Control of Soilborne Pathogens in Containerized Ornamentals

Donald J. Merhaut
Monrovia Nursery Company, 18331 East Foothill Blvd., Azusa, California 91702-1385

The propagation and production of woody ornamental plants often involves the use of containers during part or all of the production life of the plants. Containers inevitably restrict the development of the root systems and expose the rhizosphere to environmental stresses that would normally not be encountered if the plants were grown in the ground. Secondly, the manipulation of shoot and root growth that sometimes occurs during plant production presents additional internal physiological stresses to the plant. All of these stresses weaken plants and make them more susceptible to attack by various pathogens and pests. Therefore, containerized plants must be treated differently so these stresses can be minimized or eliminated, thus reducing the likelihood of diseases.

The following is a general synopsis of plant growth and development and the challenges faced by growing plants in containers, with a strong emphasis on understanding whole plant growth, development, and physiology. This review is organized into three topics: (1) the basic physiology of plants and how different cultural practices affect the major metabolic pathways; (2) pathogens encountered in nursery production; and (3) cultural control practices that can minimize plant stress and reduce the incidence of pathogens and pests.

PHYSIOLOGICAL PROCESSES OF SHOOTS AND ROOTS

Decisions on container sizes, planting media, and cultural practices are often based on the immediate aesthetic quality of the plants. Although these qualities are essential for plant display and sale, the short- and long-term impact of cultural practices on the physiological processes (photosynthesis, respiration, transpiration, and nutrient/water uptake) should be carefully considered. It is the proper functioning of these metabolic pathways which ultimately determines the long-term health and survival of plants.

In general, container-grown plants are usually subjected to restricted and/or manipulated root and shoot growth. Root growth is challenged, not only by the size of the container, but also by the physical, chemical, and biological characteristics of the planting medium. Normal shoot growth is altered directly by pruning, spacing, and synthetic growth regulators, and indirectly by factors affecting normal root growth. Understanding the different physiological processes which occur in the roots and shoots will aide in making sound cultural decisions to ensure optimum health and survival of plants.

DISEASES AND PATHOGENS OF ROOT SYSTEMS

There are several types of diseases that can have a significant impact on the proper functioning of root systems. Some of the major diseases include: root dieback, roothair senescence, galls, root-knot nematodes, lesions, and vascular plugging. These diseases impact the functionality of roots in several ways. Some diseases

destroy the root tips and root hairs, directly reducing the ability of the roots to take up water and nutrients. Others, such as galls formed by nematodes or other pathogens, reduce the number and efficiency of roots. Finally, the ability of the root system to transport water and nutrients to the shoots can be impaired by vascular plugging, galls, and lesions caused by mechanical damage, fungi, bacteria, and viruses. There are many pathogens responsible for root senescence. Some of the major pathogens include: *Agrobacterium*, *Cylindrocladium*, *Fusarium*, *Phytophthora*, *Pythium*, *Rhizoctonia*, *Sclerotinia*, and *Verticillium*. While some of the organisms are very pathogenic, attacking even healthy plants, most pathogen-related root diseases can be reduced or prevented by growing healthy plants in nonstressed environments.

PLANT HEALTH PRACTICES

Producing disease-free plants can be achieved by keeping plants healthy throughout production, eliminating the source of pathogens, and providing an environment that is not favorable to the growth and spread of pathogens. Horticultural practices can be divided into four primary categories: water management, sanitation practices, nutrient management, and cultural practices.

Water Management. There are three factors to consider regarding water management: water quality, irrigation timing, and irrigation methods.

Water Quality. Water quality can influence plant health indirectly by the presence/absence of pathogens in the water and directly by the amount and type of fertilizer in the water. Pathogen contamination of water should be tested regularly. If pathogens are a problem, proper purification procedures should be implemented such as filtration and/or chemical treatments. Nutrient concentrations should also be monitored regularly. The proper nutrient concentration of water is dependent on the fertilization program of the nursery, the time of year being considered, the crop in question, and the climatic conditions. If the nursery relies more on mineral additions into the planting media, less fertilizer is required in the water. Fertilizer requirements are usually higher during the spring and summer, when plants are actively growing.

Irrigation Timing. Similar to water quality, time of irrigation directly and indirectly impacts plant health. Containerized plants should never be in a state of drought stress. Although, many xerophytic plants, in their native habitat, are adapted to long periods without water, these same plant species will often senesce if exposed to even short periods of drought. This is associated with the restricted root system and lush vegetative growth that often occur with containerized plants. Time of day for irrigation may also be critical to plant health. Many plants, which are susceptible to foliar diseases, will benefit from watering in the morning rather than in the evening, so that plant foliage can dry out before dark. Otherwise, the extended period of leaf wetness may allow certain pathogen spores to germinate and infect the plant.

Irrigation Methods. Overhead watering verses drip irrigation or similar ground irrigation methods will influence plant health and disease incidence. Plants susceptible to foliar pathogens usually benefit from drip irrigation. However, if plants are susceptible to heat stress and root systems are incapable of providing sufficient water, overhead irrigation can cool canopies and therefore prevent heat stress.

Sanitation Practices. Proper sanitation practices will reduce the incidence of pathogen infestations, minimizing the likelihood of introducing pests into the nursery, and/or providing a favorable environment for a pest/pathogen to grow and reproduce.

Plants and Materials. Plants used for propagation and production should be free of any pests or pathogens. Infected plants must be properly discarded if they cannot be properly cleaned. Also, plant material, if rooted, should have a well developed uniform root system. Any rooted plants or seedlings that have roots wrapped around the main stem should be thrown away, since these roots will girdle the main stem when the plant is older. In addition to plant quality, planting media and the water sources also should be free of pest and pathogens.

Propagation and Production. All regions of propagation and production should be clean. Any plant debris or areas of standing water will harbor pests and pathogens. Weeds should also be removed since they may play host to various insects and lower pathogens. A well established Integrated Pest Management Program (IPM) will directly and indirectly control the spread and establishment of many pests and diseases since many fungal and viral diseases are spread by insect feeding.

Nutrient Management. Plants grown with a sound nutritional program are stronger and more resistant to pests and pathogens. When designing a fertilization program, consideration should be given to fertilizer rates, fertilizer source, plant type, and time of year. If plants are over fertilized, not only is there a greater risk for nutrient toxicity, but there is also a potential risk to contamination of the environment. Secondly, it is critical that the fertilization program is balanced with regard to all the essential elements. Over fertilization with one element can often lead to nutrient deficiencies of other elements, such as over fertilization with magnesium inducing a calcium deficiency. In a similar manner, plants do not produce the same growth with all fertilizers, even though the fertilizer nutrient content may be the same. For example, nitrogen can be supplied from ammonium or nitrate sources. However, different growth will often result from these two nitrogen sources. There are also seasonal differences for plant nutrient requirements. In general, most plants, especially woody temperate species, require and take up more fertilizer during the spring and summer months. By autumn, the nutrient requirements of plants as well as their ability to take up nutrients are drastically reduced.

Cultural Practices. Several processes in the growth and production of plants will increase plant health and reduce the incidence of pest and pathogen infestations.

Bed Structure. Containerized plants should not be in direct contact with the ground, since this greatly increases the risk of pathogen movement from the ground to the container and from one container to another container. Containers can be elevated off of the ground with benches, gravel, etc. The use of gravel or benches will also reduce the spread of pest and pathogens caused by water splashing from the muddy ground. In addition to bed structure, container spacing can reduce plant stress. In the summer, plants that are "container-tight" will experience less root dieback caused by high container temperatures.

Planting Practices. When planting young liners into larger containers, careful consideration should be given to planting depth, since some plants are very susceptible to root rot caused by planting too deeply. Proper watering schedules are also important until new plants are established.

Plant Maintenance. As discussed earlier, proper pruning decisions must take into consideration the environmental conditions and all of the major physiological processes that are occurring in the whole plant. Similar considerations must be made when staking and tying plants. Placing stakes into containers will damage root systems. If possible, stakes should be placed in containers before the plants. Tying plants to stakes should be done carefully. Sufficient room should be left between the stake and the stem to allow expansion of the stem. If crops are long-term, ties should be replaced to prevent stem girdling.

CONCLUSIONS

The propagation and production of plants in containers exposes plants to many stresses that are not normally encountered in nature. This makes container-grown plants more susceptible to many diseases. Therefore, it is imperative that plant health is maintained by providing optimum water and nutrients and providing a stress-free environment. Secondly, the sources of plant pests and pathogens should be eliminated to reduce the likelihood of infection. Environmental conditions should also be adjusted to make conditions less favorable for pest and pathogen establishment. Finally, when making any horticultural decisions, the effects of cultural practices on whole-plant physiological processes should be taken into consideration.