SAVING WATER IN LANDSCAPE IRRIGATION

You can keep from wasting water in irrigating landscape plantings and reduce plant loss or damage in a time of water shortage. To do so you need the answers to three questions:

1. How much water do your plants use and, if necessary, how little can they get by on?

2. How can you give them as much water as they need without applying too much?

3. In a drought, what can you do to help them survive?

The answers to these questions depend on your location, climate, soil, and type of plant. This leaflet will help you find answers for your particular situation.

Soil Water Storage and Plant Water Use

To determine when to irrigate and how much water to apply, it helps to know the water storage capacity of the soil where the plant roots are situated (the "soil reservoir") and the rate of water use by the plants.

The soil reservoir

Although the amount of organic matter makes some difference, the water storage capacity of a soil is determined mostly by soil texture—the size of the particles and their distribution.

Table 1 indicates the amounts of water that soils of various textures can store and make available to plants. Note that a fine-textured soil, such as clay, holds about twice as much water as a coarse, sandy soil.

Table 1. Water Storage Capacity of Soils.

Soil texture	Inches of available water per foot of soil depth	Gallons per cubic foot of soil
Sand	1/2"–1"	1/3–2/3
Sandy loam	1"–1-1/2"	2/3–1
Clay loam	1-1/2"–2"	1–1-1/3
Clay	1-1/2"–2-1/2"	1–1-2/3

(An inch of water is the amount that would cover the surface 1 inch deep. 1-1/2 inches covering 1 square foot = 1 gallon.)

The storage capacity of your soil reservoir depends not only on the soil type but on the depth of soil that will be penetrated by plant roots during the growing season. When there is normal moisture in the soil, the top 3 or 4 feet can be considered the soil reservoir for most trees and shrubs. In dry periods, deep-rooted plants will draw water from farther down. Short-rooted plants such as most grasses have a more shallow soil reservoir.

One other factor may be important: The depth of the soil itself. If hardpan, bedrock or some other restricting layer is close to the surface, the soil reservoir will be limited accordingly. (Take care not to over-irrigate shallow soils. They can easily become waterlogged.)

Water use by plants

Most irrigation water applied to plants goes out through the leaves as water vapor, while some evaporates from the soil. This is known as evapotranspiration—generally shortened to ET. The rate of ET is

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influenced by climate: sunlight, temperature, humidity, and wind. Because of differences in climate, ET rates are different in various locations and from season to season. It is important to have a rough idea of the amount of water used through ET by your landscape plantings. Otherwise you may put on too much or too little water to replace the loss.

Average ET rates for California are listed in table 2. These figures reflect the amount of water that most plantings will use if there is plenty of moisture in the soil and if the soil surface is at least 80 percent covered or shaded by plant foliage.

The figures in the table indicate the average daily water use by four-inch-high turfgrass. (This is the standard ET rate used by water scientists.) In estimating the ET rate for your landscape plantings, you will need to consider two other factors:

1. The figures in the table are averages. The actual water loss will range up or down somewhat (possibly 20 percent to 25 percent during unusually hot or windy days or unusually cool, cloudy days).

2. Larger plants may use somewhat more water than grass, depending on their shape and exposure to the sun. Solid or almost solid plantings of shrubs or trees often use 10 percent or 20 percent more water than indicated in the table. A large solitary shrub or tree, because of its greater exposure to the sun and wind, may use two or three times as much water as a comparable area of turf. (Its larger root system compensates for the additional water use.)

You can use the ET rates listed in table 2 to estimate the actual daily and seasonal amounts of soil moisture being used by your plants. However, one important point should be kept in mind: The ET rate is the *maximum* amount of water a plant will use if plenty of soil moisture is available. All plants can get by with less. Most woody plants can survive on half that much.

Water spenders and water conservers

One other factor may make a difference in your particular irrigation requirement: Certain drought-tolerant plants use significantly less water.

Table 2. Daily and Seasonal ET Rates in California*

	Northeastern Mountain Valleys	North Coast—Coastal Valleys and Plains	North Coast—Interior Valleys	Sacramento Valley	San Joaquin Valley	Central Coast—Coastal Valleys and Plains	Central Coast—Interior Valleys	Sierra (Tahoe Basin)	South Coast—Coastal Valleys and Plains	South Coast—Interior Valleys	Southern California Desert
	inches per day										
January	0.02	0.02	0.03	0.04	0.03	0.06	0.05	—	0.06	0.06	0.09
February	0.04	0.04	0.04	0.06	0.06	0.08	0.08	—	0.09	0.09	0.13
March	0.07	0.06	0.08	0.1	0.1	0.1	0.11	—	0.1	0.11	0.19
April	0.12	0.08	0.11	0.15	0.15	0.13	0.14	0.10	0.13	0.14	0.25
May	0.16	0.11	0.16	0.19	0.21	0.15	0.18	0.13	0.14	0.16	0.33
June	0.19	0.12	0.20	0.24	0.25	0.16	0.21	0.16	0.17	0.20	0.38
July	0.26	0.11	0.23	0.26	0.25	0.17	0.22	0.20	0.18	0.22	0.37
August	0.23	0.11	0.20	0.22	0.21	0.16	0.19	0.17	0.18	0.22	0.31
September	0.16	0.09	0.15	0.17	0.16	0.13	0.16	0.13	0.15	0.17	0.28
October	0.09	0.06	0.09	0.11	0.11	0.1	0.12	0.09	0.11	0.12	0.2
November	0.03	0.04	0.04	0.05	0.05	0.07	0.08	—	0.09	0.08	0.12
December	0.02	0.02	0.02	0.03	0.02	0.05	0.05	—	0.07	0.06	0.06
Totals: inches											
November-March	5.1	5.3	6.3	8.5	7.9	10.7	10.8	—	12.1	11.5	17.7
April-October (growing season)	37.1	20.8	34.9	40.7	40.7	30.6	37.5	30.0	32.3	37.9	65.1
Annual	42.2	26.1	41.2	49.2	49.0	41.3	48.3	—	44.4	49.4	82.2

* From Dept. of Water Resources Bulletin 113-3, except for figures for Sierra (Tahoe Basin), which are UC observations for the growing season.

This is not true of all plants commonly considered drought-tolerant. Some such plants, like most landscape plants, are "water spenders"—their ET rates are similar to those listed in table 2. They have extensive root systems and as long as some of their roots are in moist soil they can survive drought; but they still use relatively large amounts of water. Examples are eucalyptus and black walnut trees.

But other drought-tolerant plants have naturally low rates of water use. Some of these ("drought evaders") become virtually dormant during dry periods. Examples are California buckeye and bermudagrass. Others ("water conservers") have ways of reducing water loss. Their leaves may be small, gray-colored, leathery, and arranged to reduce the amount of sunlight that strikes them or structured in other ways to save water. Many California native plants and plants from similar climates are of this type. Examples are ceanothus, manzanita, and olive.

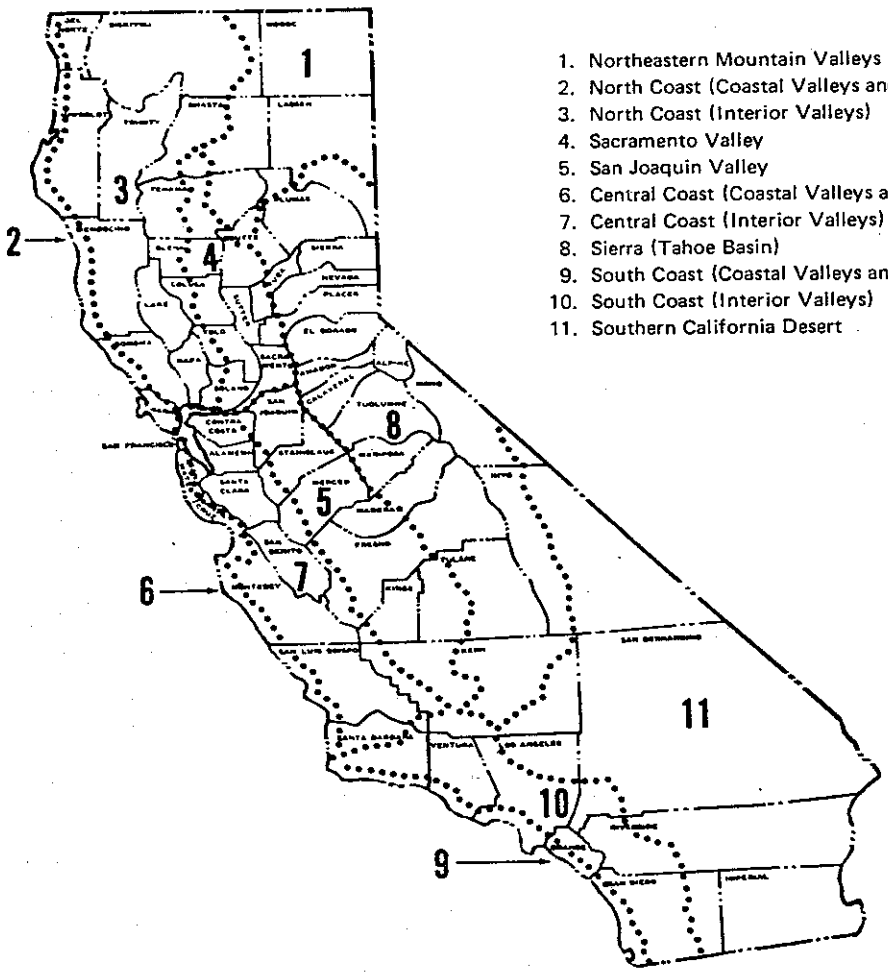
Drought evaders and water conservers ordinarily use somewhat less water than other plants. In a drought, they can survive on far less.

How to Irrigate Without Wasting Water

Knowing the water storage capacity of your soil and the ET rate in your area, you can determine when to irrigate and how much water to apply.

When to irrigate

One way to decide when to apply water is to observe the plants. This is particularly true in timing the first irrigation of the season, when you may not know how much moisture is in the soil reservoir or how fast it is being used. Symptoms of moisture stress vary with the kind of plant. Some are easy to spot and others are more difficult. Symptoms include wilting leaves; changes in appearance of the leaves



1. Northeastern Mountain Valleys
2. North Coast (Coastal Valleys and Plains)
3. North Coast (Interior Valleys)
4. Sacramento Valley
5. San Joaquin Valley
6. Central Coast (Coastal Valleys and Plains)
7. Central Coast (Interior Valleys)
8. Sierra (Tahoe Basin)
9. South Coast (Coastal Valleys and Plains)
10. South Coast (Interior Valleys)
11. Southern California Desert

Fig. 1. California's climate zones.

(shiny leaves becoming dull, bright green leaves fading or turning gray-green); and heavy leaf fall and sometimes death of young leaves.

Another way to decide when to irrigate is to check the soil. The hand-feel test is quick and easy. Take a small sample of soil in your hand. Try to roll or squeeze it into a ball. If the soil will not mold into a ball, it is too dry to supply water to plants. If the soil will mold into a ball, rub it with your thumb. If the ball will not crumble, the soil is too wet.

If the soil can be molded into a ball that will crumble when rubbed, the moisture is probably about right. Sandy soils are an exception: they will crumble even when wet. For more details on the hand-feel test, see table 3.

To get an idea of the moisture conditions throughout the rooting area, soil should be sampled in several locations and from several depths at each location—from six inches to three or four feet if possible. For the greater depths, you probably will need an auger or soil tube. If you use a shovel, be sure to fill up the hole and sample somewhere else the next time.

How much water to apply?

Even if you have plenty of water, don't over-irrigate. Too much water is not only wasteful, but it can be bad for plants. Develop a general idea of how much water the plants need by checking with the hand-feel test early in the season and, later on, estimating the rate of ET since the last irrigation and checking again with the hand-feel test.

Even if sufficient water will be available, your main goal is to use it efficiently by applying just enough water to fill up the soil reservoir, and waiting until the plants have used up at least half of the available soil moisture before adding more. If there's a water shortage, you may have to use less.

Table 3. Practical Interpretation Chart for Soil Moisture

Amount of readily available moisture remaining for plants	**Sand** *(gritty when moist, almost like beach sand)*	**Sandy loam** *(gritty when moist; dirties fingers; contains some silt and clay)*	**Clay loam** *(sticky and plastic when moist)*	**Clay** *(very sticky when moist; behaves like modeling clay)*
	Feel or appearance of soils			
Close to 0%. Little or no moisture available.	Dry, loose, single-grained, flows through fingers.	Dry, loose, flows through fingers.	Dry clods that break down into powdery condition.	Hard, baked, cracked surface. Hard clods difficult to break, sometimes has loose crumbs on surface.
50% or less. Approaching time to irrigate.	Still appears to be dry; will not form a ball with pressure.	Still appears to be dry; will not form a ball.	Somewhat crumbly, but will hold together with pressure.	Somewhat pliable, will ball under pressure.
50% to 75%. Enough available moisture.	Same as sand under 50%.	Tends to ball under pressure but seldom will hold together.	Forms a ball, somewhat plastic; will sometimes slick slightly with pressure.	Forms a ball; will ribbon out between thumb and forefinger.
75% to field capacity. Plenty of available moisture.	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms weak ball, breaks easily, will not become slick.	Forms a ball and is very pliable; becomes slick readily if high in clay.	Easily ribbons out between fingers; feels slick.
At field capacity. Soil won't hold any more water (after draining).	Upon squeezing, no free water appears but moisture is left on hand.	Same as sand.	Same as sand.	Same as sand.
Above field capacity. Unless water drains out, soil will be waterlogged.	Free water appears when soil is bounced in hand.	Free water will be released with kneading.	Can squeeze out free water.	Puddles and free water forms on surface.

Do not irrigate frequently with small amounts of water. This wastes water through direct evaporation from the soil, and little will reach the deeper roots. Besides, too-frequent watering may encourage shallow rooting and may cause root rots and other diseases.

When you do irrigate, be sure to apply enough water—if you put on only part of the amount that the soil reservoir can hold, the upper soil will fill up to its water-holding capacity while the lower soil remains dry.

To put on the right amount of water, you need to know how fast it is being applied. This is fairly easy to determine if your water is metered. If it isn't, you can place 6 to 8 cans throughout a sprinkler pattern to measure the rate of application in inches per hour; or, run a hose into a garbage can or some other container to determine the gallons of water delivered per hour. (For example, a half-inch garden hose 50 feet long, with water pressure of 50 pounds, will deliver about 350 gallons per hour.) To convert gallons into inches of water: 1 gallon = 1½ inches of water covering 1 square foot.

How to apply water

Landscape plantings can be irrigated by running water into basins or furrows, or by use of sprinklers, soakers, or drip systems. Regardless of which method you use there are three basic rules:

- *Apply water uniformly.* For example, be sure sprinklers distribute water evenly. If basins are used, be sure they are level. Avoid long furrows.
- *Eliminate or reduce runoff.* Water that is applied by sprinkler faster than the soil can absorb it will run off and cause low areas to be over-watered and high or compacted areas to be under-watered. If you see runoff, get smaller nozzles; or stop irrigating and start again after an hour or two.
- *When irrigating individual plants, keep the water inside the dripline.* A few of the roots may not be wetted, but less water will be wasted.

Properly designed and operated drip-irrigation systems apply water more efficiently than other systems because they allow a slower and more uniform application to a confined area. Drip systems are particularly efficient where plants are not close together.

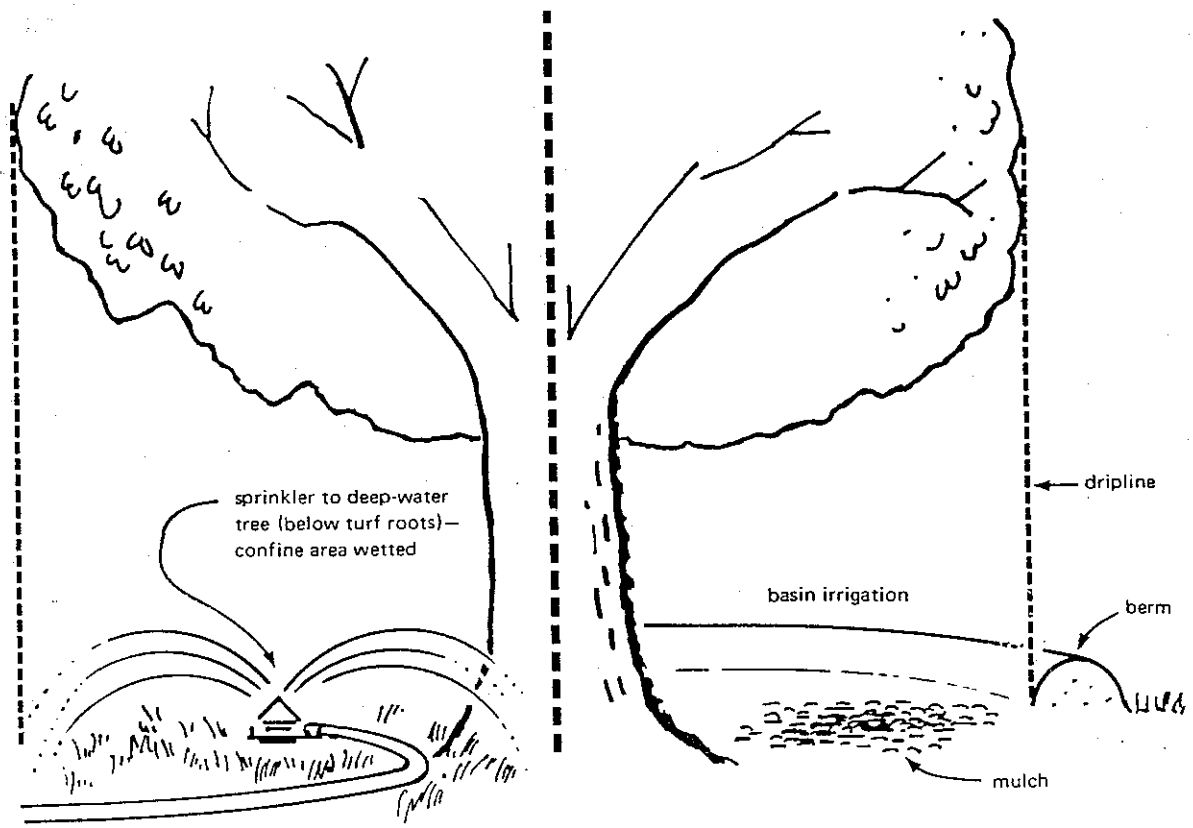


Fig. 2. Irrigation of individual plants growing in turf (left) and in open ground (right).

Before irrigating, make the soil surface loose and permeable so water can soak in rapidly. Loosen compacted surface soil by shallow cultivation. And control weeds; they use up water and plant nutrients.

Apply a mulch under and around plants. A loose, permeable mulch will keep rain and sprinkler-applied water in place, thereby minimizing erosion and run-off. Mulches also decrease surface evaporation, control weeds, and reduce soil cracking which can be a problem irrigating shallow-rooted plants. There are many possible mulch materials, including leaves, twigs, grass clippings, peat moss, straw, corn cobs, rice hulls, pomace, etc. Plastic, paper, stone, brick, gravel, coarse sand, and pavement also are effective mulches. Plastic sheeting, however, may make it more difficult to apply water evenly—particularly water that goes on slowly.

If There Just Isn't Enough Water. . .

Even when there's no shortage of water, it's important not to irrigate too much. In a drought, however, you may not have enough water even to meet the normal needs of your plantings. In that case, here are some suggestions.

In the spring, make a "water budget" for the coming season. First, estimate the inches of water that will be available to your plants during the growing season by adding the amount already stored in the soil and the amount of irrigation water you expect to add. To estimate the amount of available moisture in the soil at the start of the growing season, determine the storage capacity of your soil reservoir (see page 1). Then use the hand-feel test to estimate how full the reservoir is.

Second, determine the expected inches of ET loss during the growing season in your area (see page 2). Then estimate your minimum requirement. Remember, the ET rates given are close to maximum. Many plants can get by with less. For shallow-rooted water-spenders you are determined to save, figure on replacing almost all of the potential ET loss. For deeper-rooted woody plants on deep soil, you should be able to get by on one-half ET, or even as little as one-fourth.

If the amount of expected available water is less than the minimum amount your plants will require, then you must decide how many square feet of landscape you will be able to irrigate during the coming season and how many square feet will have to go without water.

If necessary, make a priority list of which plants to save. Consider these points:

Most established drought-tolerant plants on soil at least 4 feet deep should be able to survive in fairly good condition with no irrigation, if they start the growing season with a full soil reservoir. (Important note: for all trees and shrubs, fill up the soil reservoir at the start of the season, if possible—even if you have little water left for irrigation later on.)

Many other woody plants may need irrigation once or twice during the growing season. Fill up the soil reservoir early. Then divide the remainder of your available water into two equal amounts and apply them after the plants show symptoms of moisture stress. If you are extremely short of water, you may be able to irrigate only once.

During a drought, fertilize lightly if at all. Rapidly growing plants use more water.

Irrigate individual shrubs, trees or plant beds separately. In this way each one can be given the right amount of water. Even if your water supply is limited, don't try to spread it too thinly. When you do irrigate a plant, fill all or most of the soil reservoir.

Wait until symptoms of water stress develop before irrigating. By stressing each shrub, tree, or plant bed close to its limit, you can save as much water as possible while keeping the plants alive.

Check the soil moisture under non-irrigated trees and shrubs. Those that have not normally been irrigated or which you thought were benefiting from nearby irrigation actually may have been surviving primarily on winter rainfall. After an unusually dry winter or two, their soil moisture supply could be almost depleted. If it is, they may need special irrigation to survive.

Consider severe pruning, particularly of overgrown shrubs, hedges and vines that will grow back. This can both cut water use and revitalize the plants. Most shrubs will look better if the branches are thinned out or cut back to laterals rather than cut to stubs. This is particularly true of conifers, most of which do not sprout from old wood.

Severe pruning of trees to conserve water is more difficult, and should be attempted only in extreme drought conditions. To significantly reduce a tree's use of water, it must be cut back enough to markedly reduce its size. Otherwise, you merely expose previously shaded leaves to the sun and increase their rate of transpiration. Such severe pruning causes danger of sunburn or other injury.

It's easier to reduce water use of plants growing in containers. Just move them into a shaded area.

Remove some of the plants in crowded beds or low-priority plants that are growing close to others you want to save. This reduces competition for soil moisture. Turf may be the first to go but is easiest to re-establish later.

If no other water is available, it may be possible to irrigate outdoor plantings with household waste water—particularly rinse water. First, however, check with local health and building authorities. (Also see U. C. leaflet 2968, "Using Household Waste Water on Plants.")

Sprays to reduce transpiration (anti-transpirants) may increase the plant's chances of surviving critically dry periods. There are two types: reflecting materials, such as whitewash or white, water-based paint, that reflect sunlight and thereby reduce transpiration; and emulsions, of wax for instance, which plug many of the pores on the leaves. Reflecting materials are more effective when sprayed on the upper surfaces of the leaves; emulsions must be sprayed on the lower surface of each leaf where most, or all, of the pores are located. An anti-transpirant may reduce transpiration from a few days to several weeks, depending on the material, how well it is applied, environmental conditions, and the amount of new foliage produced by the plant after spraying.

A final step: You can start planning to replant part or all of your landscape with plants that require less water. But don't replant until more water is available. Even drought-tolerant plants require extra care and more frequent watering during the year or two required to get them established.

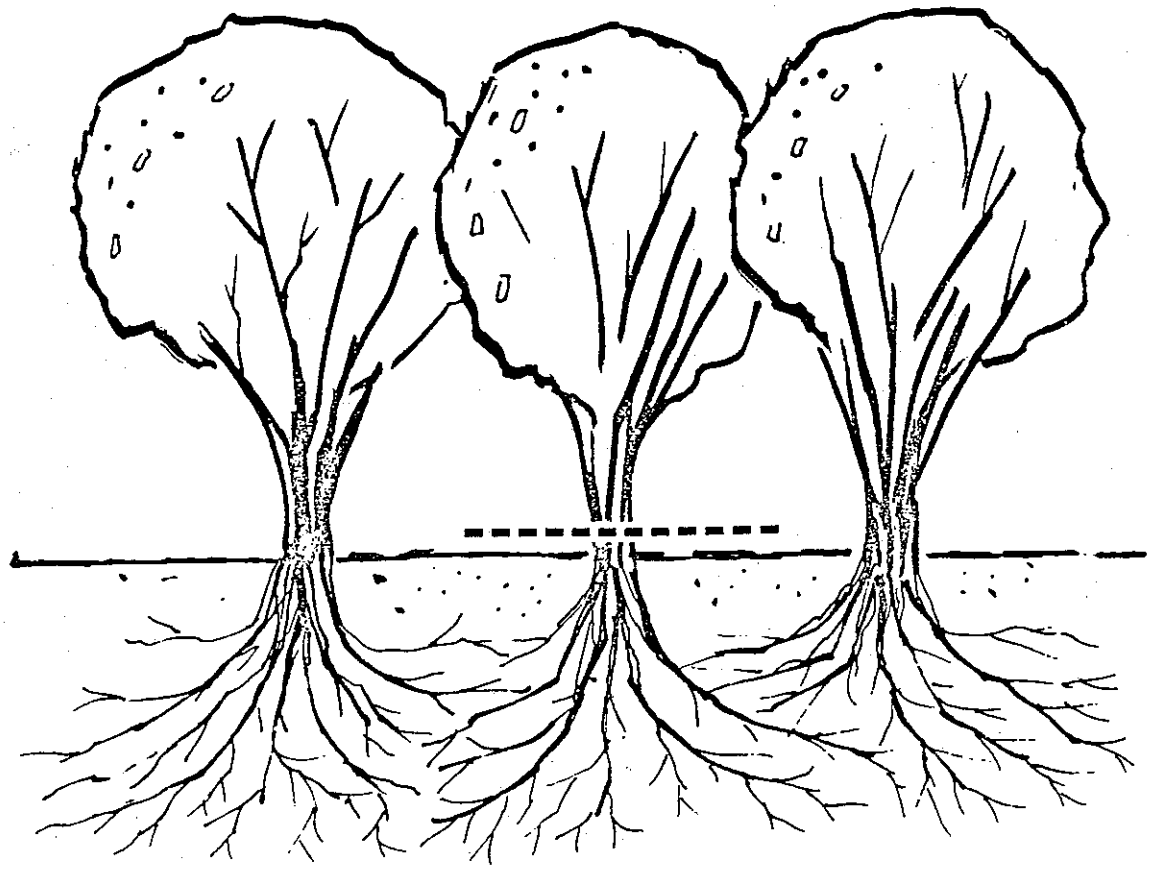


Fig. 3. Removal of the center shrub will give the others a better chance to survive by making more of the soil water storage available to them. In many landscapes, thinning out of some plants as they mature usually is a good idea.

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