2 GPH.

These emitters are PC (pressure compensating), meaning that the flow rate will be the same if the system pressure is between a given range, 15 – 45 PSI (pounds per square inch).

The flow rate of an emitter that is not PC (pressure compensating) will vary depending on the system's pressure.

You can reduce the water flow with a vari-flow valve or change the emitter to one with a lower flow rate.



A quarter-inch soaker dripline with two emitters visible as a small white dot at the tips of the arrows. A tee-connector joins the supply line providing the water.

The emitters in the soaker dripline are not PC (pressure compensating), the flow rate varies with the water pressure and with the spacing of the emitters in the line. The lines come with the emitters already installed at a spacing of 6, 9 or 12 inches with a recommended pressure regulator of 10 to 30 PSI.

These emitters are spaced every six inches. This system has a 30 PSI pressure regulator which delivers about 0.8 GPH for each emitter. A vari-flow valve is connected, allowing the flow rate to be reduced. This hay rack basket doesn't need a flow rate that high; it is reduced with the vari-flow valve.

Soaker dripline irrigating a horizontal row of 20 carrots (once thinned). There are bok choi in each quadrant with a few errant seedlings near the bottom. In six weeks, a vertical row of 20 more carrots will be planted.

Above, a tee-connector joins two of the soaker driplines. The bulges of the embedded emitters are visible. The outlet in the upper one is near the upper edge of the photo. The lower emitter's opening is pointing down and is susceptible to having soil pulled into it by back suction when the water is turned off. Rotating the tubing will place the opening on top.

Elbow connectors join this soaker dripline to the water supply. This elbow technique can also be used on the side boards of a raised bed.

A vari-flow valve in on the right, below the rim. This quarter-inch plain feeder line connects to the half-inch supply line on the ground.

Using a soaker dripline instead of the plain quarter-inch feeder line to connect to the supply line would be a waste of water and potentially could result in a loss of pressure for the entire system if there are many lines dripping but not irrigating any plants.

This cross connector joins the feeder line extending to the right, under the metal hold down. It passes to an elbow connection leading up and over the rim to the mainline water supply.

Soaker driplines extend up and down from the cross connector forming a circle around the plants. The plain feeder line to the left supplies an emitter in the center of the circle.

An overhead view of this container is next.

Overhead view of the container in the previous photo: a soaker dripline in a circle using a cross connector. The stake in the center holds a drip emitter that is on a plain feeder line connected through the cross-connector to the supply line. The 4' mark on the rim indicates the length of the circle of quarter-inch soaker line that I needed.

You can make a custom soaker dripline by installing individual inline emitters at any interval you need.

There are three staggered plants, two in back and one in front. The green inline emitters are placed along a plain quarter-inch line with sections cut to the length you need. The spacing is easily changed between emitters. These emitters have a flow rate of 2 GPH.

I placed a vari-flow valve on the left to enable the flow to be reduce if needed. These inline emitters are available with a flow rate of one-half, 1 or 2 GPH. I can add additional inline emitters if more water is needed.

Using a vari-flow valve to reduce the flow of drip emitters and to convert high volume irrigation emitters to drip emitters

A vari-flow valve can reduce the water flow to an emitter, thus reducing the water pressure. Flow from PC and non-PC emitters can be reduced.

The valve is fully open when the arrow is in line with the tubing. When perpendicular to the tubing, the valve is shut. You vary the flow by pointing the arrow anywhere between these two; fully open to fully closed. Slowly adjust the valve to reduce the amount of water flowing out of the emitter until you reach your desired level.

The arrow on top of the vari-flow valve indicates it is almost fully open. This spray attachment has a fixed setting with a maximum flow rate of 8.1 GPH. It will supply too much water at this setting for the timed irrigation. Most of the other emitters are at a much lower flow rate.

The valve is partially closed to reduce the flow of water to the emitter.

This is my usual setting used for this emitter in this 5-gallon pail for the single plant. Drip systems are designed to deliver the optimum amount of water to each plant. You control the water flow through emitters by selecting ones with different flow rates or by using vari-flow valves to reduce it. When the top several inches of soil become dry, it's time for the system to come on at your preset interval.

This vari-flow valve is almost completely closed. The 1 GPH emitter has been reduced to a slow drip. A drop of water can be seen just below the tip of the emitter. The emitter is PC (pressure compensating). This feature has been defeated by significantly reducing the water flow through the vari-flow valve.

Normal flow from this self-flushing, take- apart, PC emitter with a one-GPH (gallon per hour) flow rate. The valve is fully opened, allowing water to stream out. It is being supported by a 6-inch support stake for quarter-inch tubing.

You can also reduce the high-volume mini-jet spray emitter's flow rate and diameter of spray with a vari-flow valve.

Mini-jet spray head on a seven-inch stake between a firebush and an African blue basil.

Mini-jet spray emitters are threaded. This one is screwed into a one-inch piece of quarter-inch tubing on a tee-connector. Normal tubing will bend if long. The short tubing will also keep the spray off the foliage.

A thicker walled quarter-inch tubing, a Rigid Riser, can be used if you want to elevate the sprinkler. They must be used with threaded fittings due to the thicker wall. Only straight connectors have a threaded option. These emitters are threaded to avoid the problem with thick-walled tubing that was reviewed above under "**Half-Inch Supply Line Tubing"** that included the thicker, half-inch risers. Quarter-inch riser tubing also has thicker walls like the half-inch riser tubing.

A dripper on a stake is in the center of this pot of herbs. It can be ordered with a flow rate of one-half, 1 and 2 GPH (gallons per hour).

I find it cost effective to order the higher volume dripper and use a vari-flow valve if the flow rate needs to be reduced. This process also reduces the amount of time needed to remove and place an emitter with a different flow rate.

These dripper emitters are especially useful in hanging baskets.

GETTING STARTED ON YOUR DRIP IRRIGATION SYSTEM

FIRST – list of supplies needed

You will want to get the attachments in this photo you saw earlier in the section titled **"GETTING STARTED FROM THE FAUCET".**

The list includes:

1. Y-splitter
2. Timer
3. Filter – if using unfiltered well or pond water it must be before (upstream from) the timer and rated to function under continuous water pressure.
4. Backflow preventer
5. Pressure regulator
6. Leader garden hose

Additional supplies:
Complete your garden layout before deciding on most of these additional items. They are listed before the SECOND step so the list of all the supplies you will need is in one place.

1. Punch to insert quarter-inch connectors with barb into half-inch supply lines
2. Tubing cutter or shop scissors
3. Half-inch supply line – available in 50-, 100-, 250- and 500-foot rolls. The length will depend on the size of your garden.
4. Hose start fitting(s) to connect the leader garden hose to your half-inch supply line tubing
5. Couplers (get 2) for the half-inch supply line (to extend a supply line or repair one that has been cut)
6. Hold downs for half-inch supply line (both J and U designs). The J has one leg longer for a stronger hold.
7. A figure 8 end or a male hose end fitting with a cap for half-inch supply line
8. Quarter-inch polyethylene micro tubing (feeder line) 50- or 100-foot roll
9. Quarter-inch soaker dripline – pre-installed emitters spaced at 6, 9 or 12 inches
10. Quarter-inch fittings to attach feeder line and soaker dripline to your half-inch supply lines:
    a. Straight connector – use most often
    b. Elbow connector
    c. Tee connector
    d. Cross connector – will not use very often
    e. Goof plugs
11. Vari-flow valves
12. Six-inch support stakes for quarter-inch lines – helps keep soaker dripline above the soil
13. Hold downs for quarter-inch tubing – come in J and U designs
14. Emitters – these are the ones I currently use; you may prefer others. There are many to choose from
    a. Number 9, above, is the quarter-inch soaker dripline with emitters already installed
    b. Mini-jets – I use the lowest flow rate available. I place them mostly in my high flow gardens. See **"Considerations for using high volume emitters"** below.
        i. Half circle spray pattern
        ii. Full circle spray pattern
    c. One-half or 1 GPH dripper emitters on stakes for hanging baskets
    d. Self-flushing, take-apart, PC emitters – 2 GPH - use vari-flow valve to reduce flow if needed
    e. PC shrubbler on a stake (also come with just a barbed base for insertion directly on a supply line.) Use the vari-flow valve to adjust flow for those on a stake
    f. Inline emitters– they are PC – I prefer the ones with a flow rate 2 GPH

SECOND – Draw the outline of your garden

Include measurements to help you decide where to place your half-inch supply line and how long a line you'll need. Outline the plants. Indicate the supply lines, soaker driplines, feeder lines and emitters by specific type. This won't have to be your final design. As you place the lines and emitters, expect to make some changes. You'll probably do some fine tuning after the plants are in.

Keep the dimensions small for your first attempt while you get a handle on how many emitters you will need.

- -if you are going to grow vegetables in rows, with equal spacing of the plants, you could select a system that consists of a half-inch supply ribbon with built-in emitters. Easy peasy. Just prepare the bed and roll out the tape. You will need drip tape fittings for beginning and end.

Drip tape comes with factory embedded emitters that are pre-inserted every 4 or 8 inches.

They cost less than a half-inch supply line with embedded emitters and are ideal for row crops.

Additional emitters cannot be inserted.

Some brands (more costly ones) have a non-clogging design that enables them to be used beneath mulch and even buried under the soil.

You may choose to run the half-inch main line down the center of the bed and run quarter-inch feeder lines to reach the plants on one or both sides.

- If you have a garden longer than 20 feet, run the supply line the full length. You can then add the emitters just to the first 20 or so feet to get a feel for the flow rate and penetration of water with varying emitters. The makeup of your soil will determine the speed of soil penetration and length of time between irrigation sessions along with the flow rate of the emitters.

  Another option is to run a supply line for just part of the length of you garden and later, add an extension. You would use a coupler fitting to join two half-inch supply lines.

- You determine the speed of penetration by measuring the time the water takes to moisten your garden to a depth of 6 to 8 inches. It is fastest with lots of sand and slowest with a higher clay content.

- The degree of retention will be measured by how long it takes for the top few inches (2 – 4) to become dry after irrigation to depth. It is shortest with sand and ideal with organic matter.

- Most of my gardens are raised due to the high content of clay in the natural soil where I live in Folsom. If I dug a hole and filed it with a high-quality garden soil, the clay base would result in any excess irrigation water very slowly draining away, and my plants would spend a good bit of time standing in water. That's the reason my beds are raised from 8 to 12 inches.

- If you're going to install a supply line with feeder lines leading to emitters or driplines, keep the dimensions of your first installation small while you familiarize yourself with the spacing and flow rate to get the 6-to-8-inch depth of moisture penetration. The composition of your soil and its degree of compaction will both play a role. You may also find that some plants require a little more water than a different class nearby. The above garden is a vegetable and herb combination. You may prefer just ornamentals, or even a combination of ornamentals and herbs. A photo of this garden when filled out is in the photos of **"MATURE GARDENS WITH AUTOMATED IRRIGATION SYSTEMS"**, near the beginning of this article. It is Garden 1 in the foreground.

- This garden is 20 feet by 5 feet and a good dimension so I can work it from both sides. When determining the width of your garden, let your reach be your guide. You want to comfortably reach the center from the sides.

- If it's against a building, consider using a width a little closer to 4 feet. The plants next to your home will be set a bit away from the foundation and are usually taller and wider than the plants in front of them. Depends on what you are growing near the building as well as the length of your arms.

I installed an irrigation system in this garden in 2008. There have been changes in the feeder lines and emitters as the plants and garden layout have changed over the years.

A PVC water line extends up into this garden in the middle of the lemon grass clumps in the back. A half-inch supply line runs down the middle with quarter-inch feeder lines attached with straight barbed connectors. In areas that haven't been planted for this year, the vari-flow valves shut off the water to each smaller line until the plants are in. I change some feeder lines and emitters each year, to varying degrees, depending on my plant selections.

The rectangular area on the right in the back is outlined by soaker dripline tubing with 6-inch emitter intervals. I installed it this year. In the front near the twin blue pipes, are three plants with the green inline emitters that I also added this year.

Six depressions on the right are where I planted lettuce seeds. I used the existing irrigation lines. Existing lines were also used for the three plants on the left near the divider board. Several other areas haven't been planted. The existing emitters and feeder lines have been left in place. I can replace or modify them depending on the types of plants and their placement.

Barely visible wire cages are on either side that I place over the plants to prevent browsing by deer and rabbits. They also discourage armadillos from rooting up the plants as they dig for grubs and earthworms.

I placed the horizontal divider board in the middle to support the sides. Twin PVC pipes on the left are on each side of a half-inch supply line that extends underground to the container garden. The twin blue pipes in the front mark the extension of the supply line to a small ornamental garden. The tall pipe in the center marks where the container main supply line connects to this garden's supply line through a half-inch tee-connector. The half-inch lines between and near the blue pipes mark the location of the deeply buried lines. The pipes remind me not to dig too deeply or enthusiastically in these areas.

The half-inch supply line comes either solid or with drip emitters installed at the factory. The spacing for these emitters are all the same. They can be ordered with either 9, 12, 18, 24 or 36-inch spacing. If your plant spacing will never change, you might want to consider them. I no longer use these half-inch supply lines with pre-installed emitters. I frequently change the design and spacing of the plants in my gardens. It is easier to adjust with the quarter-inch feeder lines, soaker drip lines and emitters. Changing the placement of plants can leave the installed emitters in the supply line releasing water where I don't need it. Excess water can add up when several emitters are emitting where there aren't any plants.

This summer I changed the half-inch supply line with emitters that were in the container garden to one without any emitters. All the plants are in containers connected to the water supply through plain quarter-inch feeder lines. All the emitters that were in the half-inch tubing weren't irrigating any plants. This resulted in run-off that flooded the surrounding lawn and the path in the container garden every time the system came on. The total wasted water from the 80-foot supply line was 40 gallons per hour. Emitter spacing was 24 inches. Flow rate for each emitter was 1 GPH.

- With a wide bed and a single row of plants near each side, you may choose to run a supply line on each side between the edge of the bed and your plants. This will make it easier to attach the feeder lines to the supply line and easier to reach around the plants.

- If you have a wide bed and plan to have several rows of plants along the sides, it might be easier for you to run the supply line between two rows along one side and another between two rows on the opposite side.

- An asymmetrical placement of your ornamentals or veggies will require you to make additional decisions. Some of the sections will need different types of quarter-inch feeder and soaker drip lines and emitters.
    a. Will you use a series of quarter-inch feeder lines ending in a terminal emitter?
    b. Will you want to incorporate soaker driplines that will feed off the main half-inch supply line?
    c. Will you want to include inline emitters? Up to 15 of them can be installed on a quarter-inch feeder line.
    d. Will you use emitters placed directly on your half-inch supply line?

This circular soaker dripline irrigates both the lettuce on the outside of the circle and the kohlrabi in the center of your circle. The feeder line leading to the circle is plain and doesn't have any embedded emitters.
You could add a second circle if you wanted to place some garlic or bunching onion bulbs along the edges of the container.

- If a quarter-inch soaker dripline is in your plans, the plants will indicate what spacing you'll want to use. They are preinstalled every 6, 9, or 12 inches. They are not Pressure Compensating so the flow rate will depend on the spacing and the pressure. If you have a 30 PSI regulator, the rate for every 10 feet of soaker line will be 16 GPH for 6-inch placement; for 9-inch, it will be 10.7 GPH; for 12-inch spacing, you will have 8 GPH. The emitter spacing will be factory-installed.

- If your plant spacing doesn't correspond to the preinstalled emitters, think about making your own soaker line with individual inline emitters. Use plain quarter-inch line, insert one inline emitter, and cut another piece of tubing to place the next emitter exactly where you would like it, then cut another piece of line for the next inline emitter. Place a goof plug at the end of the line. There is a photo of these inline emitters at the end of "**A few quarter-inch feeder lines and emitters in place"** section**.**

Should your supply and feeder lines be arranged before or after the mulch is placed?

This is the location for seeding six lettuce plants.

Before placing plants or seeds is the best time to install your irrigation.

It can be done after the plants are in but you're likely to damage them when the lines are manipulated. The six-inch support stakes can be driven deeper into the soil when placing the mulch. The stakes are attached to the quarter-inch soaker driplines to secure their location and keep the lines slightly above the soil.

When you install the mulch, you want to:

1) Run your half-inch supply lines first.
2) Avoid stepping on your freshly prepared soil – use a board to distribute you weight.
3) Place your supply line.
4) Place your mulch – pull it back from the area where the seeds or transplants will be located.
5) Arrange and install your feeder lines and emitters with the support stakes.
6) Finally insert your plants or seeds
    a. Pull the mulch back to give you plenty of room for your plantings.
    b. Keep a pail close by for the extra dirt you will remove (if transplanting)
    c. Rearrange the mulch.

During your selection process, keep in mind the flow rate of your different emitters. You don't want them to vary to the extent that some areas of your garden will be in standing water while other areas don't get enough. Flow rate of emitters used in this article can vary from less than 0.5 GPH (gallons per hour) to over 8 GPH. You will find the flow rates usually indicated in the catalogs or the packaging. A lower flow rate allows the irrigation water to slowly penetrate the soil with less run-off than with a high flow rate.

You can get the flow rates (GPH) in a closer range by either changing some emitters or installing vari-flow valves to reduce the higher flowing ones. After the plants, seeds, soaker lines and emitters are in, reevaluate the length of time it takes for the top of the soil to dry. It should be similar for all areas. If not, consider modifying the placement of the emitters and soaker lines.

Considerations for using high volume emitters

GARDEN A - I have a linear bed next to a parking apron that is 20 feet long by 4 feet wide within the drip line of a large pistachio tree.

This mini-jet spray emitter on a stake is one of six, each with a flow rate of 6.8 GPH. Total flow rate for the garden is 40.8 GPH. I need so much water because the tree will hog much of the water normally required for just the plants.

The pistachio tree is behind the fence that supports the confederate jasmine. The Christmas berry plants in the photo are at one end, then come four Canyon Creek Abelias ending with a medium sized gardenia shrub.

Because all the emitters are the higher volume mini-jets without any true drip emitters used, it is easier to time the irrigation for the desired water penetration across the entire area.

GARDEN B - My other high-volume garden is four rows with 7 blueberry bushes per row. The total length of the supply line is just over 100 feet. One mini-jet emitter is between each bush for a total of 24 emitters, each with a flow rate of 6.8 GPH for a total of 163 GPH for this zone. These emitters are on 7-inch stakes that are far enough above the soil to easily see, if sprayed with minimal spots of bright, neon paint. This helps the grandkids avoid stepping on them during harvest time.

Attaching your half-inch supply line to your water source

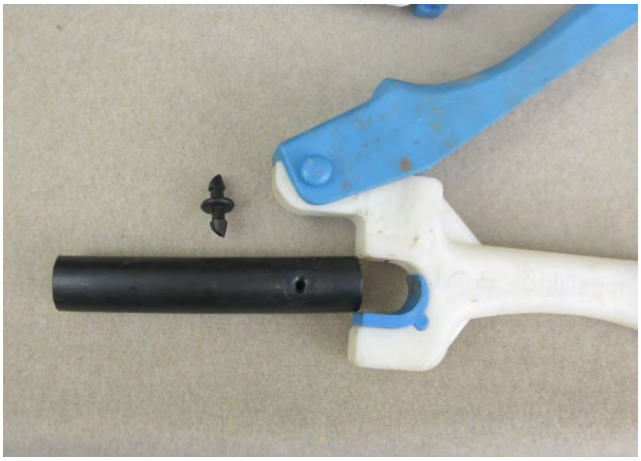
Female hose start fitting for the half-inch supply line.

The green hose runs from the pressure regulator on the top timer in the photo at **"Getting started on your drip irrigation system"** and is connected to the top of the female hose start fitting.

The black half-inch supply line tubing leading from the bottom of the fitting to the bottom of the photo brings water to my plants. The supply line is forced over an enlarged ring around the base of the fitting (visible in the photo of "**Half-inch tubing attachments"**). The nut is then screwed down holding the tubing firmly in place.

This supply line irrigates Mature Garden 4 near the beginning of this article.

How to attach quarter-inch feeder lines and emitters to the half-inch supply line using a straight transfer barb



The blue arm punches a hole in the half-inch supply line when closed. You'll find insertion will be easier if you place the quarter-inch tubing on the quarter-inch transfer barb before inserting it into the half-inch supply line.

Goof Plugs

They also are available in a one-way version without the larger size on one side and the smaller barb on the other. You'll need the larger size if a hole is occasionally torn when a transfer barb is removed. They are used in several situations:

- - If a transfer barb breaks off when I accidently step directly on it or on a line attached to it, I use an end-cutting pair of pliers to slip under the shoulder of the remaining half of the transfer barb. I have to be careful not to cut through the barb as I lift out the bottom half of the connecter from the half-inch tubing. I place smaller end in the line below with the double size end sticking up if the line doesn't have a tear. If the hole appears to be larger than the smaller end and fits without much resistance, you will have a leak and should place the larger end in the line.

Broken transfer barb

Water on

Barb removed; goof plug placed

- To replace a feeder line that you don't need this growing season

  NOT A GOOD IDEA because in the future, you may not be able to remove a goof plug and replace with a transfer barb without a leak developing, especially if the larger end has been inserted. Easier to leave a section of feeder line attached to the transfer barb, cut it, and insert a goof plug in end of the quarter-inch feeder line. Next time you need a line here, just cut off the goof plug and insert a transfer barb in the quarter-inch tubing to attach the new feeder line.

- At the end of a soaker dripline or a custom-made soaker line with inline emitters and a plain feeder line.

You can see the small opening in the soaker drip line facing toward you.

This quarter-inch soaker dripline ends with a goof plug.

Maximum flow rate capacity for quarter-inch soaker feeder lines

Friction of the water flowing over the inner walls of the quarter-inch soaker feeder line, rapidly diminishes the ability of water to flow long distances and maintain the original pressure. That's why it is recommended that you use a soaker dripline to deliver small amounts of water (about 39 GPH) over short distances. By keeping the distance short, you will maintain a consistent flow rate in all the emitters. The emitters in the soaker dripline are not Pressure Compensating. The flow rate varies with the pressure and is a little over 1/2 GPH with 30 PSI maximum. The specific amounts can be found under **"Quarter-inch soaker dripline – the inserted emitters are not PC".**

The maximum run lengths for 1/4" soaker driplines to keep the emitter flow rates consistent are:

6 inch spacing = 18 feet max
9 inch spacing = 25 feet max
12 inch spacing = 34 feet max
If you over extend these lengths, you may have insufficient water pressure and experience inconsistent flow rates.

For the orientation of the emitter holes in your soaker dripline, up is better than down. This will avoid the potential for a back-suction drawing in muddy water when the system stops running.

Maximum flow rate capacity for half-inch supply lines is 240 GPH

With a true drip system, your emitters will have a flow rate of between 1/2 and 2 GPH (gallons per hour). If you are using one-half GPH emitters, you can use 480 of them, with 1 GPH emitters you can have 240 and 2 GPH emitters would limit you to 120 emitters.

Tomato plants like a little more water than many other vegetables, so you can use a 2 GPH emitter here while lower flow rates on other plants in your vegetable garden or use an extra emitter.

To be sure you haven't installed too many emitters:

- Add up the flow rates of all your emitters. OR
- Turn on the system and check the emitters most distant from the start to see if the distant ones have an acceptable flow. Does it appear to be in a normal range? My longest supply line is 119 feet with numerous emitters. Most are at 2 GPH or less. They all have acceptable flow rates.

  Unless you select a lot of emitters with very high flow rates, you shouldn't have a problem.

Board with tools used for placing and repairing irrigation lines

Top row from the left: end-cutting plier (slips under the edges of the broken transfer fitting), transfer barb with 2 broken ones, wire cutter, small fillet knife, two large hold downs for half-inch tubing (J shape goes deeper to hold firmer in loose soil), a smaller J hold down for quarter-inch tubing, a 6-inch support stake for quarter-inch tubing and a roll of quarter-inch soaker dripline.

Bottom row from left: Shop scissors to cut tubing, a blue handled Channellock wrench, a punch for quarter-inch transfer barbs and a roll of quarter-inch plain polyethylene tubing.

I use the board to distribute my weight when installing or adjusting the lines attached to the main supply line and any time I might step in a garden that hasn't been planted. The freshly turned soil has plenty of air spaces and is easily compressed.

If your bed has a row on each side and a supply line down the middle, the width of your board should not reach to the main supply line. My board is 24 by 30 inches.

Prepared garden soil that has been compressed because I stepped on it while inserting a goof plug.

Compressed soil from my boots when board was not used.

Fifty percent of an ideal soil in a prepared bed consists of air and water. Standing or kneeling on prepared soil will result in compression and elimination of the spaces.

Roots have a harder time penetrating compressed soil. The spaces occupied by oxygen and water are minimized. Plant health can suffer.

Small plastic box with supplies I most often need for installation and repair of my drip systems.

Here is a list of the emitters I routinely have in my large irrigation toolbox and the small one pictured above. They are used in different configurations and with vari-flow valves on different settings. I installed my first drip system in 2008. I currently have 10 beds and have tried many different emitters from different sources. The ones I most often use are listed below.

Most are drip type emitters:

- Quarter-inch soaker dripline with embedded emitters
- Stake drip emitter for hanging baskets available in ½, 1 and 2 GPH
- Take-apart, self-flushing PC emitters
- Take-apart, self-flushing PC emitters on a stake. (Flow rate can be reduced with a vari-flow valve.)
- Inline emitters that are added along a quarter-inch feeder line, available with ½ GPH, 1 GPH and 2 GPH flow rates. They are joined by plain quarter-inch feeder lines. The spacing depends on plant locations and usually vary.

I do have a few spray emitters for special applications. They are not truly 'drip' emitters. I had them before converting mostly to drip systems; I found they can be forced into that roll with a vari-flow valve.

- Mini-jet spray emitter with a threaded base, full and half-circle designs. Their individual flow rates vary from 5 GPH to 28.9 GPH, less with a vari-flow valve
- PC shrubblers – spray is in fingers of water – diameter of spray varies with flow rate which varies from 6.6 to 9.3 GPH depends on the rating of the pressure regulator being used. Can be reduced if a vari-flow valve is used. I usually use these emitters attached to a stake, but they are available directly attach to a supply line

A wide variety of emitters are available, both spray and drip, from many different suppliers. I prefer the sprayers that are low and keep the water off the lower leaves, especially when the plants are susceptible to fungal diseases.

This bed is ready for planting. Orange tipped emitters – shrubblers – are on quarter-inch feeder lines. I have attached them to the half-inch water supply lines. I can easily move the emitters, feeder lines and supply line as the plants are placed. This was a system I used before going to drip irrigation. Note there are no vari-flow valves.

Follow the general rule of keeping the emitters releasing the approximate same amount of water so one area of your garden doesn't get overwatered while another area is not receiving sufficient water.

Keep in mind that some plants will require a little more water (like tomatoes) than others.

SQUIRRELS, !*$@&%!!

I've only experienced one problem with rodents and my irrigation systems. It was several years ago.

We had a bird feeder containing peanuts outside our kitchen window. Running beneath it was a long-established half-inch supply line. Pieces of peanut fell on the ground and on the supply line beneath the feeder. The squirrels ate the peanut pieces and kept chewing into the irrigation line.

Squirrel chewed holes in half-inch supply line.

The irrigation valve was closed most of the day so water pressure didn't scare them away, but the stream of water squirting toward the feeder early in the morning when the system was on, did alert me that I might have a problem.

Moving the feeder or irrigation line was not a consideration.

Solution: I cut out a 6-foot section of half-inch supply line with the chewed holes. I inserted a new supply line section inside a 4-foot section of three-quarter inch PVC tubing. Coupler fittings joined each end of the new line to the existing supply line.

Half-inch coupler fitting with two pieces of half-inch supply line, one inside three-quarter inch PVC.

I spray painted the bright white PVC with dull, green, and tan paint.

The peanut feeder was replaced with a ‘squirrel-proof’ sunflower seed feeder.

SOURCES

Home Depot and Lowe's – visit their stores or check their websites for drip irrigation – bought some items here

Ewing Irrigation and Supply – Hwy 59 in Mandeville – also have a website – bought some items here

DripWorks.com – online design and supplies – many products pictured in this article were purchased here

leevaley.com – water and irrigation supplies – bought some items here

Google 'Drip Irrigation supplies and systems' – for many other sources

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