University of Idaho
College of Agricultural and Life Sciences

CIS 1098

Watering

HOME LAWNS AND LANDSCAPES

Plants must have water to survive and flourish. Living, active plant tissues are usually 85 or 90 percent water, and even seeds, the least active form of plants, must contain 5 to 9 percent water to be viable. Plants use water for many things, among them, supporting their leaves so that they expose the maximum area to light for photosynthesis, transporting nutrients, and evaporative cooling. In the soil, nutrients must be dissolved in water before plant roots can absorb them.

Correct watering makes good economic sense. Landscapes add value to a house, and correct watering will enhance landscape growth. Wise water use is becoming more important every year in Idaho, where good quality water is a limited resource in many urban areas. Correct watering minimizes the use of water, or allows the same amount of water to serve more landscape plants. Based on water cost and use patterns in Boise, our analysis shows that overwatering can add $75 to $150 annually to the cost of water for a typical urban household, depending on lot size and watering practices.

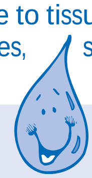
Effects of Overwatering

Although water is essential to plants, too much of it can be harmful. Overwatering encourages disease development; inhibits uptake of nutrients such as iron, causing iron chlorosis; and contributes to the leaching of soluble fertilizer and lawn chemicals to groundwater, particularly in sandy soils.

Overwatering can damage plants because oxygen is only partially soluble in water. Air-filled pores in the soil ensure a supply of oxygen is available to dissolve in the water film around plant roots. When water fills the soil pores, displacing air, the roots find insufficient oxygen for normal growth and may die of asphyxiation. Insufficient oxygen levels also can stunt root system development, making the plant more susceptible to moisture stress later in the season even though early season water was excessive.

Effects of Water Stress

Underwatering also can contribute to disease development and cause thin stands of sickly looking grass and weak, unattractive landscape plants. Typical symptoms of water stress are drooping, soft stems and leaves and curling or rolling leaf edges. The edges of deciduous leaves may dry out and turn brown due to tissue death, while evergreen leaves, such as those of the rhododendron, may scorch in winter. Flowers are smaller and fewer with inadequate watering, causing lower yields on fruit trees. Plants do best if they never undergo water stress, but adequate moisture is especially important during critical growth stages such as seed germination, flowering, and fruit set. Trees, bushes, and vines bearing fruit require more water than those without fruit.



Windbreaks, weed control, mulches, and compost all tend to conserve water

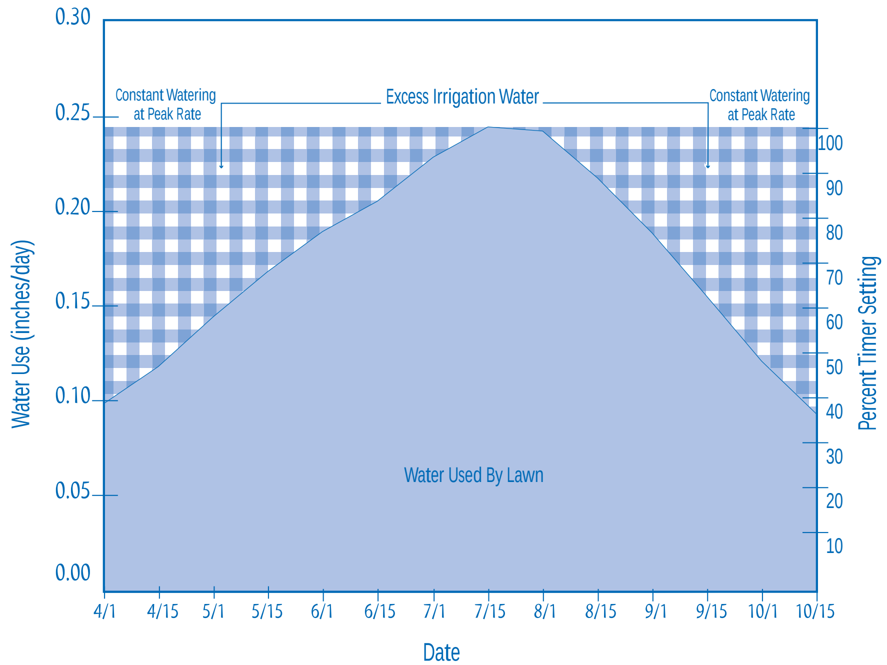
Inadequate soil moisture is often a major cause of winter damage. All plants, particularly evergreens, use water during winter, so it is important for plants to go into the winter with the soil adequately wetted to the depth of rooting. This is usually 2 to 3 feet for shrubs and small trees and 4 to 5 feet for larger trees. Under inadequate snow cover or dry conditions, winter watering may be required if the ground is not frozen.

Factors that Influence Water Need

Proper irrigation replaces both soil water that evaporates from the soil surface (evaporation) and water released into the air through plant pores (transpiration). Evapotranspiration (ET) is the term used for the combined losses. ET depends on the growth stage, size, and type of plant; weather conditions; and available water in the soil.

Lawn and landscape water use begins to rise as plants break dormancy in early spring. As the weather warms and new vegetation develops, water use increases. Use remains high through mid summer and then drops off in August and September (figure 1). Large, daily variations between cool, cloudy days (low water use) and hot, windy days (high water use) can be up to 0.2 inches. As a result, water needed after a week of cool, cloudy weather can be much different from water needed after a week of hot, windy weather. Windbreaks, weed

Figure 1: 11-year seasonal water use pattern for lawns in southwestern and southcentral Idaho.



control, mulches, and compost added to improve soil structure all help to hold water and decrease the need for frequent irrigation.

Irrigation Systems

Decisions about how often and how long to irrigate depend somewhat on the nature of your water delivery and your type of irrigation system. For example, if you get water delivery only once per week, then your irrigation method must be able to apply all the water needed to refill the soil profile during the time when water is available. This may mean flood irrigating lawn and garden areas. A homeowner with well or municipal water may choose to irrigate on a more optimal schedule, possibly two or three times per week.

Flood Irrigation

Flood irrigation of leveled lawns or furrowed gardens may be required if you need to spread water quickly over the property in a deep but infrequent irrigation mode, such as when water is available just one day a week. This method requires little equipment, but gives a less uniform irrigation and less efficient use of water than do sprinkler systems. About the only decision you need to make is how long to allow water to flow onto each area. Because of the complexity of surface irrigation, experience is the best guide to avoid over- or underwatering.

Hose-Move System

In many lawns, irrigation water is applied by single sprinklers attached to moveable hoses. This is an inexpensive but labor-intensive system, and the labor requirements usually result in deep, infrequent watering. You can use this system quite successfully if you match the frequency and depth of watering to soil water-holding capacity and plant water use.

Single sprinklers apply water in a pattern much like that in figure 2. For uniform applications, you should locate the sprinkler so that the edge of a wetted circle overlaps the last (or next) wetted area (figure 2).

Because the irrigation pattern depends on proper water pressure, adequate hose size is important. A $^5/_8$-inch diameter hose will usually supply one sprinkler if the hose is no longer than 150 feet. To serve two or three sprinklers, or for longer distances, a $^3/_4$-inch hose is required for adequate water supply and pressure.

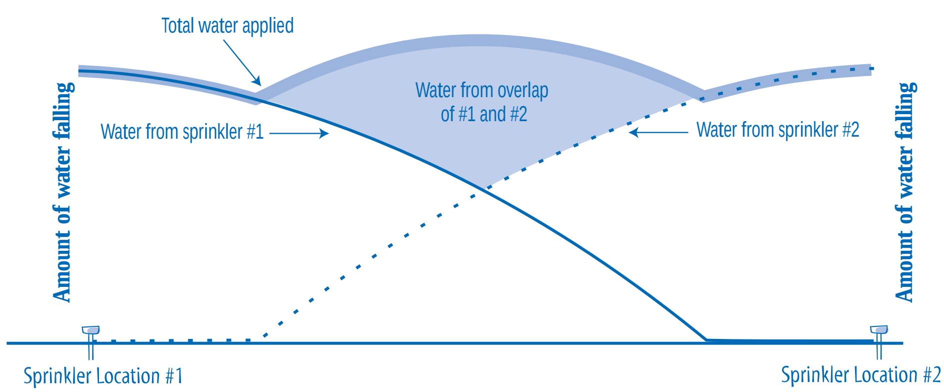
Automatic Sprinkler Systems

Where water is available any time from wells or other pressurized systems, an automatic sprinkler system with buried pipes and sprinklers can produce a uniformly watered lawn in a minimal amount of time. It has the flexibility of delivering on schedules ranging from shallow and frequent to deep and infrequent. In general, for all but very sandy soils, watering two or three times per week to the root system depth to replace water used since the last watering works well. Very sandy soils may require watering every two days.

Systems for Public Areas

Many public areas irrigated by automatic sprinkler systems, such as parks and golf courses, are irrigated nightly with an irrigation of about 0.25 to 0.3 inches to just meet the daily ET. This

Figure 2: Sprinkler overlap strategy to provide uniform watering.



schedule avoids irrigating during the day when people are present. Small, frequent irrigations to refill the soil profile also avoid saturating the soil surface, which can make it more prone to compaction. This type of turf management is usually not desirable for homeowners because, although it produces an attractive lawn, it requires frequent fertilization and mowing.

Determining Sprinkler Application Rate

To determine if you are adding the proper amount of water, check the depth of water applied by an irrigation of a specific duration. For example, if your sprinkler system runs for 20 minutes every night, how much water is it applying?

To find out, set out some empty cans or other parallel-walled containers at regular intervals between two sprinkler heads or within the wetting pattern of a single portable sprinkler. Turn on the water for 20 minutes. After watering, measure the depth of water collected in each can and calculate the average (total depth water collected divided by the number of cans). Multiply this average depth by 3 to give application rate in inches per hour (20 minutes x 3 = 60 minutes, or 1 hour).

For example, if the average depth of water in the cans was 1/4 inch after 20 minutes, the application rate in inches per hour would be 1/4 x 3, or 3/4 inch per hour. This number could then be used to determine how long the system should run to apply the required amount of water.

On a hose-move system, measure the depths of water collected in cans located from 5 to 15 feet away from the sprinkler. Average the depths and proceed as above.

Determining How Much to Water and When

Usable soil water, which is a function of soil texture (the amount of sand, silt, and clay in the soil), and plant rooting depth determine the maximum amount of water that plants will use between irrigations. Soil texture can be obtained from your local USDA Natural Resources Conservation Service office or from University of Idaho Extension personnel in your county. A very sandy soil may hold only about 0.2 inches of usable water per foot of plant rooting depth, while a silt loam or clay loam soil may hold 1 to 1.3 inches of usable water per foot (table 1).

Table 1. Usable water for various textural classes of soils.

Soil texture class	Usable water (inches/foot)
Sand (almost pure sand)	0.2
Sandy loam, sandy clay loam	0.75
Loam	1.0
Silt loam	1.1
Silt	1.1
Clay loam, silty clay loam	1.1
Silty clay	1.0
Clay	1.0

Source: Modified from Ashley, R. O., W. H. Neibling, and B. A. King. 1997. Irrigation Scheduling Using Water-Use Tables. CIS 1039. Moscow, ID: University of Idaho Cooperative Extension System and Agricultural Experiment Station.

Most lawn grasses have a root zone of between 1 (bluegrass) and 2 (fescues) feet, while trees and shrubs may root to a depth of 3 to 6 feet, with the majority of the roots in the top 2 feet of soil. Hardpan, a compacted soil layer, will restrict rooting depth. Usable water and plant rooting depth can be used to determine the maximum amount of water to apply to a lawn. For example, for a mature fescue lawn growing in a sandy loam soil you would apply a maximum of 0.75 inches/foot (from table 1) times 2 feet rooting depth for a total of 1.5 inches.

Using the Feel and Appearance Method

Methods for determining when and how much to water range from general guidelines to the use of sophisticated soil moisture measurement devices. Homeowners can successfully use the soil "feel and appearance" method with a little practice (table 2). This method involves conducting three simple tests on a handful of soil. Sampling should be done at one-third the rooting depth, 4 inches for lawns and 8 inches for trees and shrubs. Because of the triangular water extraction pattern with depth (figure 3), sampling at one-third of the rooting depth gives the average soil moisture in the plant root zone. Roots will extend deeper than 12 inches for grass and 24 inches for shrubs and trees, but most water uptake comes from above these depths.

First, run a ball test (BT). Form a ball by squeezing a handful of soil in your hand. Observe what happens when you break the ball between your thumb and forefinger, and locate the best description in the BT rows under the proper soil type. For example, if a sandy loam soil from your lawn forms a weak ball with a distinct fingerprint outline and soil particles stick to your hand, 0.4 inch of usable water remains and irrigation should occur in about 1.5 days at midsummer.

For the ribbon test (RT), roll out soil between your thumb and forefinger, keeping them about 1/8 inch apart so that they exert little pressure on the soil. If a silt loam soil ribbons out about 1/2 inch and moist soil particles are left on your thumb, about 0.6 inch of water remains for your lawn's use.

The open palm test (OPT) is used only for silts, loams, and clays. Gently roll out a ball of soil between open palms.

Figure 3. Plant roots extract water from the soil in a triangular pattern, with the average extraction occuring about a third of the way into the plant root zone.

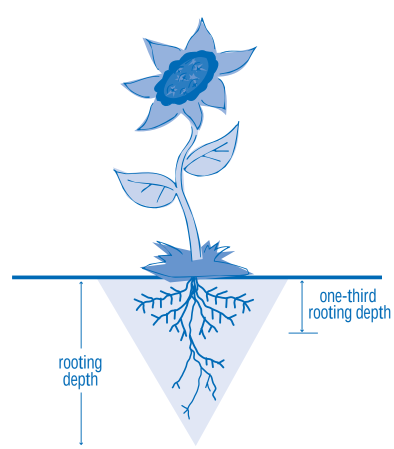
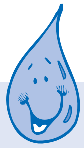


Table 2. Inches of usable water remaining in one foot of soil and days before irrigation is required at mid season in southern Idaho.

	Lawn and garden		Trees and shrubs	
	Usable water remaining (inches/foot)	Days to irrigate at mid-season[1]	Usable water remaining (inches/foot)	Days to irrigate at mid-season[1]
Loam, silt loam, clay loam soil texture				
BT: Forms a ball readily, holds its shape. No moist feeling is left on hand nor will any soil fragments cling to palm. Ball is very brittle and breaks readily. Soil falls or crumbles into small granules when broken. RT: Will not ribbon—soil too crumbly. OPT: Sample very crumbly; readily dissolves into individual particles.	0		0	
BT: Forms firm ball. Finger marks imprint on ball. Hand feels damp, but not moist. Soil doesn't stick to hand. Ball is pliable. When broken, ball shatters or falls into medium-size fragments. RT: Ribbons out 1/4-inch or just barely ribbons. OPT: Soil breaks down into granules and is a little crumbly. Continues to crumble until a tiny round ball is left in palm.	0.3	1	0.6	2
BT: Damp and heavy; slightly sticky when squeezed. Forms tight plastic ball. Shatters with a burst into large particles when broken. Hand is moist. RT: Ribbons out 1/2-inch. Moist soil particles left on thumb. OPT: Sample can be molded into a round ball; somewhat plastic; will not shatter readily.	0.6	2	1.2	4
BT: Wet, sticky, doughy, and slick. A very plastic ball is formed. Handles like stiff bread dough or modeling clay; not muddy. Leaves water on hand. Ball will change shape and cracks will appear before breaking. RT: Ribbons readily if not too wet. OPT: Forms a tight ball. Will work into a long round pencil-like shape.	1.1	4	2.2	8
Sandy loam and loamy sand soil texture				
BT: Forms very weak ball. If soil well broken up, it will form more than one ball upon squeezing. Fingerprint outline barely discernible. Soil grains will stick to hand. RT: No ribboning. Soil particles will just cease to lie down. Patchy soil layer on thumb.	0		0	
BT: Forms weak, brittle ball. Fingerprint outline not as distinct. Soil particles will stick to hand in a patchy pattern. RT: No ribboning. Soil particles will stick to thumb in a patchy layer.	0.2	1	0.4	1.5
BT: Forms weak ball. Distinct fingerprint outline on ball. Soil particles stick to palm. RT: No ribboning. Soil particles will stick to thumb during ribboning process in a distinct layer over surface of thumb.	0.4	1.5	0.8	3
BT: Upon squeezing, no free water appears on ball, but wet outline of ball is left on hand. Ball has some stickiness and a sharp fingerprint outline is left on it. RT: No ribboning. Soil particles will form smooth layer on thumb.	0.75	3	1.5	6

Notes: Sample at 4 inches deep for lawn and garden, 8 inches deep for trees and shrubs. Assume a 1-foot root zone on lawn and garden, 2 feet on trees and shrubs, and the usable water values from table 1.

[1]For days to the next irrigation in northern Idaho, multiply by 1.18.



Feel and appearance tests

BT (Ball Test)—Form a ball by squeezing a handful of soil hard in your fist. Observe the effect when you break the ball between your thumb and forefinger.

RT (Ribbon Test)—Roll out the soil between your thumb and forefinger, keeping your thumb and forefinger 1/8 inch apart so that you exert little pressure on the soil.

OPT (Open Palm Test)—Gently roll a ball of soil between your open palms.

If you form a tight ball and can work it into a long, pencil-like shape, about 1.1 inches of water are left for use by your lawn.

Use the information on inches of usable water remaining in conjunction with the water use curve (figure 1) to forecast the days until you need to water and how much to water. This can be done anytime during the growing season.

For example, suppose it's early season in southern Idaho.

Step 1. Run a feel and appearance test to find out how much usable water is in your soil:

The results of the feel and appearance method on a soil sample from your lawn, taken 4 inches deep, are the following: "BT: Wet, sticky, doughy, and slick. A very plastic ball forms. The soil handles like stiff bread dough or modeling clay and isn't muddy. The soil leaves water on your hand, and the ball changes shape and cracks appear before the ball breaks. RT: Ribbons readily. OPT: Forms a tight ball. Will work into a long, round pencil-like shape." From table 2, you would see that 1.1 inches of usable water remain in the soil.

Step 2. Use figure 1 to find out how much water your lawn uses at this time of year:

From figure 1, you can assume that water use will be about 0.1 inch/day.

Step 3. Calculate days until the next irrigation (inches usable water remaining ÷ inches of water use per day):

Given your results in steps 1 and 2, days until the next irrigation would then be

1.1 inches ÷ 0.1 inches/day = 11 days

Step 4. Use information from table 1 to determine how much water to add back to the soil:

If the soil is silt loam, 1.1 inches of water should be applied to fill the soil to capacity.

Step 5. Correct for various water losses that occur during watering:

Since only a portion of the water pumped (about 80% for sprinklers) ends up in the plant root zone for use by the plant, you will need to apply more than 1.1 inches. Actual irrigation depth required to re-fill the root zone is then

1.1 inches ÷ 0.8 = 1.4 inches.

Water added in excess of 1.4 inches is wasted and has the potential to move soluble herbicides and pesticides below the root zone.

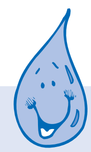
Table 2 also gives days until irrigation is needed at mid-season (four days in the above example). These numbers are based on averages from 11 years of weather data in southern Idaho.

ET for northern Idaho conditions is about 85 percent of southern Idaho values during mid-season. Therefore, the number of days until the next irrigation should be increased 1.18 times for northern Idaho. These numbers are based on average conditions. By checking the soil before every scheduled irrigation, any tendency to over or under-irrigate can be spotted and the water application rate modified.

General Watering Guidelines

Apply enough water during each irrigation to replenish the water used by the plants between irrigations. The best practice is to thoroughly soak the soil, then irrigate again only when necessary. For most lawn or garden conditions, this means you should never add more than 1.1 inches of water to silt loam soils or 3/4 inch to sandy soils in a single irrigation. Shrubs and trees can accommodate about twice as much. Because trees and grass both use water, a grassy area beneath a tree will require about twice as much water as other parts of the lawn. This means adding extra water by sprinkler or garden hose.

For most lawns, avoid frequent irrigation with small amounts of water. Because the entire root zone is not refilled, this practice results in shallow-rooted lawns, excessive evaporation without deep wetting in the root zone, and possibly excessive build-up of salts. Frequent applications of water may also encourage root rots and other diseases because the plant and soil surfaces are always moist.



The ideal time to irrigate is early morning.

Time of Day to Irrigate

The ideal time to irrigate is early morning. Avoid evening irrigation in warm weather because it leaves plants wet overnight. This encourages fungal diseases. Automatic systems can be set to start irrigating after midnight when the disease hazard is less, traffic is absent, water pressure is highest and most stable, and the wind is usually calm.

Using Automatic Sprinklers

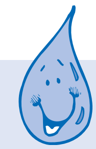
Make sure you have a properly designed irrigation system. If heads are improperly spaced, nozzles improperly sized, or pressure too low or high, uniform distribution of water will be impossible. The result will be areas of over- and underwatering.

Sprinkler systems are designed for peak, mid-season use and must be adjusted for off-peak spring or fall operation. A reasonable practice is to change sprinkler settings monthly or, at the least, three times during the growing season (figure 4). Most modern irrigation system controllers use a "percent timer" setting to make changes in water added per irrigation easier. The percent setting is the fraction of the maximum system application rate that is applied. The setting should be low in early season, increase to a maximum by mid season, and then decrease in the fall, with the general change in setting following the curve in figure 1. Frequent system adjustment provides the best use of applied water (figure 5).

Sprinklers should never apply more water than soil in the root zone can hold. Operate the sprinklers to replace the water used since the last irrigation (generally 30 to 60 minutes per zone). If appreciable run-off starts in less than 30 minutes, modify the sprinkler system for a lower application rate. Sprinkler heads are available for low application rates and good distribution. A temporary solution is to shut off the water when runoff starts, and complete the application later.

Irrigations of equal amounts of water at equal intervals are seldom correct for all plants being watered. The best solution is a combination of several light irrigations for the turf and a less frequent, heavier irrigation for deeper-rooted plants, all properly timed. Most modern lawn water controllers can accommodate one watering schedule and irrigation depth for the lawn and another for trees and shrubs. To properly take advantage of this capability, trees and shrubs must be plumbed as one set of zones and the lawn as another set. In many controllers, that means the area to be watered on a lawn schedule could be connected to "program A" zones and trees and shrubs to "program B" zones. If you have an older controller without dual program capability, you should consider updating since water savings can usually pay for the new unit in about two years.

Some new equipment uses a soil water sensor to control lawn sprinklers. One, the Water Watcher by Turftech, has a soil sensor that measures average soil moisture in the top 6 inches of the root zone. A control box on the sensor connects to the sprinkler system. If the soil is wetter than a pre-set level, the control box prevents the sprinkler system from turning on. Once the soil dries below the pre-set level, the system is allowed to run. This system automatically avoids over- or underwatering. Cost is approximately $100 for the sensor and control box.



Shrubs and trees often show symptoms of water shortage only after damage has been done.

Irrigating Your Trees and Shrubs

Leaves of woody plants that are improperly irrigated become yellowish-green, stunted, curled, or brown-tipped and may fall prematurely. Since shrubs and trees often show symptoms of water shortage only after damage has been done, you will need to know the soil-water condition 2 or 3 feet beneath the soil surface, particularly early in the season. If early season deep moisture is adequate, then irrigation based on measurements at 8 inches for the rest of the year should be applied. Ideally, deep moisture should be checked once or twice during the season just to ensure that it is adequate. You can use a soil tube or probe, but the best and easiest way to check is with a soil-water measuring instrument such as a tensiometer (figure 6).

Tensiometers measure the work a plant must do to remove water from the soil. They read near 0 after an irrigation when the soil is nearly saturated and very little work is required to remove water. As the soil dries, readings increase. Tensiometers should be installed at soil depths of 24 to 36

Figure 4: Using three sprinkler control settings to approximate seasonal variations in water use saves water over using just one peak setting.

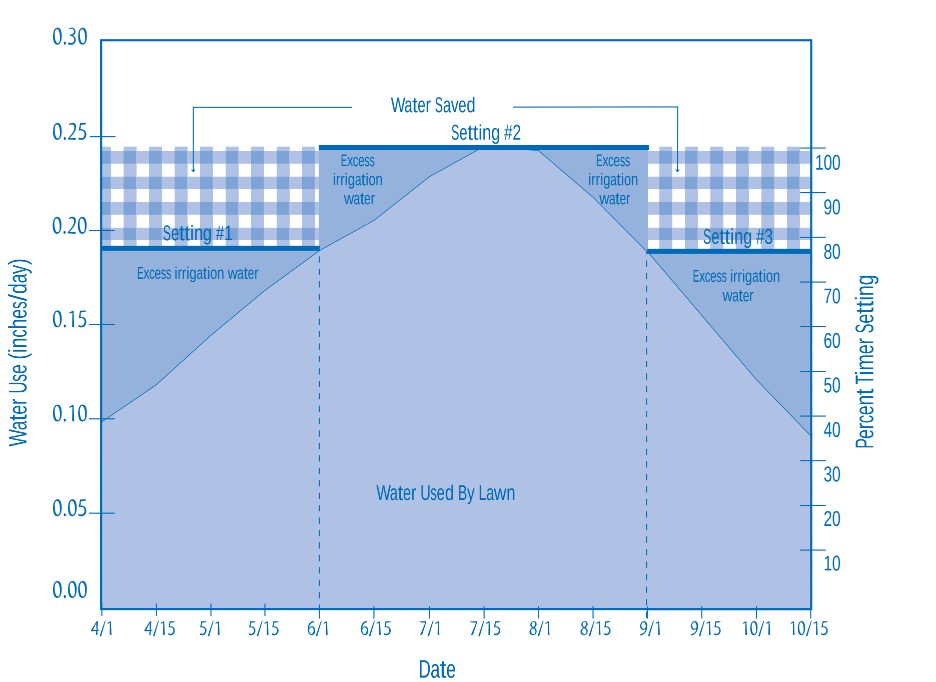
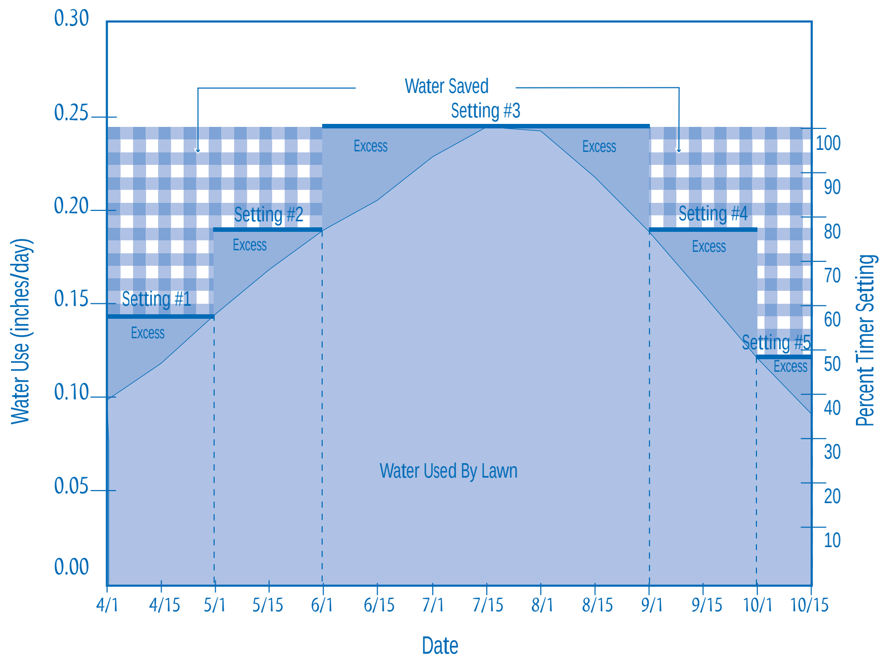


Figure 6: Setting sprinkler controls to approximate seasonal variation in lawn water use using five settings for the summer saves water.



inches under trees and 12 to 24 inches under shrubs. The most critical factor in tensiometer installation is to ensure good contact between the ceramic cup at the bottom of the tensiometer and the soil. If you follow the manufacturer's installation and maintenance suggestions carefully, this device will work well for many years. Because these devices contain water, they need to be removed in the fall and stored in a nonfreezing area.

Tensiometers should always be read about the same time of day. When the instrument gauge shows a moderately dry reading (30 on sands to 70 on silt loam soils), apply water based on the guidelines discussed above to rewet the soil. Recheck the gauge 12 to 24 hours after irrigating. If the reading is 5 to 15, your irrigation was correct. If the reading is 0 to 5, use a shorter application next time. If the reading is more than 15, your next irrigation should be longer.

If irrigating flowers, gardens, or trees with a hose, bubblers, or trickle system, apply enough water to soak down to full root depth. One or 2 inches will probably suffice for flowers and vegetables, but 4 or 5 inches are needed in a tree basin. If the basin is shallow, fill it with water, and keep it full for one to two hours without overflowing.

Newly transplanted trees may need more frequent irrigation until they become well established. At the time of tree planting, water sufficiently to ensure that air pockets in the soil around the root ball are filled with water. This helps the soil to settle, providing better support against the wind, and provides better soil/root contact. Because the root ball usually contains only about 10 percent of the roots originally formed by the tree, it must be kept moist during the first growing season to avoid water stress. In subsequent growing seasons, the root system will have developed so trees can be watered deeper and less frequently. When possible, transplant trees in early spring or fall. The cooler weather produces less demand for water, and root growth occurs before the next high-water-demand season.

Figure 6: Tensiometers determine when irrigation is required. Cost is approximately $30 to $50 each, depending on the length of the tube.

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