Characterizing different horticultural substrates and growth containers

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Abstract

Substrates are natural or artificial materials where plant roots develop. Among the substrate properties (physical, chemical and biological) the physical properties are particularly important because they directly affect the relative proportion between air and water within the substrate. Particle size, which determines the density and porosity of the substrate, has a fundamental influence on the volume of air and water held by the substrate. For this reason, smaller containers require lower density substrates to avoid growth constraint of plant roots.

In addition to its physical properties, the fertility of a substrate also depends on how accessible the essential nutrients are made to plants. This depends on the chemical form in which nutrients are available and other chemical characteristics such as pH and cation exchange capacity (CEC) of the substrate. pH and CEC influence the movement of nutrients in solution making them more or less available to plants. The pH value, for example, is crucial because it strongly affects the availability of micronutrients. In addition, higher pH are associated with higher salinity in the water since mineral salts are alkaline. The value of electrical conductivity (EC) is indicative of the concentration of ionized salts in the substrate. However, plant species tolerance to salinity levels varies and so do the effects of pH and CEC.

The organic materials used in most substrates include peat, shredded bark, sawdust and coconut fibre, and materials of mineral origin such as vermiculite, perlite and pumice. The replacement of peat by bark, pumice, coconut fibre, vermiculite, perlite and rock wool by professional producers in the last decades is due to better performances of these materials for certain specific purposes. Other raw materials used in mixtures for substrates include: rice hulls (natural, carbonized or burned), polystyrene, sand, sub-products like wood fibre, composted household waste and remaining of pruning, humus, and mineral soil.

The increasing environmental limitations of peat exploitation boosted the demand for alternative materials to be used as substrate components. Among these, composted household wastes have often been tested in mixtures with peat and pine bark, in particular for the production of pot substrates. However, several problems have limited the widespread use of these household composts, among which the high values of EC, inadequate pH, presence of heavy metals, low porosity and lack of consistency between the different lots (large variation in physical and chemical properties depending on sources, manipulation, etc) of these materials.

Currently there are various types of substrate components, either of mineral or organic origin, natural or synthetic, whose characteristics differ markedly from natural soil. However, there is no consensus on a material or mixture of materials universally accepted as the substrate for all species and purposes. Thus, individual research for each species is required to identify the best substrate components, with the most appropriate physical and chemical characteristics for seed germination and plant growth. In this review the characteristics of the main substrates currently used in horticulture as well as the advantages and disadvantages of different container types are described.