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Best Management Practices for Irrigating Landscape Plant Material

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Planning Ahead

Landscape plantings typically convey the property owner's image to the neighborhood or commu-nity. Consequently, the types of plants included in the landscape can be as diverse as the individuals who own them. When properly assembled into a landscape, they become a living picture. Individual plants or the assembled landscape as a whole can modify or create it's own microclimate. Differing types of plant material, variability in plant drought tolerance, and changes in environmental conditions pose great challenges for those designing, installing, and managing irrigation systems.

New Jersey has experienced three severe droughts and several minor ones from 1986 and into 2002. In each of the severe droughts, restrictions were instituted on the use of water for landscapes. As a consequence of the drought, restrictions and management practices, trees and shrubs died. Proper design and management of an irrigation system can help reduce the impact of the next drought.

While natural rainfall is the best source of water for plants in the landscape, irrigation may be required to satisfy plant needs. The overall water requirement for plants is approximately one inch per week during the period of greatest need. That normally occurs during the summer months. The primary need for an irrigation system, however, is to supplement natural rainfall during those inevitable periods of need.

The successfully designed irrigation system should be flexible enough to adequately water plants under various environmental conditions and also allow for changes in water needs as the plants grow. As with planning for a worst-case flood, the irrigation system should be designed for a worst-case drought event. Property owners must learn how to properly manage their irrigation system so it meets plant needs based on the total environment. Natural rainfall, heat and relative humidity are several of the factors that need to be reviewed. Four facts should form the basis for a management plan:

1) A mature well-maintained landscape will normally tolerate a one-year drought while young, over-mature or otherwise compromised plantings can be killed from a single drought episode;

2) It is nearly impossible for an irrigation system to make up a deficit once the property owner gets behind in watering.

3) If a defoliated plant is watered to recovery during a drought event, the plant cannot be allowed to defoliate again without serious consequences. It is usually better to let plants that are defoliated remain that way until natural rainfall returns;

4) Landscape plants die much more rapidly and more often from excessive or improper irrigation than from lack of water.

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Plant Response to Drought Conditions

For most of us, a wilted plant is a sign of drought stress. To determine if there really is a drought problem, one must look at the past and present growing conditions. A problem that manifests itself today could have originated days or weeks earlier, or even during the last growing season. Things that should be reviewed include air and soil temperature, soil moisture, sun and wind exposure and relative humidity. Site-specific issues may include abiotic effects from nearby construction, increased soil compaction or lawn weed killers. Abiotic problems are those not caused by living organisms.

Observe and record how symptoms are presented on the plant. Is the scorch only on one side of the plant? Is the wilting on a single branch or only on the outer growing tips of the plant? What time of year was the damage present? Are symptoms of insect or disease damage also present? Are there physical factors causing problems? Remember that the problem can be either above ground or below ground. Many questions need to be answered to properly determine the cause of the damage as well as proper treatment. When in doubt, check with your landscape professional or county agricultural agent.

Plants respond to drought conditions in several ways. One of the first signs is downward leaf curling. To minimize moisture loss, curling reduces the exposed area on the underside of the leaf where stomata (pores) are located. With further drought stress, a true wilt will occur, as leaves become limp from lack of moisture to maintain leaf firmness. Still later, leaves dry up and drop from the plants, in some cases mimicking an early dormancy. Under prolonged drought conditions, plants will start dying from the branch and root tips inward. If the drought conditions do not kill the plants outright, it increases their susceptibility to attack from secondary organisms such as insects and diseases.

Serious drought conditions may cause "summer dormancy," where plants defoliate and set bud, awaiting sufficient rainfall or irrigation to continue the growing season. Two scenarios can adversely affect the plant's health following summer dormancy:

1) Re-growth is initiated very late in the year, the new growth is injured by frost, and the plant may enter the winter with dangerously low carbohydrate storage levels;
2) Re-growth is initiated, followed by another prolonged drought period. The plant defoliates for the second time in the same growing season, again entering the winter with dangerously low carbohydrate storage levels.

Plants that have heavy cuticles (waxy leaves) have evolved to tolerate drought conditions better than those with thin cuticles. Some plants curl more rapidly and protectively cover their stomata more efficiently than others. Rhododendrons exhibit both these characteristics, in summer as well as during the winter. This adaptation by rhododendrons helps makes up for their shallow root system that is prone to damage from low levels of soil moisture. Generally speaking, plants that are deep rooted and/or are able to maintain higher humidity within the plant foliage because of tightly spaced foliage area are more tolerant of drought conditions.

Just as stress is a silent killer for humans, it is with plants. Drought is a form of stress, but there are many other possible stressors. Plants need to be properly sited, unaffected by weed competition, growing under adequate moisture conditions, and properly maintained with appropriate fertilization and pruning. Stress results when plants have insufficient, excessive, or unbalanced availability of resources necessary for proper growth functions.

Soils and Irrigation

New Jersey soils range from beach sand to silt and clay loams. To properly site and manage plants, one must have good information about the host soils. Even on a small property, several types of soils can be present. In many housing developments, soil compaction and poor quality imported soil are likely to be encountered. It is important to identify the soil type but is equally important to evaluate the soil profile. Even with excellent topsoil, a clay layer in the soil can restrict water movement and proper root establishment of your plant material. With soil profile information, one can develop site strategies to ensure the success of landscape plantings.

If you are building a house you may be able to get soil profile information from your builder. Check the profile when the foundation is being dug or when the test pit is dug for a septic system. Otherwise try using a soil core sampler or dig a hole to view the profile.

Homeowners should attempt to identify water requirements for plantings as well. Lighter sandy soils require more irrigation water than heavier clay or silt soils. Mulch can be an effective landscape tool in reducing the landscape's overall irrigation need. Used properly, mulch will cool the soil, help retain soil moisture, and can help suppress certain root diseases. Too much mulch can cause plant problems. The heavier the mulch, the less one should use. Be sure to use mulch that is light and airy and breaks down slowly, but one that won't move off site with heavy rain or wind event. Heavy mulches may compact, allowing plants to root into it. The resulting shallow root system may be susceptible to increased winter damage. Compacted mulch also provides a good habitat for rodents and a potential for some fungus problems. Pine needle mulches are nearly ideal. Organic mulches with excessive fine components tend to compact. Stone mulches can increase landscape water need through a combination of solar heating and large spaces between the stone resulting in increased water evaporation.

Design of an effective and efficient irrigation system must take into account the drought tolerance of the existing or planned landscape material. Computer controlled trickle irrigation systems provide a wide array of benefits. Trickle systems use considerably less water than overhead irrigation or soaker hoses. Timed controls also allow for irrigation to be done early in the morning when temperatures are cooler, evaporation rates are low, and plant uptake of water is high. To ensure the longevity of the irrigation system, hard tubing with emitters is more effective than tapes. For annual and perennial bedded material, emitters can be pre-installed. Individual trees or specimen plants are most efficiently served by use of emitters specifically installed, spaced, and sized for the plants.

Pulsed irrigation water systems offer significant benefits in water use efficiency. A pulse system applies water sequentially to the same locations. The first pulse wets the soil to a shallow depth. Subsequent pulses start after the water from the previous pulse has spread to its maximum extent in the soil. Pulses are allowed to spread, but are stopped prior to soil saturation. Timing of pulses and the amount of water used for each pulse must be determined for each site. Use of this technique in commercial nurseries has resulted in reduced water use, reduced runoff, and enhanced plant growth.

Recommended Irrigation Management Practices

The primary need for an irrigation system is to supplement natural rainfall during periods of need. Information needed to effectively anticipate and manage plant health during a drought includes rainfall, temperature and relative humidity. Don't wait for a drought to observe and record weather information; do it continually. While natural rainfall is the best source of water for plants in the landscape, irrigation should be used to supplement and satisfy the requirement of approximately one inch of water per week during periods of greatest need (usually the summer months). Irrigation water should be applied during one time period each week to ensure water penetrates deeply into the soil. That encourages deep rooting. To minimize damage to your plants during drought periods, be sure to maintain them in top condition. That way, if drought-related water use restrictions are initiated, they should be able to better tolerate the event. An integrated crop management scouting program or regular landscape inspections can assess seasonal stress levels and help determine necessary courses of action.

Recognize that inefficient and high water use irrigation systems may be restricted during drought emergency declarations. When supplies become limited, water will ultimately be allocated for uses that protect human well-being. From the perspective of landscapes, irrigation of established lawn areas and landscapes will probably be restricted. Irrigation systems should be designed to water turf and landscape plant areas separately. If possible, the system should be flexible enough so newly planted and drought sensitive material can be irrigated.

Irrigation Considerations

The following table provides selected drought-planning considerations in abbreviated form. It is intended to help determine best options for irrigation system design and use. Remember that irrigation systems must be designed using site-specific information for optimal efficiency. Also, recognize that the suggestions are for evaluative purposes. Depending on the total site picture, some items can be effectively implemented while others cannot. The overall goal is the effective use of a minimal amount of irrigation water to enhance and protect your landscape.

Planning for a Drought - Irrigation Considerations

Weather Information	• On-site records are best. • Weather reporting service information can be used. • Keep information on rainfall, high and low temperatures, relative humidity, and hours of sunlight As rainfall and relative humidity decrease and temperature and sunlight increases; there is increased plant need for water
Soil & Water	• Evaluate soils for texture, profile, and physical characteristics. • Use high quality mulch and avoid a buildup over successive growing seasons. • Irrigate to supplement rainfall to a total of 1/2" to 1" per week based on soil type. Keep soils moist for best plant performance. Sandier soils dry and re-wet quickly while heavier soils containing clay or silt dry and re-wet slowly. Mulching reduces soil drying when it is kept light.
Plants & Irrigation	• Make special efforts to provide irrigation for new and/or young plantings. • Stress-free, mature plantings generally survive summer droughts. • Successive droughts will cause problems for all plantings. Remember: some watering restrictions of landscape plant material are likely duringa drought. Be sure plants are normally kept stress-free.
Irrigation System	• Use hard tubing with emitters. • Use computer controls with moisture sensors. • Irrigate in pulses to avoid runoff and to optimize water use. • Install irrigation zones, rotate their use, and separate turf from landscape bed areas. If you wait to install your irrigation system when a drought occurs, it is too late.
Decision to Irrigate	• Consider weather history & growing conditions, time of year and weather patterns. • Consider age of plant material & growing history for prior stress factors. Plan ahead: irrigate if it isn't raining and the plants need water. Don't base your irrigation schedule on a weather forecast.
Irrigation Timing & Frequency	• Supplement to meet water needs, irrigating prior to the onset of drought conditions. • Use pulse irrigation to more efficiently use water. • Water early morning (4-5 am) for optimal efficiency. Temperatures are cooler, evaporation rates are low, and plant uptake of water is high. **Remember** – Don't over irrigate! Too much water is worse than too little.

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Irrigation Scheduling with the Feel Method

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Monitoring soil moisture is one of the most important management procedures available for irrigation management. Estimating soil moisture using the feel method is one of the easiest methods available for monitoring soil moisture, and can be used to determine the proper frequency of irrigations. Proper irrigation depth can be determined from known plant and soil characteristics. Determining when to irrigate and how much water to apply with each application are the goals of the management practice termed irrigation scheduling.

Soil Water-Holding Capacity and Available Water

Soil in the plant root zone acts as a reservoir for water. Soil texture is the primary factor influencing the amount of water that the soil reservoir can store. Available water is defined as amount of water that plants are able to withdraw from the soil and use. Fine textured soils, such as clays, silt loams, or loams, are able to hold much more available water than sandy, coarse-textured

TABLE 1. Influence of Soil Texture on Available Water-Holding Capacity

Soil Texture	**Available Water-Holding Capacity** (inches of water per foot of soil)
Sand	0.25 - 1.00
Loamy sand	0.75 - 1.50
Sandy loam	1.25 - 1.75
Loam and Silt loam	2.00 - 2.75
Clay loam	1.75 - 2.50
Clay	1.50 - 2.25

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soils (see Table 1). Soil water-holding capacity is an important factor to consider in determining the proper irrigation depth.

The water storage capacity of soils is also influenced by soil depth. Nearly all vegetables and agronomic crops grown under irrigated conditions extract water from the top 2 feet of the soil profile, even though the roots of some crops can extend much deeper. In fact, in most crops, 75%-95% of the roots are in the top 12 inches of the soil profile. For this reason, manage irrigation events with the top 12 inches of the root zone in mind. Water which seeps beyond this depth may not be used by the crop. Together, soil water-holding capacity and plant rooting depth can be used to determine the appropriate irrigation depth.

The appropriate irrigation frequency is influenced by soil water-holding capacity and by the rate at which plants use water, and can be determined by monitoring soil moisture. The feel method is a simple and inexpensive procedure which can be used to monitor soil moisture.

Soil Sampling and Evaluation

Samples evaluated using the feel method can be extracted from the plant root zone using a soil probe, auger, or spade. Be certain to evaluate a number of samples from between 3 inches and 9 inches below the soil surface. This is likely to be the most active root zone. Test samples from various locations in the field where soil texture, plant size or vigor, or plant species are different. Sample a minimum of four sites from a single management zone.

Remove a small handful of soil from your sampling tool and squeeze the soil firmly. Open your hand and observe the condition of the soil. For fine- or medium-textured soils, try to ribbon the soil by working it between your thumb and forefinger. Use Table 2 to estimate the amount of available moisture remaining in the soil. Field capacity is the moisture content at which a soil is holding the maximum amount of water it can against the force of gravity. Wilt point is the moisture content at which plants wilt and are adversely affected by moisture stress. The water that a soil releases to plants between field capacity and wilt point is termed available water. Irrigate when 50% of available water has been depleted. Allowing the soil to dry below this moisture level may jeopardize obtaining maximum yields.

Learning to accurately predict soil moisture with the feel method requires practice. To learn the feel of your soil at particular moisture contents, start early in the spring when soils are wet, or start a day or two after a saturating rain or irrigation. Soil sampled under these conditions will be at or near field capacity. Likewise, sample soil in which plants are growing that are beginning to wilt. Soil at this moisture content is at the wilt point. Knowing the feel of soil at these endpoints will help you estimate soil moisture at points between these moisture contents.

As an example of how to schedule irrigations using the feel method, assume tomatoes are being grown on soils of fine sand texture, and that the plants have a 1-foot root zone depth. Use Table 1 to determine that these soils have an available water-holding capacity of 1 inch per foot of soil depth. After using the feel method and estimating that available soil moisture in the crop root zone is at 50% and that irrigation is required, determine the appropriate irrigation depth by multiplying the root zone depth by the available water-holding capacity of the soil and by the percent available water depletion. In this case:

$$\text{Irrigation depth} = \text{1-ft root zone depth} \times \frac{\text{1 in. available water}}{\text{foot of soil}} \times 50\% = \tfrac{1}{2}\ \text{inch}$$

TABLE 2. Irrigation Guidelines for Using the Feel Method

Available Soil Moisture Depletion	Soil Textures		
	Sand, Loamy sand	Sandy loam, Loam, Silt loam	Clay loam, loam
0% (Field Capacity)	forms ball, wet outline of ball is left on hand, will not ribbon	forms ball, wet outline of ball is left on hand, ribbons easily	forms ball, wet outline of ball is left on hand, ribbons easily
50% (Irrigation Range)	forms weak ball, breaks easily when bounced in hand, will not ribbon	forms ball, will ribbon with some difficulty	forms ball, will easily ribbon
100% (Wilt Point)	will not form ball, crumbles into small aggregates	crumbly, but will hold together under pressure, will not ribbon	somewhat pliable, holds together under pressure

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