Rooting Substrates©

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The blueprint for designing a substrate, whether it be for germinating seed, rooting cuttings, or finishing a crop, should focus on a balanced root environment. Simply stated, the root environment consists of physical, chemical, and biological properties. Interaction between these three properties forms a complex control over plant and root health.

These three properties interact with each other to provide a balanced and ideal environment to sustain and promote root development and create the foundation for the plant. If any of these properties are substandard, the overall health and performance of the root will be jeopardized. An ideal rooting medium must have sufficient air, easily available water, and good drainage.

This article will focus only on the physical aspects of the root environment, specifically aeration. Aeration can be defined as pore spaces that provide oxygen to the roots and allow roots to expel carbon dioxide. Insufficient air-filled pores increase stress on roots and the probability of poor root health. A properly designed rooting substrate becomes a precursor to a healthy and fully functional root system. This ideal environment creates a balance between water and nutrient uptake as well as gaseous exchange. The composition of a rooting medium has a dramatic effect on water and oxygen availability.

Physical properties, specifically particle size and stability of each component, create a network of macro- and micro-pores that provide a proper balance between oxygen and water. The macro pores freely drain off excessive water due to gravity, to provide pores for oxygen and CO_2 exchange. The micro-pores do not give up the water that freely and move water throughout the mix to provide a uniform moisture content. In designing a mix, it is very important to know the actual particle size before combining the components together. Mixing substandard components cannot be corrected once the mix has been put into production.

The physical properties of a substrate are the main factors which influence the quantity, as well as quality of roots initiated on the stem of a young cutting. A root, in the broadest sense, is to provide anchorage and stability to the plant. As a plant physiologist, I look beyond the main root and concentrate on specific areas that are the prime activity sites for water and nutrient uptake.

When I make a greenhouse call to examine a questionable root problem in progress, I elect to take a diagnostic approach and observe overall root development. The status of the basal roots, adventitious roots, root hairs, and the root cap are all good indicators of the air-to-water ratio of the rooting substrate. These are the working parts of the main root which all benefit significantly in the presence of oxygen.

Basal roots are found at the base of a rooted cutting which serve as the main framework for a developing root system. If the proper ratio of oxygen to moisture exists, callus forms at the base of the cutting and becomes the site for basal roots to initiate. The number of root initials that develop into root primordia is dictated by the presence of oxygen. Poinsettia cuttings are good indicators of basal root development in a rooting substrate. Under excessive moisture conditions with limited oxygen, the callus will be tan to brown in color and the number of root primordia will be greatly reduced. As the root system develops, the root surface contact area will be reduced due to less basal root development.

With many species of plants, adventitious roots on the stems of the cuttings are the main support for the plant at maturity. Without this stabilization, plants at the time of sales become top heavy and floppy, greatly reducing the quality of a finished plant. *Chrysanthemum* and *Aglaonema* are just a few of the species that show marked differences in adventitious root development when quantities of oxygen in the medium vary at the time of root initiation.

The degree of branching and lateral root production from the main root is another indicator as to how well your medium is working for you. Under saturated conditions, the main roots will be very thin and branching will be minimal. These very long and thin main roots are often referred to as water roots since they developed under less than optimal conditions.

The health and activity of a root system is also measured by the amount of fuzzy root hairs growing from the surface of the lateral roots. Root hairs can increase the soil contact surface area of a root system by twenty-fold. They extend so widely throughout the medium, that they make available, a supply of water and minerals that the plant could not otherwise obtain.

The root cap, that terminal portion of a young root that pushes forward through the substrate, protects the root from mechanical injury. Immediately behind the root cap is an area of rapid root elongation. It is this area that is also involved in the uptake of soil solution as well as gaseous exchange. Any type of water stress along with a poorly aerated medium, places the health of the root cap in jeopardy. Excessive water retention generally hinders root cap advancement and can lead to rotting of the root system.

A viable root system takes into account the status and health of all its working parts. A healthy and extensive root system can be attributed to an optimum water-to-air balance within the root environment.

In conclusion, grower experience has taught me that the rooting responses of various plant species may require different air-to-water ratios to enhance that species rooting ability. Keeping this in mind, it is advisable to initiate small trials to determine the appropriate substrate to complement your system.