Sprinkler Irrigation Management and Scheduling for Diverse Container-Grown Plants

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Abstract—Nurseries are looking at irrigation scheduling to help conserve water and solve environmental concerns regarding water quality and runoff. Irrigation scheduling increases the level of management for nurseries who grow a large number of diverse species. Nursery managers must consider irrigation efficiency, zone irrigation, and crop water requirements.

INTRODUCTION

Forest and conservation nurseries are expanding their product line to include a wider variety of plant species. These species are in demand for planting projects that involve new forest management strategies, riparian revegetation, wildlife habitat enhancement, and recreation and parks. Much of this expansion is with container-grown plants. Nurseries often select new plants that fit into their general mode of operation. This avoids drastic changes in facilities, specialized equipment, and additional capital. Nonetheless, increasing the number of diverse plant species grown will complicate cultural practices and management decisions.

Irrigation is more difficult when you increase the number of plants grown at the nursery. Overhead sprinklers are commonly used to apply water to large areas or zones. If only one plant species is located within a zone, then water can be applied to replace the amount used by the crop. Growers have found that certain plants need more water than others. When several diverse species are located within the same zone, water must be applied to satisfy the needs of the high water use plant. This extra amount of water can be over twice that required by the other plants causing root rot, excessive leaching, and increases surface runoff. This irrigation strategy requires a large supply of water. To comply with irrigation water runoff regulations Oregon nurseries have installed tail-water return systems.

Water supply and environmental issues regarding water quality are concerns of the nursery industries. Nursery managers have an obligation to use irrigation water efficiently. In addition, water costs are increasing and water use regulations are more restrictive. Good irrigation practices and management can conserve water and reduce runoff (Kabashima, 1993). This strategy is based on increasing the water application uniformity and irrigation scheduling.

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IRRIGATION EFFICIENCY

A major objective of sprinkler system design is to apply water uniformly. In practice, uniformity is never perfect. Distribution pattern efficiency is a measure on how uniformly water is applied to all the containers within an irrigated area (Regan, 1987). It can be estimated either on site using the can test, or by computer software. Good water distribution requires the correct nozzle size, system pressure, and sprinkler spacing. Wind disrupts application uniformity, especially when it is above 8 MPH. Low distribution pattern efficiency means that large dry areas exist. Additional irrigation water is applied to compensate for these dry areas resulting in increased use of water, over-watered areas, and excessive runoff.

With container nurseries, most the irrigation water applied through sprinklers is not stored in the root zone. Water stored in the root zone compared to the total amount of irrigation water applied is called the application efficiency and is very low due to water falling outside of the containers. Application efficiency in ornamental nurseries ranges between 15% to 25% (Beeson, 1991) and about 40% for traveling boom irrigated forest seedlings (Dumroese et al., 1991). The application efficiency is best when the plants are small and spaced can-tight, but decreases dramatically when the spacing between containers increases. Water shedding and water holding by dense plant canopies can further reduce application efficiency by preventing water from reaching the container medium surface.

CROP WATER REQUIREMENT

Crop water requirement is the amount of water needed to replace the water lost from evapotranspiration of a healthy crop. Water use of container-grown plants is strongly influenced by the climate, and by production practices and crop characteristics (Regan, 1991). Daily weather conditions effect the amount of water a plant will use. Most temperate zone plants use more water on hot, dry, and windy days. Variation in water use also exists within the major plant groups (conifer, deciduous, broadleaf evergreen) as well as between the groups (Burger et al., 1987). Crop coefficients are used to adjust irrigation to specific production practices and crop characteristics (Doorenbos and Pruitt, 1977). For example, plants use more water when their spacing is increased and less water is used after summer pruning.

Crop coefficients are different for each growth and development stage of a specific crop. Generally, as plants get larger they require more water (Knox, 1989). During crop establishment water use is low and rather constant. As the crop develops it is influenced by the type of shoot growth and dormancy. Plants that grow continuously (free-growth) tend to use more water than plants which have only one growth flush (fixed-growth). Plant growth rate also affects crop coefficients with fast growing species using more water (Roberts and Schnipke, 1987). Plant water use declines rapidly with the onset of dormancy and winter acclimation. Comparison of crop coefficients shows the relative difference in water use between plants or crops.

IRRIGATION SCHEDULING

Irrigation scheduling means applying only the amount of water that is needed, when it is needed. Most container growers irrigate on a daily basis and make adjustments based on crop appearance and time of year. The ideal way to schedule irrigations is by determining how much water the plants are using and then replenish it. This works well if plants with similar crop coefficients have been grouped under the same irrigation zone. Irrigation can then be scheduled for daily crop water use. If crop coefficients for each diverse species is unknown, past experience can be used to arrange plants by water use. Plants can be grouped into three general water use categories: high, moderate, and low. Each separate irrigation zone should only accommodate one of the water use categories. In addition, all plants within a zone should be at the same stage of production.

When to irrigate is based on the amount of water depleted from the container medium. Frequent irrigations (pulse or daily) that minimizes medium water depletion is considered best for plant growth and irrigation efficiency (Beeson, 1994; Karam et al., 1993). Nursery managers are likely to use container weight measurement to determine percent water depletion. They lift the container and judge the amount of water left in the container by how heavy it is. Moisture measuring technology has not advanced far enough to assist container nurseries. Containers that are allowed to dry down (below 50% medium water depletion) are very difficult to wet and cause plant stress. In dry containers, water tends to move along the sides of container with less chance of it being stored in the medium.

How much water to apply should be adjusted daily. A standard run time that delivers a specified amount of is budgeted for the weather conditions (temperature, wind, relative humidity, and sunshine) the previous day. This standard irrigation is based on crop water use for the average evapotranspiration at that time of year. This can be done by a irrigation controller operated by a trained irrigator, or by a computer. For example, if the standard amount of water to be applied is 0.4 inches, and yesterday was much cooler than normal, the irrigation budget for today might be 75% of the standard (0.3 inches). Container medium salinity is maintained by applying additional water to remove these excess salts. It is very important to evaluate how completely the available water is replenished following an irrigation.

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