MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #264

Irrigation Equipment

Outline:

Equipment for delivery of landscape irrigation water ranges from automated in-ground sprinkler systems and drip irrigation systems to hose-end watering. A basic outline of each with their strengths and limitations follows.

In-Ground Sprinklers

Different types of irrigation equipment are most effective to water various types of planting in the home landscape. For lawns, sprinkler irrigation with pop-up spray heads and rotor heads are generally used. Because each type of sprinkler delivers water at a different rate, do not mix sprinkler types in a zone.

All sprinkler systems must comply with local building codes, requiring building permits and inspection. In-ground sprinkler systems have the following basic components.

Point of Connection – The system starts at the point of connection where the supply line connects to the water supply. This is in the basement of the typical house. The size of the pipe and water pressure determine water flow and thus influence design of the system (how many heads can run at one time).

A **pressure regulator** provides uniform, lower water pressure for uniform water delivery. This is typically found just before the point of connection. It should be set at 30 to 40 psi for the landscape irrigation system and household water use. Sprinkler systems have maintenance problems and values may fail to shut off when the pressure is above 80 psi. Pressure regulators are typically not found in older

homes. Due to increased uniformity of water delivery, adding a pressure regulator may result in significant water savings in landscape irrigation.

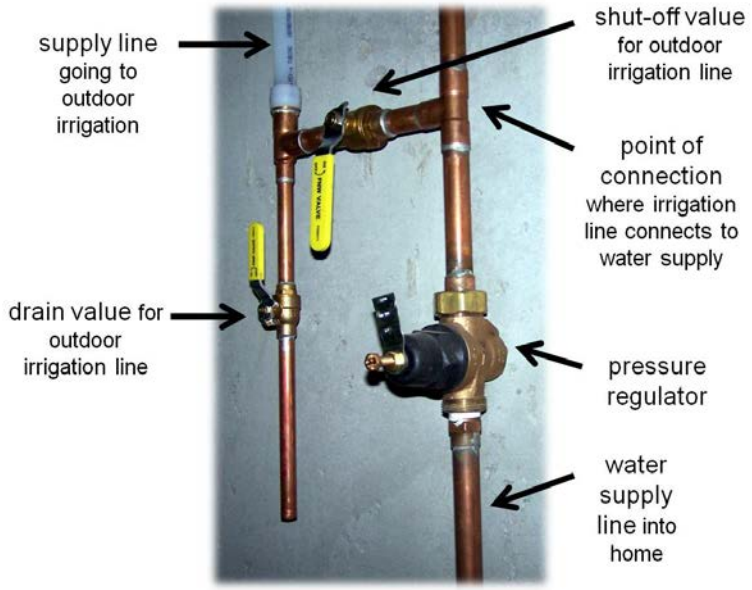

Figure 1. Point of connection with pressure regulator, shut-off value for outdoor line and drain valve that drains the outdoor line to the backflow prevention device (located just outside the house).

Local building codes require a **backflow prevention device** to protect the community's water supply. This is typically placed where the water line comes out of the house. Some valves have a backflow prevention device build into the value. The type to use depends on the local building code. [Figure 2]

Figure 2. Required by local building codes, backflow prevention devices are typically located where the line comes outside from the house.

The main **supply line** (water line holding water under pressure throughout the summer) splits in a **valve box** to a **valve** for each zone. To minimize maintenance headaches, use Schedule 40 PVC pipe for below-ground supply lines and copper pipe for any above-ground pipe. PVC fitting are connected with special glue. Copper pipefittings are soldered. [Figure 3]

Figure 3. Valve box with two zone valves.

Beyond the valve, **secondary lines** (lines that have water only when the zone is running) go to sprinkler heads. Being easy to work with, these are generally made of flexible black poly pipe. Connect poly pipe fitting with pinch clamps.

The size of the pipe and the water pressure determine the number of sprinkler heads that can be used per zone. Various brands of sprinkler equipment have planning booklets with specific details for their product lines.

A **controller** (timer) runs the system from a central location (typically in the garage). In the home garden market, there are many styles of controllers with a variety of features. [Figure 4]

Figure 4. Controller – Many brands offer a variety of features.

In climates where the soil freezes, the lines need to be **drained** in the winter. This starts by turning off the water with the valve near the point of connection and opening the internal drain line. This drains the line to the backflow prevention valve (which is outdoors at the high point in the system).

Depending on how the system was designed, there are several methods to drain the supply line and secondary lines. Some systems are "blown out" by connecting an air compressor. Other systems have valves that are manually opened, allowing for drainage by gravity. In some systems, secondary lines have self-draining valves that automatically drain the line each time the water is turned off.

Pop-Up Spray Heads

This is a generic name for sprinklers that automatically "pop up" with a fan-shaped spray pattern and do not rotate when running. The head retracts by spring action when the water is turned off. [Figure 5]

Figure 5. Pop-up spray heads are used for small areas, 15 feet wide and less.

Delivery pattern – Pop-ups spray heads are best suited for small to moderate sized home lawn areas (larger than seven to ten feet wide up to 30 to 45 feet wide) and irregular or curvilinear areas.

Pop-up spray nozzles are most common with 15, 12, 10, and 8 foot radii. The radius can usually be adjusted down about 30%, using the nozzle's adjustment screw. Therefore, a commonly available ten-foot nozzle can be reasonably

adjusted down to seven feet. Any greater adjustment would significantly distort the pattern, resulting in poor application efficiency.

The spray pattern of a pop-up spray head depends on choosing nozzles to water quarter circles, half circles, or full circles. Some manufacturers offer adjustable arch nozzles that can be set at any angle. However, do not use adjustable nozzles where a fixed nozzle would work, as the uniformity of water delivery is not as high.

Some specialty patterns to handle narrow, rectangular turf areas are available (often called "end-strip," "center-strip" or "side-strip" nozzles). However, nozzle performance is not as uniform compared to quarter-circle, half-circle, or full-circle nozzles.

Within any given brand, spray nozzles have "match precipitation rates." That is, a half-circle head uses half the amount of water per hour as a full-circle head. With match precipitation rates, full, half and quarter circles may be used in the same zone. It is also acceptable to mix a combination of nozzle radii in a zone.

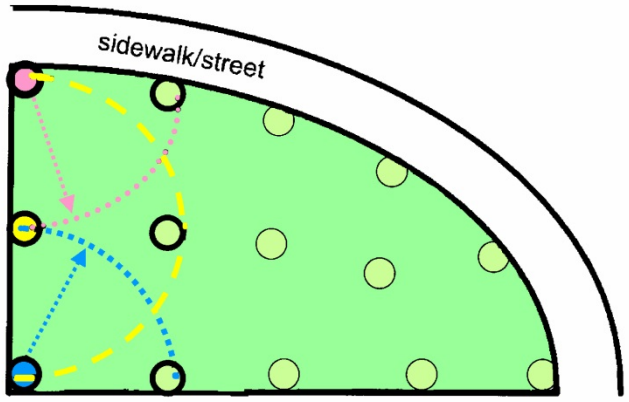

Figure 6. For uniform water distribution, the spray head needs to release water above the grass height.

Pop-up height – For uniform water distribution, the sprinkler heads should rise above the grass height, making the 4-inch pop-up style most popular. High pop-up heads, with a 12-inch rise, are suitable for ground-cover areas and lower flowerbeds. [Figure 6]

Pressure – Pop-up spray heads work best with water pressure around 30-40 psi. The water pressure at some homes may be significantly higher, and an in-line pressure regulator will be needed in these cases. A sprinkler producing a "mist cloud" around the head is a common symptom of excessive pressure. This gives a distorted distribution pattern (significantly increasing water use) and leads to increased maintenance problems.

In addition, a grade change of more than eight vertical feet on a single zone will result in significantly higher pressure at the lower end, creating distribution problems.

Small Areas – Small areas less than seven to ten feet wide are difficult to sprinkle irrigate efficiently with pop-up spray heads. Consider landscape alternatives. For example, that small side yard between houses may be an excellent site for a low maintenance, non-planted, non-irrigated mulch area. Alternatively, the small area could be a shrub/flower bed watered with drip irrigation. A narrow lawn strip may be watered efficiently with the new sub-surface drip for lawns.

Precipitation rate – Pop-up spray heads have a high water delivery rate (***precipitation rate***) of 1 to 2½ inches per hour. At the typical rate of 1½ inches per hour, the zone would apply 1/2 inch of water in just 20 minutes.

Rotor Head

Rotor heads mechanically rotate to distribute the spray of water. Impact and gear-driven heads are two common types in the home garden trade. [Figures 7 and 8]

Rotor heads in the home garden trade are best suited for larger lawn areas, generally 18 to 24 foot radius and greater. Some rotor-type heads in the commercial line have a radius of 30 to 90 feet.

Figure 7. Impact or impulse heads rotate as the water stream coming from the nozzle hits a spring-loaded arm. Impact heads tend to experience fewer problems with marginal (dirty) water quality.

Figure 8. Gear-driven heads use the flowing water to turn a series of gears that rotate the head. Gear-driven heads are quieter to operate than impact heads.

The spray pattern depends on the head. Most can be set at any angle from 15º up to a full circle. Some are adjusted at 15º increments. Others are designed for a quarter-circle, half-circle or full-circle spray pattern.

In rotor head design, do not mix quarter, half and full circle patterns in the same zone. The water flow is the same for each head, but the area covered will be different. For example, a full circle (covering twice the area of a half circle) will have half the precipitation rate of a half circle. The full circle will need to run twice as long to apply the same amount of water as the half circle.

Pressure – Rotor heads typically operate at 30 to 90 psi, 30 to 40 psi being most common for heads in the home garden trade. Better quality heads have built-in pressure regulators.

Precipitation rate – Rotors are more uniform in water distribution than pop-up spray heads and take much longer to water. As a rule of thumb, rotor heads deliver water at a rate of ¼ to ¾ inch per hour. At the typical precipitation rate of ½ inch per hour, it would take 60 minutes to apply ½ inch of water. The slower precipitation rate can be an advantage on clayey or compacted soils where water infiltration rates are slow.

Multi-Stream Rotors

The newer multi-trajectory rotating streams, provide unmatched uniformity in water distribution for significant water savings. They have a lower application rate, reducing runoff on compacted, clayey soils and slopes. The streams of water are large enough to resist wind disturbance, so they reduce the amount of water blowing onto driveways, sidewalks, and roads.

Several manufacturers offer multi-stream rotors in today's market, including Hunter MP Rotator, Toro Precision Series, Rainbird R-VAN, and others. Generally used by landscape contractors, multi-stream rotors are less common in the home garden trade. For the home gardener, they may be found online.

Almost any type of sprinkler head can be retrofitted with an MP Rotator® sprinkler, including spray heads and traditional rotors. MP Rotators® can apply water to distances ranging from four to 30 feet. They can also be used to water narrow planting strips, which are often difficult to water effectively with traditional sprinkler heads.

Depending on the head, they perform best at 30 to 40 psi. With matched precipitation rates, quarter, half and full heads may be mixed in a zone.

Strengths and Weaknesses of In-Ground Sprinklers

Strengths of in-ground sprinklers include the following:

- Convenience
- Time savings
- Usefulness for irrigating small areas
- Very efficient if well-designed, maintained and managed according to plant water needs (ET).

Weaknesses of in-ground sprinklers are that they can be very inefficient if poorly designed, maintained, or managed. Being "too" convenient, many gardeners give them little attention, significantly wasting water.

Bubblers

Small groupings of flowers and other small plants can be efficiently watered with bubblers, which flood an area and rely on the natural wicking action of the soil to spread the water.

They are ideal for level shrub and ground cover areas. Heads are typically placed at three to five feet intervals or placed by individual plants for spot watering. Stream bubblers are directional and come in a variety of spray patterns.

Bubblers deliver water faster than drip emitters and are used to water trees and shrubs. Refer to manufacturers' literature for design and management criteria related to various models.

Drip Systems

For flower and shrub beds, small fruits and vegetable gardens, drip emitters, drip lines, micro-sprayers, and soaker hoses are popular.

Water use rates, weed seed germination, and foliar disease problems are reduced in drip systems that do not spray water into the air and over the plants and the soil surface. As a rule of thumb, a drip system coupled with mulch can reduce water needs by 50%.

Drip emitters, micro-sprayers, and drip lines require clean water, which is relatively free of soil particles, algae, and salts. In-line filters are part of the system. Water quality is generally not a problem when using potable water sources. However, with non-potable water sources, the filtering system required may be expensive and high-maintenance, making drip impractical.

Drip systems work with lower pressures (typically around 20 psi), generally using **in-line pressure regulators**. The system snaps together with small fittings. No gluing or bands are required. It is much easier to work with if the tubing has been warmed by the sun for an hour. [Figure 9]

Figure 9. In-line filter and pressure regulator going to drip line poly tubing.

The system is put together with half-inch and quarter-inch poly tubing, fittings and emitters. For the main line and branch lines, **half-inch poly tubing** is used. The **quarter-inch micro-tubing** serves as feeder line to individual drippers or micro-sprinklers. Ideally, the tubing is on the soil surface under the mulch.

- **Drip emitters** deliver water at a slow, consistent rate, such as one-half gallon, one gallon, or two gallons per hour. Emitters can connect to the branch line or extend on micro-tubing out to individual plants or pots. Small annuals and perennials typically have one emitter per plant. Several would be used spaced around larger perennials, shrubs, and small trees. [Figure 10]

Figure 10. Drip emitter on ½" poly tubing

As a point of clarification, some gardeners mistakenly think that using half, one, and two gallon per hour drippers is an effective method to manage differing water needs. Although this works to a small degree, the concept is basically flawed. The two-gallon per hour drippers will have significantly larger wetting zones than the half-gallon per hour dripper. However, plants with the higher water needs (two-gallon/hour drippers) do not necessarily have a larger root spread. Likewise, plants with lower water needs (half-gallon/hour dripper) will not necessarily have a smaller root spread (in fact, a large root spread is what makes some plants more xeric). The factor missing here is irrigation frequency to match the water needs.

- **In-line drip tubing** is a quarter-inch micro-tubing with built-in emitters spaced at six, 12, or 24 inch intervals. The 12-inch spacing is readily available in the home garden trade. These are great for snaking through a bed area. For sandy soils, spacing of the tubing should be at 12 inches. For clayey soils, spacing may be at 18 to 24 inches for perennial beds.

- **Micro-sprayers**, often held up on a spike, cover a radius of two to 13 feet. Delivery rates vary from 0.1 to 10 inches per hour, depending on the head selected. Because water is sprayed in the air, drift and water waste in wind resembles sprinklers more than ground-applied drip. Micro-sprayers work with a very small droplet size that readily evaporates. For this reason, their efficiency in Colorado's low humidity is questionable.

Specifications on design and management vary among manufacturers and types selected. Refer to the manufacturer's literature for details. Typical run times are 60 to 90 minutes.

Drip systems are easy to automate by connecting the zones to valves and a controller (like an in-ground system for a lawn). For ease of programming to the specific watering needs of the drip system, use a dedicated controller for multiple drip zones. In small yards, a single zone or two could be added to the controller used for the lawn, but they would run on a different program than the lawn to match the different watering needs.

When connected to the garden hose, the zone can be automated with single-zone controllers that connect with hose-end fittings at the tap. Some simple models turn the water off after a set number of minutes or gallons. More elaborate battery-

operated models turn the water on and off at the day and time interval set by the gardener. [Figure 13]

Like any irrigation system, drip systems require routine maintenance. They are not an install-and-forget type of system.

For additional information on drip irrigation, refer to CSU Extension Fact Sheet #4.702, *Drip Irrigation for Home Grounds.*

Soaker Hose and Soaker Tubing

The **soaker hose** is a different type of drip system that allows water to seep out the entire length of a porous hose. They are great for raised bed gardens and flower beds. In sandy soils, space runs at 12 inches. For flower and shrubs beds on clayey soil, space runs at 18-24 inches. In a raised bed vegetable garden (where uniform delivery to small vegetables is important), make three to four runs up and down a four-foot wide bed. Typical run time is 10 to 20 minutes.

- **Quarter-inch Soaker Tubing –** Quarter-inch soaker tubing is availble in the drip irrigation section at garden stores. Cut the soaker tubing to desired length and connect with drip system components. An in-line pressure regulator (Figure 10) is required; otherwise, the fitting may pop or leak.

- **Half-Inch Soaker Hose** – Some brands (like *Swans Soaker Hose*) are a ½-inch hose that connect with a standard hose fitting. These are found in the garden hose section. It can be cut to any length and connected with garden hose fittings.

  A small plastic disc fits inside the female hose connection as a flow regulator. To adequately water the garden with the reduced water flow, it may need to run for around an hour. For better performance, use the pressure regulators with hose-end fittings found with the drip irrigation supplies (Figure 11). To adequately water the garden with this type of regulator, the drip line runs 10 to 20 minutes. Without a pressure regulator of some type, the soaker hose tends to rupture, sending out steams of water at spots rather than dripping along the line. [Figure 11]

Figure 11. Tap, pressure regulator (with hose connections) and half-inch drip hose in raised bed garden.

This half-inch hose style is more tolerant of small amounts of dirt, algae, or salts in the water than other types of drip systems and may be successful on some non-potable water sources. Periodically, open up the end of the hose and flush out soil deposits.

Because the soaker tubing has a higher delivery rate, it cannot be on the same zone as other in-line drip tubing, button emitters, or bubblers.

Strengths and Weaknesses of Drip Irrigation

- **Strengths** of drip irrigation include the following:
    - Convenience.
    - Water saving.
    - Operates with low water pressure.
    - Easy to change when the plantings change.
    - Does not require trenches for installation.
    - Readily automated on a multi-zone controller or single-zone controllers that connect to the faucet.

- **Weaknesses** of drip irrigation include the following:
    - Require good-quality water and filtration.
    - Maintenance difficulty in seeing if systems are operating and need to check water delivery to individual plants.
    - Cost: for large areas, the cost will be significantly higher than a sprinkler system.
    - Unsuitable for watering large trees.

Subsurface Drip

Subsurface drip is a relatively new way to water lawns and flowerbeds. Tubes are permanently buried below ground. Water soaks upward and laterally so subsurface drip works in clay-containing soils, but not well in sands.

Generally installed by a trained and experienced professional, subsurface drip requires very exact installation depth and spacing. Without proper attention to installation, the lawn becomes striped with green and dry strips. Studies being conducted by the Northern Colorado Water Conservation District find that water use is similar to a well-designed sprinkler system.

Strengths of subsurface drip include:

- Convenience.
- Operation at low pressure.
- Equipment located out of sight, where it is less prone to damage.
- Easy to water anytime day or night, even when the lawn is being used.
- Application of water directly to the root zone.
- Easy to automate with soil moisture sensors.
- Potential to inject fertilizers with the irrigation water.

Weaknesses of subsurface drip include:

- Requires high-quality water.
- Inability to see if it is operating correctly and need to dig it up if it is not.
- Prohibition of inserting stakes in the ground.

- Requires professional installation.
- Relatively high cost.
- Evolving technology that has not stood the test of time.

Hose-End and Hand Watering

Hose-end watering devices include various types of spray heads, water wands and water breakers, soaker hoses, and soil needles. Such devices are commonly used for temporary situations and where permanent installations are impractical or not desired.

Hose-end watering is very inefficient in uniformity of water delivery, resulting in high water use. However, significant water savings may occur because gardeners generally do not water until the lawn/garden show signs of being dry.

A common problem with hand-held water wands is that folks tend to only water the surface, rather than deep watering of the root system. Avoid soil needles because they apply the water below the primary root system of trees, shrubs, and flowers.

A hand-moved sprinkler can be automated with single-zone controllers that connect with hose-end fittings at the tap. Some simple models turn the water off after a set number of minutes or gallons. More elaborate battery-operated models turn the water on and off at the day and time interval set by the gardener. [Figure 12]

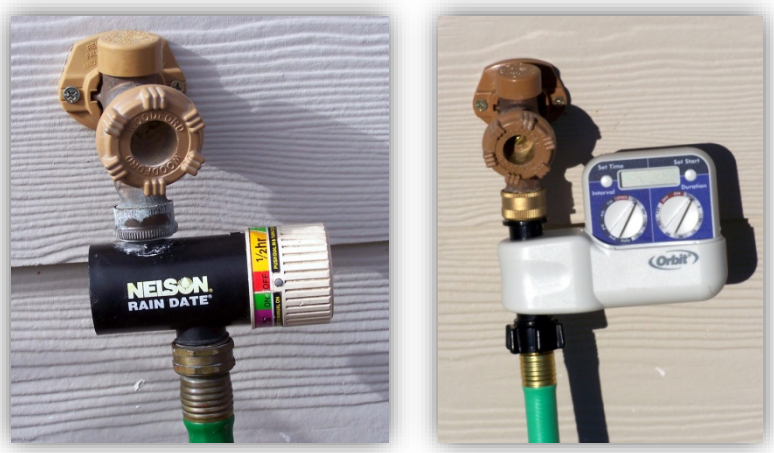

Figure 12. Single-zone controllers connect to the hose line. Left: This style is manually turned on and automatically turns off after a set number of minutes. Right: This battery powered controller turns water on and off at the day and time intervals set by the gardener.

Strengths and Weaknesses of Hose-End Watering

Strengths of hose-end and hand watering include the following:

- Relative low cost of equipment.
- Ability to water plants differently and usefulness for spot watering.
- Allows for close observation that may result in more timely care of plants.

- Being outside in the yard encourages neighborhood relationships.

Weaknesses of hose-end hand watering include the following:

- Time-consuming.
- Poor uniformity of water distribution with hand-placed sprinklers, leading to high water use.
- Hand-held watering often leads to surface watering rather than effectively watering the root zone.
- Wasting water by allowing it to run too long.

Summary

Any type of irrigation system (in-ground sprinklers, drip, or hand watering) can be very efficient with attention to detail. Likewise, any type of irrigation can be inefficient, wasting water. What makes a system efficient or inefficient is not the equipment, but rather the attention given by the gardener.

CMG GardenNotes on Irrigation Management

#260 Irrigation Management: References and Review Questions
#261 Colorado's Water Situation
#262 Water Movement Through the Landscape
#263 Understanding Irrigation Management Factors
#264 Irrigation Equipment
#265 Methods to Schedule Home Lawn Irrigation
#266 Converting Inches to Minutes
#267 Watering Efficiently
#268 Home Lawn Irrigation Check-Up

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Revised September, 2017