BEST MANAGEMENT PRACTICES FOR CONTAINER-GROWN PLANTS

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Growing plants in containers is a unique production system compared to growing plants in field soil. Container plants are grown in substrates that contain a limited amount of water, retain small quantities of nutrients, and confine roots in a limited volume. Consequently, production inputs such as irrigation and fertilization require precise and properly timed applications in quantities that result in maximum benefit to the container plant production system. Thus, the opportunity exists to make sure the best possible management strategies or Best Management Practices (BMPs) are used, recognizing the site-specific nature of nursery production facilities. BMPs include operating procedures and practices to control site runoff which can result in the discharged of nutrients and pollutants to the waters of the State.

When preparing a nutrient management plan for an out-of-ground operation, a nutrient management consultant must conduct an Environmental Risk Assessment which is described in Section II-D of this manual. The purpose is to evaluate the potential risk to the environment of nutrient movement from these out-of-ground growing areas. If the potential risk is medium or high, BMPs shall be utilized to minimize risk. A selection made from the best management practices described below shall be recommended and utilized in accordance with their applicability to site conditions when required for reducing risk of nutrient movement. BMPs not listed here may also be used if they serve the same purpose to reduce risk.

This Guide includes two parts: Part 1 includes Container Irrigation Management Practices and Part 2 addresses Container Nutrition Management Practices. Under the subheadings in each part are specific best management practices that are marked with a bullet (*). These are meant as a supplement to the text and a quick guide to commonly used best management practices for container operations.

Part 1: Container Irrigation Management Practices

Introduction

Irrigation is a very important aspect of plant production since fertilizer and pesticide runoff are related to irrigation practices. Irrigation efficiency can be expressed relative to three aspects of water application:

1. uniformity of application;
2. amount of water retained within the substrate following irrigation; and
3. for overhead irrigation, the amount of water that enters containers compared to that which falls between containers. Irrigation application efficiency will be addressed relative to irrigation system design and management. While some irrigation systems are more efficient than others, it is important to realize that poor management of a relatively efficient system can greatly reduce or negate system efficiency and increase pollutant discharge to runoff or percolating waters.

Methods of Application

During the growing season most nurseries irrigate on a daily basis in which the daily water allotment is applied in a single application (continuously). An alternative to continuous irrigation is cyclic irrigation in which the daily water allotment is applied in more than one application with timed intervals between applications.

* Cyclic irrigation is used to decrease the amount of water and nutrients exiting the container.
* Periodically check the nozzle orifice for wear or plugging.
* Install a backflow prevention valve at the water source or pump
* Recycle nutrient-laden irrigation water used in subirrigation systems to prevent discharge of contaminants to the environment.

Irrigation Application Amount

* A substrate's absorption capacity is related to the pre-irrigation substrate water content. The wetter a substrate is, the less water it will hold, so adjust the daily irrigation volume according to the substrate water content in order to minimize leaching.

Irrigation Water Quality

Irrigation water quality is the most critical factor for production of container-grown nursery plants. Poor water quality applied with overhead irrigation can result in damage to foliage, change substrate pH, or result in unsightly foliar residues or stains.

Use of poor quality water in irrigation systems can clog mist nozzles and microirrigation emitters. Irrigation, fertilization, and pesticide efficacy are more easily managed when using good quality water. To ensure the use of water with desirable qualities, monitor the irrigation water constituents. Monitor water quality at least twice a year (summer and winter). However, more frequent monitoring is needed to alter production practices in response to changes in water quality.

Use of reclaimed water, runoff water, or recycled water may require some reconditioning since disease organisms, soluble salts, and traces of organic chemicals may be present. Water quality should be tested to ensure that the concentration of chemical constituents is acceptable for plant growth. If so, the risk of concentrating pollutants that may be discharged to surface or ground water is minimized.

* Monitor irrigation water quality to ensure pollutants are not discharged.

Management Strategies for Water Conservation

* Use rain shutoff devices to prevent irrigation system operation and minimize nutrient runoff.
* Collect irrigation and rain runoff and use for irrigation.
* Manage irrigation runoff to minimize the possibility of nutrient laden water polluting surface or ground waters.

Runoff Water Management

Erosion is the process by which the land surface is worn away by the action of water, wind, ice, or gravity. Water flowing over exposed soil picks up detached soil particles and debris that may possess chemicals harmful to receiving waters. As the velocity of flowing water increases, additional soil particles are detached and transported. Water flows have a tendency to concentrate, creating small channels and eventually gullies of varying widths and depths. Sedimentation is the process where soil particles settle out of suspension as the velocity of water decreases. The larger and heavier particles sand and gravel settle out more rapidly than fine silt and clay particles. It is difficult to totally eliminate the transportation of these fine particles even with the most effective erosion control program. Container nurseries are especially susceptible to erosion during times of new development and prior to filling empty container beds.

* Develop a plan for erosion and sediment control for each container nursery.
* Seed, sod, or stabilize in some manner newly constructed or barren areas to prevent erosion and sediment loss.
* Address unsuitable site-specific topographical characteristics before establishment of vegetation.
* Use temporary vegetation when bare areas will exist for 30 days or longer.
* Use permanent vegetative establishment to stabilize disturbed areas and reduce erosion and sediment loss.
* Use mulch to control erosion on disturbed land prior to vegetation establishment.
* Use erosion control blankets or netting to hold mulch in place as necessary during vegetation establishment.
* Use filter strips to prevent erosion.
* Use ground covers to provide a means of erosion and sediment control on slopes where mowing is not feasible or grass establishment is difficult.

Collection Basins

Use of collection basins may be a primary means of reducing water quality problems. The goal of each operation is to prevent irrigation water from leaving the property. Evaluation of each site will determine if collection basins are necessary or possible.

During the irrigation season, to the maximum extent practicable, all irrigation return flows should be recirculated with no discharge back to public waters. As a general rule, design newly constructed water collection and recycling facilities to accommodate the irrigation return flow. If irrigation return flow is used for another irrigation practice not associated with the container nursery, it is considered equivalent to recirculation, provided no discharge to public waters occurs.

Construct collection basins with clay-like materials with good sealing characteristics or line them with an acceptable membrane liner. Construct these basins with an emergency overflow to prevent dike damage in the event of overtopping. Basins or other structures must have all necessary state and local permits prior to construction. When rainwater is allowed to discharge from the property, it must be considered in the design of the water collection basin.

* Collection basins are a primary means for reducing the potential of chemical laden water leaving the container nursery site.
* If rainwater is discharged from the property, it must be considered in the design of the collection basin.
* Design collection basins to collect about 90% of the applied irrigation water.

Grassed Waterways

A grassed waterway is a natural or constructed channel; shaped or graded to required dimensions and established with suitable vegetation for the stable conveyance of runoff. This practice is used to reduce erosion in a concentrated flow area, such as in a gully or in temporary gullies. It is also used to reduce the amount of sediment and substances delivered to collection basins, nearby waterways or sensitive areas. Vegetation may act as a filter in removing some of the sediment delivered to the waterway, although this is not the primary function of a grassed waterway. Do not use grassed waterways as travel lanes. Maintain vegetation to prevent erosion and control runoff.

* Grassed waterways provide for the uniform movement of water resulting in reduced sediment and other substances delivered to collection basins.
* Do not use grassed waterways as travel lanes; maintain vegetation.
* Use lined waterways to direct concentrated flows of water to collection basins.
* Use lined waterways reduce erosion in concentrated flow areas.

Management of Stormwater

Stormwater runoff is water flowing over the land, during and immediately following a rainstorm. On-site storage of stormwater can reduce peak runoff rates, provide for settling and dissipation of pollutants, lower the probability of downstream flooding, stream erosion, and sedimentation, and provide water for other beneficial uses. Never discharge stormwater runoff into surface or ground waters. Route runoff over a longer distance, through grassed waterways, wetlands, vegetative buffers and other places designed to increase overland flow. These components increase infiltration and evaporation, allow suspended solids to settle, and remove potential pollutants before they are introduced to other water sources.

Whenever possible, construct the components of the stormwater management system on the contour following the topography. This will minimize erosion and stabilization problems caused by excessive velocities. It will also slow the runoff allowing for greater infiltration and filtering. If the components of stormwater are not constructed on the contour, the components must be stabilized to prevent erosion. Other methods to stabilize the components of stormwater management include tile outlet terraces and grade stabilization structures.

* Stormwater management minimizes erosion.
* Treat agricultural wastewater with wetlands designed and managed for that purpose.

Part 2: Container Nutrition Management Practices

Container Substrates

Many terms including soil, media, soilless media, medium, potting or container mixes, and substrates are used to describe potting materials for growing plants. However, many of these terms are imprecise or confusing. Container mixes or potting mixes imply that more than one component is used in potting and growing plants. The term "substrate" avoids much of the confusion of other terms and is descriptive of the entire composition. Substrate is the term used in Europe and most other parts of the world to describe the components of the root rhizosphere within containers.

* Choose components of container substrates that are best adapted to plants and management.
* Recommended physical characteristic values for nursery container substrates after irrigation and drainage are (% volume): Total porosity 50 to 85%; Air space 10 to 30%; Container capacity 45 to 65%; Available water content 25 to 35%; Unavailable water content 25 to 35%; and Bulk Density 0.19-0.70 g/cc. A substrate with a high proportion of coarse particles has a high air space and a relatively low water holding capacity. Consequently, leaching of pesticides and nutrients is likely to occur.
* Apply micronutrient amendments according to manufacturer's recommendations listed on the product label.

Fertilizer Applications

There are a number of acceptable methods to achieve fertilization of container-grown plants. During the growing season fertilization can be accomplished by one or more applications of a controlled-release fertilizer. One method is to apply a fertilizer solution through the irrigation system with the frequency of application dependent on nutrient concentration in the substrate solution. CAUTION: when fertilizer is injected in the overhead irrigation system, steps shall be taken to address the nutrient loading of the water leaving your property, because much of the water from overhead irrigation systems falls between containers. Fertilizing through irrigation water is appropriate for low-volume irrigation systems in which irrigation water is delivered to the container. Even then, care shall be taken to minimize leaching from the container to prevent nutrient laden runoff from entering surface or ground water.

* Apply fertilizer only when needed. Use a fertilizer nutrient ration of approximately 3:1:2, N:P2O5:K2O.

Controlled Release Fertilizer

Controlled-release fertilizers may supply essential plant nutrients for an extended period of time (months). Fertilizers are available that contain different mechanisms of nutrient release and different components.

* Amend the growth substrate prior to potting with controlled-release fertilizer rather than applying fertilizer to the substrate surface if containers are subject to blow over. Mix controlled-release fertilizers uniformly throughout the growth substrate.
* Do not broadcast fertilizer on spaced containers.
* Nutrients in the substrate solution can be leached regardless of the type of fertilizer applied, making irrigation management important.

Superphosphate

Phosphorus leaches rapidly from a soilless container substrate. Complete controlled-release fertilizers applied during the growing season should supply adequate phosphorus.

* Do not add superphosphate to the container substrate.

Application Rate

Controlled-release fertilizer application rates vary from product to product, but also depend on species and container size. The goal of a fertilizer program is to apply the least amount of fertilizer for the desired growth so that nutrient leaching is minimized.

* Apply controlled-release fertilizers at the manufacturer's recommended rate. Reapply fertilizer when substrate solution status is below desirable levels.
* Application rates for fall and winter (after first frost) or when using subirrigation, are usually one half the rates used in summer.

Supplemental Fertilization

* Accomplish supplemental fertilization or reapplication by injecting fertilizer into irrigation water or placing fertilizer on the surface of container substrate.
* If injection is used with overhead irrigation systems, runoff must be collected or steps taken to address nutrient loading of water leaving your property.

* Inject an individual element or a combination of elements in concentrations slightly less than desirable levels to be maintained in the growth substrate.
* Surface-applied fertilizer should be applied to small blocks or groups of plants, thus minimizing nutrient loss and nutrient loading of runoff water.
* Avoid broadcast fertilizer applications unless containers are jammed together.
* Record fertilizer product name and analysis, date and location applied, and general notes about plant and environmental conditions. Use past records for troubleshooting current problems.
* Group plants according to their fertilizer needs so supplemental fertilizer applications can be made only to plants requiring additional fertilizer. This is particularly important if fertilizer is injected in irrigation water.

Monitoring Container Substrate Nutrient Status

Environmental conditions influence the longevity of fertilizer release. Thus, to ensure adequate nutrient levels in the growth substrate, monitor the container substrate nutrient status and use the results to determine fertilizer reapplication frequency, ensuring that desired levels are maintained. Periodic monitoring is important because excessive or inadequate nutritional levels may not be expressed by visual symptoms, although growth is reduced. High concentrations of nutrients can result from substrate components, inadequate irrigation frequency and duration, water source, and/or fertilizer materials and application methods. Container substrate nutritional levels may also accumulate during the overwintering of plants in polyhouses. Excessive nutrient concentrations injure roots, ultimately restricting water and nutrient uptake. Conversely, rainfall and excessive irrigation can leach nutrients from the container substrate resulting in inadequate nutritional levels and threaten water quality.

Substrate used for long-term crops should be tested at least monthly, but biweekly monitoring during the summer may be necessary to track fluctuations in electrical conductivity (EC) which is used as a relative indicator of the nutritional status of the container substrate. Even when controlled-release fertilizers are used, substrate nutritional levels will gradually fall during the growing season to levels that may not support optimal growth.

High temperatures in overwintering structures can result in nutrient release from controlled-release fertilizers. Monitor substrate electrical conductivity two or three times during the winter to ensure levels are not toxic.

* During the growing season, monitor container substrates every 2-4 weeks.
* During the winter, monitor substrate electrical conductivity two or three times.
* Collect several representative substrate samples to ensure that samples represent the growth substrate being considered.

Interpretation of Substrate Extract Levels

Most fertilizers (except urea) are salts and when fertilizers are in solution they conduct electricity. Thus, the electrical conductivity of a substrate solution is indicative of the fertilizer level that is available to plant roots.

* Desirable container substrate electrical conductivity levels are 0.5 - 1.0 mmhos/cm for solution fertilizer only or the combined use of controlled-release and solution fertilizer. Desirable container substrate electrical conductivity levels are 0.2 to 0.5 mmhos/cm for the use of controlled-release fertilizer only. Ranges given in Table 1 correspond to most container-grown landscape plants; however, adjustments must be made for plants known to be sensitive to fertilizer additions.

* Plants with a low nutrient requirement may grow adequately with nutrient levels lower than those given in Table 1.

* Measure the irrigation water electrical conductivity. The irrigation water electrical conductivity will allow you to know the contribution of your water to the extracted liquid or leachate electrical conductivity and this should be considered when interpreting the substrate electrical conductivity.

Table 1.

Desirable nutritional levels to be maintained in the container substrate for plants with medium to high nutritional requirements. Levels are for the interpretation of the Virginia Tech Extraction Method when fertilizing with solution or liquid fertilizer alone or in combination with controlled-release (CR) fertilizer or using only controlled release-fertilizer.

	Recommended range	
Analysis	Solution only or Solution plus controlled release fertilizer	Controlled release fertilizer only
pH	5.0-6.0	5.0-6.0
Electrical conductivity, dS/m (mmhos/cm)	0.5-1.0	0.2-0.5
Nitrate-N (NO_3-N), mg/L (ppm)	50-100	15-25
Phosphorous (P), mg/L	10-15	5-10
Potassium (K), mg/L	30-50	10-20
Calcium (Ca), mg/L	20-40	20-40
Magnesium (Mg), mg/L	15-20	15-20
Manganese (Mn), mg/L	0.3	0.3
Iron (FE), mg/L	0.5	0.5
Zinc (Zn), mg/L	0.2	0.2
Copper (Cu), mg/L	0.02	0.02
Boron (B), mg/L	0.05	0.05

Levels should not drop below these during periods of active growth. Plants with low nutritional requirements may grow adequately with lower nutrient levels.